11 Decision Making and Relevant Information

Learning Objectives

1. Use the five-step decision-making process to make decisions
2. Distinguish relevant from irrelevant information in decision situations
3. Explain the opportunity-cost concept and why it is used in decision making
4. Know how to choose which products to produce when there are capacity constraints
5. Discuss factors managers must consider when adding or dropping customers or segments
6. Explain why book value of equipment is irrelevant in equipment-replacement decisions
7. Explain how conflicts can arise between the decision model used by a manager and the performance-evaluation model used to evaluate the manager

How many decisions have you made today?

Maybe you made a big one, such as accepting a job offer. Or maybe your decision was as simple as settling on your plans for the weekend or choosing a restaurant for dinner. Regardless of whether decisions are significant or routine, most people follow a simple, logical process when making them. This process involves gathering information, making predictions, making a choice, acting on the choice, and evaluating results. It also includes deciding what costs and benefits each choice affords. Some costs are irrelevant. For example, once a coffee maker is purchased, its cost is irrelevant when deciding how much money a person saves each time he or she brews coffee at home versus buying it at Starbucks. The cost of the coffee maker was incurred in the past, and the money is spent and can't be recouped. This chapter will explain which costs and benefits are relevant and which are not—and how you should think of them when choosing among alternatives.

Relevant Costs, JetBlue, and Twitter[1]

What does it cost JetBlue to fly a customer on a round-trip flight from New York City to Nantucket? The incremental cost is very small, around $5 for beverages, because the other costs (the plane, pilots, ticket agents, fuel, airport landing fees, and baggage handlers) are fixed. Because most costs are fixed, would it be worthwhile for JetBlue to fill a seat provided it earns at least $5 for that seat? The answer depends on whether the flight is full.

Suppose JetBlue normally charges $330 for this round-trip ticket. If the flight is full, JetBlue would not sell the ticket for anything less than $330, because there are still customers willing to pay this fare for the flight. What if there are empty seats? Selling a ticket for something more than $5 is better than leaving the seat empty and earning nothing.

If a customer uses the Internet to purchase the ticket a month in advance, JetBlue will likely quote $330 because it expects the flight to be full. If, on the Monday before the scheduled Friday departure, JetBlue finds that the plane will not be full, the airline may be willing to lower its prices dramatically in hopes of attracting more customers and earning a profit on the unfilled seats.

[1] *Source*: Jones, Charisse. 2009. JetBlue and United give twitter a try to sell airline seats fast. *USA Today*, August 2. www.usatoday.com/travel/flights/2009-08-02-jetblue-united-twitter-airfares_N.htm

Enter Twitter. Like the e-mails that Jet Blue has sent out to customers for years, the widespread messaging service allows JetBlue to quickly connect with customers and fill seats on flights that might otherwise take off less than full. When JetBlue began promoting last-minute fare sales on Twitter in 2009 and Twitter-recipients learned that $330 round-trip tickets from New York City to Nantucket were available for just $18, the flights filled up quickly. JetBlue's Twitter fare sales usually last only eight hours, or until all available seats are sold. To use such a pricing strategy requires a deep understanding of costs in different decision situations.

Just like JetBlue, managers in corporations around the world use a decision process to help them make decisions. Managers at JPMorgan Chase gather information about financial markets, consumer preferences, and economic trends before determining whether to offer new services to customers. Macy's managers examine all the relevant information related to domestic and international clothing manufacturing before selecting vendors. Managers at Porsche gather cost information to decide whether to manufacture a component part or purchase it from a supplier. The decision process may not always be easy, but as Napoleon Bonaparte said, "Nothing is more difficult, and therefore more precious, than to be able to decide."

Learning Objective 1

Use the five-step decision-making process to make decisions

. . . the five steps are identify the problem and uncertainties; obtain information; make predictions about the future; make decisions by choosing among alternatives; and implement the decision, evaluate performance, and learn

Information and the Decision Process

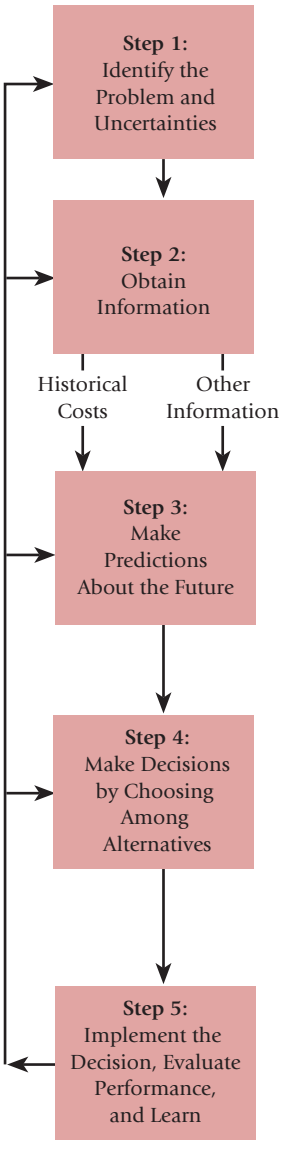
Managers usually follow a *decision model* for choosing among different courses of action. A **decision model** is a formal method of making a choice that often involves both quantitative and qualitative analyses. Management accountants analyze and present relevant data to guide managers' decisions.

Consider a strategic decision facing management at Precision Sporting Goods, a manufacturer of golf clubs: Should it reorganize its manufacturing operations to reduce manufacturing labor costs? Precision Sporting Goods has only two alternatives: Do not reorganize or reorganize.

Reorganization will eliminate all manual handling of materials. Current manufacturing labor consists of 20 workers—15 workers operate machines, and 5 workers handle materials. The 5 materials-handling workers have been hired on contracts that

Exhibit 11-1

Five-Step Decision-Making Process for Precision Sporting Goods



Should Precision Sporting Goods reorganize its manufacturing operations to reduce manufacturing labor costs? An important uncertainty is how the reorganization will affect employee morale.

Historical hourly wage rates are $14 per hour. However, a recently negotiated increase in employee benefits of $2 per hour will increase wages to $16 per hour. The reorganization of manufacturing operations is expected to reduce the number of workers from 20 to 15 by eliminating all 5 workers who handle materials. The reorganization is likely to have negative effects on employee morale.

Managers use information from Step 2 as a basis for predicting future manufacturing labor costs. Under the existing do-not-reorganize alternative, costs are predicted to be $640,000 (20 workers × 2,000 hours per worker per year × $16 per hour), and under the reorganize alternative, costs are predicted to be $480,000 (15 workers × 2,000 hours per worker per year ×$16 per hour). Recall, the reorganization is predicted to cost $90,000 per year.

Managers compare the predicted benefits calculated in Step 3 ($640,000 − $480,000 = $160,000—that is, savings from eliminating materials-handling labor costs, 5 workers × 2,000 hours per worker per year × $16 per hour = $160,000) against the cost of the reorganization ($90,000) along with other considerations (such as likely negative effects on employee morale). Management chooses the reorganize alternative because the financial benefits are significant and the effects on employee morale are expected to be temporary and relatively small.

Evaluating performance after the decision is implemented provides critical feedback for managers, and the five-step sequence is then repeated in whole or in part. Managers learn from actual results that the new manufacturing labor costs are $540,000, rather than the predicted $480,000, because of lower-than-expected manufacturing labor productivity. This (now) historical information can help managers make better subsequent predictions that allow for more learning time. Alternatively, managers may improve implementation via employee training and better supervision.

permit layoffs without additional payments. Each worker works 2,000 hours annually. Reorganization is predicted to cost $90,000 each year (mostly for new equipment leases). Production output of 25,000 units as well as the selling price of $250, the direct material cost per unit of $50, manufacturing overhead of $750,000, and marketing costs of $2,000,000 will be unaffected by the reorganization.

Decision Point

What is the five-step process that managers can use to make decisions?

Managers use the five-step decision-making process presented in Exhibit 11-1 and first introduced in Chapter 1 to make this decision. Study the sequence of steps in this exhibit and note how Step 5 evaluates performance to provide feedback about actions taken in the previous steps. This feedback might affect future predictions, the prediction methods used, the way choices are made, or the implementation of the decision.

The Concept of Relevance

Much of this chapter focuses on Step 4 in Exhibit 11-1 and on the concepts of relevant costs and relevant revenues when choosing among alternatives.

Relevant Costs and Relevant Revenues

Learning Objective 2

Distinguish relevant from irrelevant information in decision situations

. . . only costs and revenues that are expected to occur in the future and differ among alternative courses of action are relevant

Relevant costs are *expected future costs,* and **relevant revenues** are *expected future revenues* that differ among the alternative courses of action being considered. Revenues and costs that are *not relevant* are said to be *irrelevant*. It is important to recognize that to be relevant costs and relevant revenues they *must*:

- **Occur in the future**—every decision deals with selecting a course of action based on its expected future results.
- **Differ among the alternative courses of action**—costs and revenues that do not differ will not matter and, hence, will have no bearing on the decision being made.

The question is always, "What difference will an action make?"

Exhibit 11-2 presents the financial data underlying the choice between the do-not-reorganize and reorganize alternatives for Precision Sporting Goods. There are two ways to analyze the data. The first considers "All revenues and costs," while the second considers only "Relevant revenues and costs."

The first two columns describe the first way and present *all data*. The last two columns describe the second way and present *only relevant costs*—the $640,000 and $480,000 expected future manufacturing labor costs and the $90,000 expected future reorganization costs that differ between the two alternatives. The revenues, direct materials, manufacturing overhead, and marketing items can be ignored because they will remain the same whether or not Precision Sporting Goods reorganizes. They do not differ between the alternatives and, therefore, are irrelevant.

Note, the past (historical) manufacturing hourly wage rate of $14 and total past (historical) manufacturing labor costs of $560,000 (20 workers × 2,000 hours per worker per year × $14 per hour) do not appear in Exhibit 11-2. *Although they may be a useful basis for making informed predictions of the expected future manufacturing labor costs of $640,000 and $480,000, historical costs themselves are past costs that, therefore, are irrelevant to decision making.* Past costs are also called **sunk costs** because they are unavoidable and cannot be changed no matter what action is taken.

The analysis in Exhibit 11-2 indicates that reorganizing the manufacturing operations will increase predicted operating income by $70,000 each year. Note that the managers at Precision Sporting Goods reach the same conclusion whether they use all data or include only relevant data in the analysis. By confining the analysis to only the relevant data, managers

Exhibit 11-2 Determining Relevant Revenues and Relevant Costs for Precision Sporting Goods

	All Revenues and Costs		Relevant Revenues and Costs	
	Alternative 1: Do Not Reorganize	Alternative 2: Reorganize	Alternative 1: Do Not Reorganize	Alternative 2: Reorganize
Revenues[a]	$6,250,000	$6,250,000	—	—
Costs:				
Direct materials[b]	1,250,000	1,250,000	—	—
Manufacturing labor	640,000[c]	480,000[d]	$ 640,000[c]	$ 480,000[d]
Manufacturing overhead	750,000	750,000	—	—
Marketing	2,000,000	2,000,000	—	—
Reorganization costs	—	90,000	—	90,000
Total costs	4,640,000	4,570,000	640,000	570,000
Operating income	$1,610,000	$1,680,000	$(640,000)	$(570,000)
	$70,000 Difference		$70,000 Difference	

[a] 25,000 units × $250 per unit = $6,250,000
[b] 25,000 units × $50 per unit = $1,250,000
[c] 20 workers × 2,000 hours per worker × $16 per hour = $640,000
[d] 15 workers × 2,000 hours per worker × $16 per hour = $480,000

Exhibit 11-3 Key Features of Relevant Information

- Past (historical) costs may be helpful as a basis for making *predictions*. However, past costs themselves are always irrelevant when making *decisions*.
- Different alternatives can be compared by examining differences in expected total future revenues and expected total future costs.
- Not all expected future revenues and expected future costs are relevant. Expected future revenues and expected future costs that do not differ among alternatives are irrelevant and, hence, can be eliminated from the analysis. The key question is always, "What difference will an action make?"
- Appropriate weight must be given to qualitative factors and quantitative nonfinancial factors.

can clear away the clutter of potentially confusing irrelevant data. Focusing on the relevant data is especially helpful when all the information needed to prepare a detailed income statement is unavailable. Understanding which costs are relevant and which are irrelevant helps the decision maker concentrate on obtaining only the pertinent data and is more efficient.

Qualitative and Quantitative Relevant Information

Managers divide the outcomes of decisions into two broad categories: *quantitative* and *qualitative*. **Quantitative factors** are outcomes that are measured in numerical terms. Some quantitative factors are financial; they can be expressed in monetary terms. Examples include the cost of direct materials, direct manufacturing labor, and marketing. Other quantitative factors are nonfinancial; they can be measured numerically, but they are not expressed in monetary terms. Reduction in new product-development time and the percentage of on-time flight arrivals are examples of quantitative nonfinancial factors. **Qualitative factors** are outcomes that are difficult to measure accurately in numerical terms. Employee morale is an example.

Relevant-cost analysis generally emphasizes quantitative factors that can be expressed in financial terms. *But just because qualitative factors and quantitative nonfinancial factors cannot be measured easily in financial terms does not make them unimportant.* In fact, managers must wisely weigh these factors. In the Precision Sporting Goods example, managers carefully considered the negative effect on employee morale of laying-off materials-handling workers, a qualitative factor, before choosing the reorganize alternative. Comparing and trading off nonfinancial and financial considerations is seldom easy.

Exhibit 11-3 summarizes the key features of relevant information.

An Illustration of Relevance: Choosing Output Levels

The concept of relevance applies to all decision situations. In this and the following several sections of this chapter, we present some of these decision situations. Later chapters describe other decision situations that require application of the relevance concept, such as Chapter 12 on pricing, Chapter 16 on joint costs, Chapter 19 on quality and timeliness, Chapter 20 on inventory management and supplier evaluation, Chapter 21 on capital investment, and Chapter 22 on transfer pricing. We start by considering decisions that affect output levels such as whether to introduce a new product or to try to sell more units of an existing product.

One-Time-Only Special Orders

One type of decision that affects output levels is accepting or rejecting special orders when there is idle production capacity and the special orders have no long-run implications. We use the term **one-time-only special order** to describe these conditions.

Example 1: Surf Gear manufactures quality beach towels at its highly automated Burlington, North Carolina, plant. The plant has a production capacity

of 48,000 towels each month. Current monthly production is 30,000 towels. Retail department stores account for all existing sales. Expected results for the coming month (August) are shown in Exhibit 11-4. (These amounts are predictions based on past costs.) We assume all costs can be classified as either fixed or variable with respect to a single cost driver (units of output).

As a result of a strike at its existing towel supplier, Azelia, a luxury hotel chain, has offered to buy 5,000 towels from Surf Gear in August at $11 per towel. No subsequent sales to Azelia are anticipated. Fixed manufacturing costs are based on the 48,000-towel production capacity. That is, fixed manufacturing costs relate to the production capacity available and not the actual capacity used. If Surf Gear accepts the special order, it will use existing idle capacity to produce the 5,000 towels, and fixed manufacturing costs will not change. No marketing costs will be necessary for the 5,000-unit one-time-only special order. Accepting this special order is not expected to affect the selling price or the quantity of towels sold to regular customers. Should Surf Gear accept Azelia's offer?

Exhibit 11-4 presents data for this example on an absorption-costing basis (that is, both variable and fixed manufacturing costs are included in inventoriable costs and cost of goods sold). In this exhibit, the manufacturing cost of $12 per unit and the marketing cost of $7 per unit include both variable and fixed costs. The sum of all costs (variable and fixed) in a particular business function of the value chain, such as manufacturing costs or marketing costs, are called **business function costs. Full costs of the product**, in this case $19 per unit, are the sum of all variable and fixed costs in all business functions of the value chain (R&D, design, production, marketing, distribution, and customer service). For Surf Gear, full costs of the product consist of costs in manufacturing and marketing because these are the only business functions. No marketing costs are necessary for the special order, so the manager of Surf Gear will focus

Exhibit 11-4

Budgeted Income Statement for August, Absorption-Costing Format for Surf Gear[a]

Home | Insert | Page Layout | Formulas | Data | Review | View

	A	B	C	D
1		**Total**	**Per Unit**	
2	Units sold	30,000		
3				
4	Revenues	$600,000	$20.00	
5	Cost of goods sold (manufacturing costs)			
6	Variable manufacturing costs	225,000	7.50[b]	
7	Fixed manufacturing costs	135,000	4.50[c]	
8	Total cost of goods sold	360,000	12.00	
9	Marketing costs			
10	Variable marketing costs	150,000	5.00	
11	Fixed marketing costs	60,000	2.00	
12	Total marketing costs	210,000	7.00	
13	Full costs of the product	570,000	19.00	
14	Operating income	$ 30,000	$ 1.00	
15				
16	[a]Surf Gear incurs no R&D, product-design, distribution, or customer-service costs			
17	[b]Variable manufacturing cost per unit	= Direct material cost per unit + Variable direct manufacturing labor cost per unit + Variable manufacturing overhead cost per unit		
18				
19		= $6.00 + $0.50 + $1.00 = $7.50		
20	[c]Fixed manufacturing cost per unit	= Fixed direct manufacturing labor cost per unit + Fixed manufacturing overhead cost per unit		
21				
22		= $1.50 + $3.00 = $4.50		

only on manufacturing costs. Based on the manufacturing cost per unit of $12—which is greater than the $11-per-unit price offered by Azelia—the manager might decide to reject the offer.

Exhibit 11-5 separates manufacturing and marketing costs into their variable- and fixed-cost components and presents data in the format of a contribution income statement. The relevant revenues and costs are the expected future revenues and costs that differ as a result of accepting the special offer—revenues of $55,000 ($11 per unit × 5,000 units) and variable manufacturing costs of $37,500 ($7.50 per unit × 5,000 units). The fixed manufacturing costs and all marketing costs (*including variable marketing costs*) are irrelevant in this case because these costs will not change in total whether the special order is accepted or rejected. Surf Gear would gain an additional $17,500 (relevant revenues, $55,000 – relevant costs, $37,500) in operating income by accepting the special order. In this example, comparing total amounts for 30,000 units versus 35,000 units or focusing only on the relevant amounts in the difference column in Exhibit 11-5 avoids a misleading implication—the implication that would result from comparing the $11-per-unit selling price against the manufacturing cost per unit of $12 (Exhibit 11-4), which includes both variable and fixed manufacturing costs.

The assumption of no long-run or strategic implications is crucial to management's analysis of the one-time-only special-order decision. Suppose Surf Gear concludes that the retail department stores (its regular customers) will demand a lower price if it sells towels at $11 apiece to Azelia. In this case, revenues from regular customers will be relevant. Why? Because the future revenues from regular customers will differ depending on whether the special order is accepted or rejected. The relevant-revenue and relevant-cost analysis of the Azelia order would have to be modified to consider both the short-run benefits from accepting the order and the long-run consequences on profitability if prices were lowered to all regular customers.

Exhibit 11-5

One-Time-Only Special-Order Decision for Surf Gear: Comparative Contribution Income Statements

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	A	B	C	D	E	F	G	H
1		Without the Special Order				With the Special Order		Difference: Relevant Amounts
2		30,000				35,000		for the
3		Units to be Sold				Units to be Sold		5,000
4		Per Unit		Total		Total		Units Special Order
5		(1)		(2) = (1) × 30,000		(3)		(4) = (3) – (2)
6	Revenues	$20.00		$600,000		$655,000		$55,000[a]
7	Variable costs:							
8	Manufacturing	7.50		225,000		262,500		37,500[b]
9	Marketing	5.00		150,000		150,000		0[c]
10	Total variable costs	12.50		375,000		412,500		37,500
11	Contribution margin	7.50		225,000		242,500		17,500
12	Fixed costs:							
13	Manufacturing	4.50		135,000		135,000		0[d]
14	Marketing	2.00		60,000		60,000		0[d]
15	Total fixed costs	6.50		195,000		195,000		0
16	Operating income	$ 1.00		$ 30,000		$ 47,500		$17,500
17								
18	[a]5,000 units × $11.00 per unit = $55,000.							
19	[b]5,000 units × $7.50 per unit = $37,500.							
20	[c]No variable marketing costs would be incurred for the 5,000-unit one-time-only special order.							
21	[d]Fixed manufacturing costs and fixed marketing costs would be unaffected by the special order.							

Potential Problems in Relevant-Cost Analysis

Managers should avoid two potential problems in relevant-cost analysis. First, they must watch for incorrect general assumptions, such as all variable costs are relevant and all fixed costs are irrelevant. In the Surf Gear example, the variable marketing cost of $5 per unit is irrelevant because Surf Gear will incur no extra marketing costs by accepting the special order. But fixed manufacturing costs could be relevant. The extra production of 5,000 towels per month does not affect fixed manufacturing costs because we assumed that the relevant range is from 30,000 to 48,000 towels per month. In some cases, however, producing the extra 5,000 towels might increase fixed manufacturing costs. Suppose Surf Gear would need to run three shifts of 16,000 towels per shift to achieve full capacity of 48,000 towels per month. Increasing the monthly production from 30,000 to 35,000 would require a partial third shift because two shifts could produce only 32,000 towels. The extra shift would increase fixed manufacturing costs, thereby making these additional fixed manufacturing costs relevant for this decision.

Second, unit-cost data can potentially mislead decision makers in two ways:

1. **When irrelevant costs are included.** Consider the $4.50 of fixed manufacturing cost per unit (direct manufacturing labor, $1.50 per unit, plus manufacturing overhead, $3.00 per unit) included in the $12-per-unit manufacturing cost in the one-time-only special-order decision (see Exhibits 11-4 and 11-5). This $4.50-per-unit cost is irrelevant, given the assumptions in our example, so it should be excluded.
2. **When the same unit costs are used at different output levels.** Generally, managers use total costs rather than unit costs because total costs are easier to work with and reduce the chance for erroneous conclusions. Then, if desired, the total costs can be unitized. In the Surf Gear example, total fixed manufacturing costs remain at $135,000 even if Surf Gear accepts the special order and produces 35,000 towels. Including the fixed manufacturing cost per unit of $4.50 as a cost of the special order would lead to the erroneous conclusion that total fixed manufacturing costs would increase to $157,500 ($4.50 per towel × 35,000 towels).

The best way for managers to avoid these two potential problems is to keep focusing on (1) total revenues and total costs (rather than unit revenue and unit cost) and (2) the relevance concept. Managers should always require all items included in an analysis to be expected total future revenues and expected total future costs that differ among the alternatives.

Decision Point

When is a revenue or cost item relevant for a particular decision and what potential problems should be avoided in relevant cost analysis?

Insourcing-versus-Outsourcing and Make-versus-Buy Decisions

We now apply the concept of relevance to another strategic decision: whether a company should make a component part or buy it from a supplier. We again assume idle capacity.

Learning Objective 3

Explain the opportunity-cost concept and why it is used in decision making

. . . in all decisions, it is important to consider the contribution to income forgone by choosing a particular alternative and rejecting others

Outsourcing and Idle Facilities

Outsourcing is purchasing goods and services from outside vendors rather than producing the same goods or providing the same services within the organization, which is **insourcing**. For example, Kodak prefers to manufacture its own film (insourcing) but has IBM do its data processing (outsourcing). Honda relies on outside vendors to supply some component parts but chooses to manufacture other parts internally.

Decisions about whether a producer of goods or services will insource or outsource are also called **make-or-buy decisions**. Surveys of companies indicate that managers consider quality, dependability of suppliers, and costs as the most important factors in the make-or-buy decision. Sometimes, however, qualitative factors dominate management's make-or-buy decision. For example, Dell Computer buys the Pentium chip for its personal computers from Intel because Dell does not have the know-how and technology to make

the chip itself. In contrast, to maintain the secrecy of its formula, Coca-Cola does not outsource the manufacture of its concentrate.

Example 2: The Soho Company manufactures a two-in-one video system consisting of a DVD player and a digital media receiver (that downloads movies and video from internet sites such as NetFlix). Columns 1 and 2 of the following table show the expected total and per-unit costs for manufacturing the DVD-player of the video system. Soho plans to manufacture the 250,000 units in 2,000 batches of 125 units each. Variable batch-level costs of $625 per batch vary with the number of batches, not the total number of units produced.

	Expected Total Costs of Producing 250,000 Units in 2,000 Batches Next Year (1)	Expected Cost per Unit (2) = (1) ÷ 250,000
Direct materials ($36 per unit × 250,000 units)	$ 9,000,000	$36.00
Direct manufacturing labor ($10 per unit × 250,000 units)	2,500,000	10.00
Variable manufacturing overhead costs of power and utilities ($6 per unit × 250,000 units)	1,500,000	6.00
Mixed (variable and fixed) batch-level manufacturing overhead costs of materials handling and setup [$750,000 + ($625 per batch × 2,000 batches)]	2,000,000	8.00
Fixed manufacturing overhead costs of plant lease, insurance, and administration	3,000,000	12.00
Total manufacturing cost	$18,000,000	$72.00

Broadfield, Inc., a manufacturer of DVD players, offers to sell Soho 250,000 DVD players next year for $64 per unit on Soho's preferred delivery schedule. Assume that financial factors will be the basis of this make-or-buy decision. Should Soho make or buy the DVD player?

Columns 1 and 2 of the preceding table indicate the expected total costs and expected cost per unit of producing 250,000 DVD players next year. The expected manufacturing cost per unit for next year is $72. At first glance, it appears that the company should buy DVD players because the expected $72-per-unit cost of making the DVD player is more than the $64 per unit to buy it. But a make-or-buy decision is rarely obvious. To make a decision, management needs to answer the question, "What is the difference in relevant costs between the alternatives?"

For the moment, suppose (a) the capacity now used to make the DVD players will become idle next year if the DVD players are purchased and (b) the $3,000,000 of fixed manufacturing overhead will continue to be incurred next year regardless of the decision made. Assume the $750,000 in fixed salaries to support materials handling and setup will not be incurred if the manufacture of DVD players is completely shut down.

Exhibit 11-6 presents the relevant-cost computations. Note that Soho will *save* $1,000,000 by making DVD players rather than buying them from Broadfield. Making DVD players is the preferred alternative.

Note how the key concepts of relevance presented in Exhibit 11-3 apply here:

- Exhibit 11-6 compares differences in expected total future revenues and expected total future costs. Past costs are always irrelevant when making decisions.
- Exhibit 11-6 shows $2,000,000 of future materials-handling and setup costs under the make alternative but not under the buy alternative. Why? Because buying DVD players and not manufacturing them will save $2,000,000 in future variable costs per batch and avoidable fixed costs. The $2,000,000 represents future costs that differ between the alternatives and so is relevant to the make-or-buy decision.

Exhibit 11-6

Relevant (Incremental) Items for Make-or-Buy Decision for DVD Players at Soho Company

Relevant Items	Total Relevant Costs		Relevant Cost Per Unit	
	Make	Buy	Make	Buy
Outside purchase of parts ($64 × 250,000 units)		$16,000,000		$64
Direct materials	$ 9,000,000		$36	
Direct manufacturing labor	2,500,000		10	
Variable manufacturing overhead	1,500,000		6	
Mixed (variable and fixed) materials-handling and setup overhead	2,000,000		8	
Total relevant costs[a]	$15,000,000	$16,000,000	$58	$64
Difference in favor of making DVD players	$1,000,000		$4	

[a]The $3,000,000 of plant-lease, plant-insurance, and plant-administration costs could be included under both alternatives. Conceptually, they do not belong in a listing of relevant costs because these costs are irrelevant to the decision. Practically, some managers may want to include them in order to list all costs that will be incurred under each alternative.

- Exhibit 11-6 excludes the $3,000,000 of plant-lease, insurance, and administration costs under both alternatives. Why? Because these future costs will not differ between the alternatives, so they are irrelevant.

A common term in decision making is *incremental cost*. An **incremental cost** is the additional total cost incurred for an activity. In Exhibit 11-6, the incremental cost of making DVD players is the additional total cost of $15,000,000 that Soho will incur if it decides to make DVD players. The $3,000,000 of fixed manufacturing overhead is not an incremental cost because Soho will incur these costs whether or not it makes DVD players. Similarly, the incremental cost of buying DVD players from Broadfield is the additional total cost of $16,000,000 that Soho will incur if it decides to buy DVD players. A **differential cost** is the difference in total cost between two alternatives. In Exhibit 11-6, the differential cost between the make-DVD-players and buy-DVD-players alternatives is $1,000,000 ($16,000,000 – $15,000,000). Note that *incremental cost* and *differential cost* are sometimes used interchangeably in practice. When faced with these terms, always be sure to clarify what they mean.

We define *incremental revenue* and *differential revenue* similarly to incremental cost and differential cost. **Incremental revenue** is the additional total revenue from an activity. **Differential revenue** is the difference in total revenue between two alternatives.

Strategic and Qualitative Factors

Strategic and qualitative factors affect outsourcing decisions. For example, Soho may prefer to manufacture DVD players in-house to retain control over the design, quality, reliability, and delivery schedules of the DVD players it uses in its video-systems. Conversely, despite the cost advantages documented in Exhibit 11-6, Soho may prefer to outsource, become a leaner organization, and focus on areas of its core competencies—the manufacture and sale of video systems. As an example of focus, advertising companies, such as J. Walter Thompson, only do the creative and planning aspects of advertising (their core competencies), and outsource production activities, such as film, photographs, and illustrations.

Outsourcing is not without risks. As a company's dependence on its suppliers increases, suppliers could increase prices and let quality and delivery performance slip. To minimize these risks, companies generally enter into long-run contracts specifying costs, quality, and delivery schedules with their suppliers. Intelligent managers build close partnerships or alliances with a few key suppliers. Toyota goes so far as to send its own engineers to improve suppliers' processes. Suppliers of companies such as Ford, Hyundai, Panasonic, and Sony have researched and developed innovative products, met demands for increased quantities, maintained quality and on-time delivery, and lowered costs—actions that the companies themselves would not have had the competencies to achieve.

Concepts in Action

Pringles Prints and the Offshoring of Innovation

According to a recent survey, 67% of U.S. companies are engaged in the rapidly-evolving process of "offshoring," which is the outsourcing of business processes and jobs to other countries. Offshoring was initially popular with companies because it yielded immediate labor-cost savings for activities such as software development, call centers, and technical support.

While the practice remains popular today, offshoring has transformed from lowering costs on back-office processes to accessing global talent for innovation. With global markets expanding and domestic talent scarce, companies are now hiring qualified engineers, scientists, inventors, and analysts all over the world for research and development (R&D), new product development (NPD), engineering, and knowledge services.

Innovation Offshoring Services

R&D	NPD	Engineering	Knowledge Services
■ Programming	■ Prototype design	■ Testing	■ Market analysis
■ Code development	■ Product development	■ Reengineering	■ Credit analysis
■ New technologies	■ Systems design	■ Drafting/modeling	■ Data mining
■ New materials/ process research	■ Support services	■ Embedded systems development	■ Forecasting ■ Risk management

By utilizing offshoring innovation, companies not only continue to reduce labor costs, but cut back-office costs as well. Companies also obtain local market knowledge and access to global best practices in many important areas.

Some companies are leveraging offshore resources by creating global innovation networks. Procter & Gamble (P&G), for instance, established "Connect and Develop," a multi-national effort to create and leverage innovative ideas for product development. When the company wanted to create a new line of Pringles potato chips with pictures and words—trivia questions, animal facts, and jokes—printed on each chip, the company turned to offshore innovation.

Rather than trying to invent the technology required to print images on potato chips in-house, Procter & Gamble created a technology brief that defined the problems it needed to solve, and circulated it throughout the company's global innovation network for possible solutions. As a result, P&G discovered a small bakery in Bologna, Italy, run by a university professor who also manufactured baking equipment. He had invented an ink-jet method for printing edible images on cakes and cookies, which the company quickly adapted for potato chips.

As a result, Pringles Prints were developed in less than a year—as opposed to a more traditional two year process—and immediately led to double-digit product growth.

Sources: Cuoto, Vinay, Mahadeva Mani, Vikas Sehgal, Arie Lewin, Stephan Manning, and Jeff Russell. 2007. *Offshoring 2.0: Contracting knowledge and innovation to expand global capabilities*. Duke University Offshoring Research Network: Durham, NC. Heijmen, Ton, Arie Lewin, Stephan Manning, Nidthida Prem-Ajchariyawong, and Jeff Russell. 2008. *Offshoring reaches the c-suite*. Duke University Offshoring Research Network: Durham, NC. Huston, Larry and Nabil Sakkab. 2006. Connect and develop: Inside Procter & Gamble's new model for innovation. *Harvard Business Review,* March.

Outsourcing decisions invariably have a long-run horizon in which the financial costs and benefits of outsourcing become more uncertain. Almost always, strategic and qualitative factors such as the ones described here become important determinants of the outsourcing decision. Weighing all these factors requires the exercise of considerable management judgment and care.

International Outsourcing

What additional factors would Soho have to consider if the supplier of DVD players was based in Mexico? The most important would be exchange-rate risk. Suppose the Mexican supplier offers to sell Soho 250,000 DVD players for 192,000,000 Pesos. Should Soho make or buy? The answer depends on the exchange rate that Soho expects next year. If Soho forecasts an exchange rate of 12 Pesos per $1, Soho's expected purchase cost equals

$16,000,000 (192,000,000 Pesos/12 Pesos per $) greater than the $15,000,000 relevant costs for making the DVD players in Exhibit 11-6, so Soho would prefer to make DVD players rather than buy them. If, however, Soho anticipates an exchange rate of 13.50 Pesos per $1, Soho's expected purchase cost equals $14,222,222 (192,000,000 Pesos/13.50 Pesos per $), which is less than the $15,000,000 relevant costs for making the DVD players, so Soho would prefer to buy rather than make the DVD players.

Another option is for Soho to enter into a forward contract to purchase 192,000,000 Pesos. A forward contract allows Soho to contract today to purchase pesos next year at a predetermined, fixed cost, thereby protecting itself against exchange rate risk. If Soho decides to go this route, it would make (buy) DVD players if the cost of the contract is greater (less) than $15,000,000. International outsourcing requires companies to evaluate exchange rate risks and to implement strategies and costs for managing them. The Concepts in Action feature (p. 400) describes *offshoring*—the practice of outsourcing services to lower-cost countries.

Opportunity Costs and Outsourcing

In the simple make-or-buy decision in Exhibit 11-6, we assumed that the capacity currently used to make DVD players will remain idle if Soho purchases the parts from Broadfield. Often, however, the released capacity can be used for other, profitable purposes. In this case, the choice Soho's managers are faced with is not whether to make or buy; the choice now centers on how best to use available production capacity.

Example 3: Suppose that if Soho decides to buy DVD players for its video systems from Broadfield, then Soho's best use of the capacity that becomes available is to produce 100,000 Digiteks, a portable, stand-alone DVD player. From a manufacturing standpoint, Digiteks are similar to DVD players made for the video system. With help from operating managers, Soho's management accountant estimates the following future revenues and costs if Soho decides to manufacture and sell Digiteks:

Incremental future revenues		$8,000,000
Incremental future costs		
Direct materials	$3,400,000	
Direct manufacturing labor	1,000,000	
Variable overhead (such as power, utilities)	600,000	
Materials-handling and setup overheads	500,000	
Total incremental future costs		5,500,000
Incremental future operating income		$2,500,000

Because of capacity constraints, Soho can make either DVD players for its video-system unit or Digiteks, but not both. Which of the following two alternatives should Soho choose?

1. Make video-system DVD players and do not make Digiteks
2. Buy video-system DVD players and make Digiteks

Exhibit 11-7, Panel A, summarizes the "total-alternatives" approach—the future costs and revenues for *all* products. Alternative 2, buying video-system DVD players and using the available capacity to make and sell Digiteks, is the preferred alternative. The future incremental costs of buying video-system DVD players from an outside supplier ($16,000,000) exceed the future incremental costs of making video-system DVD players in-house ($15,000,000). Soho can use the capacity freed up by buying video-system DVD players to gain $2,500,000 in operating income (incremental future revenues of $8,000,000 minus total incremental future costs of $5,500,000) by making and selling Digiteks. The *net relevant* costs of buying video-system DVD players and making and selling Digiteks are $16,000,000 – $2,500,000 = $13,500,000.

Exhibit 11-7 Total-Alternatives Approach and Opportunity-Cost Approach to Make-or-Buy Decisions for Soho Company

Relevant Items	Alternatives for Soho: 1. Make Video-System DVD Players and Do Not Make Digitek	Alternatives for Soho: 2. Buy Video-System DVD Players and Make Digitek
PANEL A Total-Alternatives Approach to Make-or-Buy Decisions		
Total incremental future costs of making/buying video-system DVD players (from Exhibit 11-6)	$15,000,000	$16,000,000
Deduct excess of future revenues over future costs from Digitek	0	(2,500,000)
Total relevant costs under total-alternatives approach	$15,000,000	$13,500,000
	1. Make Video-System DVD Players	**2. Buy Video-System DVD Players**
PANEL B Opportunity-Cost Approach to Make-or-Buy Decisions		
Total incremental future costs of making/buying video-system DVD players (from Exhibit 11-6)	$15,000,000	$16,000,000
Opportunity cost: Profit contribution forgone because capacity will not be used to make Digitek, the next-best alternative	2,500,000	0
Total relevant costs under opportunity-cost approach	$17,500,000	$16,000,000

Note that the differences in costs across the columns in Panels A and B are the same: The cost of alternative 3 is $1,500,000 less than the cost of alternative 1, and $2,500,000 less than the cost of alternative 2.

The Opportunity-Cost Approach

Deciding to use a resource in a particular way causes a manager to forgo the opportunity to use the resource in alternative ways. This lost opportunity is a cost that the manager must consider when making a decision. **Opportunity cost** is the contribution to operating income that is forgone by not using a limited resource in its next-best alternative use. For example, the (relevant) cost of going to school for an MBA degree is not only the cost of tuition, books, lodging, and food, but also the income sacrificed (opportunity cost) by not working. Presumably, the estimated future benefits of obtaining an MBA (for example, a higher-paying career) will exceed these costs.

Exhibit 11-7, Panel B, displays the opportunity-cost approach for analyzing the alternatives faced by Soho. *Note that the alternatives are defined differently in the total alternatives approach (1. Make Video-System DVD Players and Do Not Make Digiteks and 2. Buy Video-System DVD Players and Make Digiteks) and the opportunity cost approach (1. Make Video-System DVD Players and 2. Buy Video-System DVD Players), which does not reference Digiteks. Under the opportunity-cost approach, the cost of each alternative includes (1) the incremental costs and (2) the opportunity cost, the profit forgone from not making Digiteks. This opportunity cost arises because Digitek is excluded from formal consideration in the alternatives.*

Consider alternative 1, making video-system DVD players. What are all the costs of making video-system DVD players? Certainly Soho will incur $15,000,000 of incremental costs to make video-system DVD players, but is this the entire cost? No, because by deciding to use limited manufacturing resources to make video-system DVD players, Soho will give up the opportunity to earn $2,500,000 by not using these resources to make Digiteks. Therefore, the relevant costs of making video-system DVD players are the incremental costs of $15,000,000 plus the opportunity cost of $2,500,000.

Next, consider alternative 2, buy video-system DVD players. The incremental cost of buying video-system DVD players will be $16,000,000. The opportunity cost is zero.

Why? Because by choosing this alternative, Soho will not forgo the profit it can earn from making and selling Digiteks.

Panel B leads management to the same conclusion as Panel A: buying video-system DVD players and making Digiteks is the preferred alternative.

Panels A and B of Exhibit 11-7 describe two consistent approaches to decision making with capacity constraints. The total-alternatives approach in Panel A includes all future incremental costs and revenues. For example, under alternative 2, the additional future operating income from *using capacity to make and sell Digiteks* ($2,500,000) is subtracted from the future incremental cost of buying video-system DVD players ($16,000,000). The opportunity-cost analysis in Panel B takes the opposite approach. It focuses only on video-system DVD players. *Whenever capacity is not going to be used to make and sell Digiteks* the future forgone operating income is added as an opportunity cost of making video-system DVD players, as in alternative 1. (Note that when Digiteks are made, as in alternative 2, there is no "opportunity cost of not making Digiteks.") Therefore, whereas Panel A *subtracts* $2,500,000 under alternative 2, Panel B *adds* $2,500,000 under alternative 1. *Panel B highlights the idea that when capacity is constrained, the relevant revenues and costs of any alternative equal (1) the incremental future revenues and costs plus (2) the opportunity cost.* However, when more than two alternatives are being considered simultaneously, it is generally easier to use the total-alternatives approach.

Opportunity costs are not recorded in financial accounting systems. Why? Because historical record keeping is limited to transactions involving alternatives that were *actually selected*, rather than alternatives that were rejected. Rejected alternatives do not produce transactions and so they are not recorded. If Soho makes video-system DVD players, it will not make Digiteks, and it will not record any accounting entries for Digiteks. Yet the opportunity cost of making video-system DVD players, which equals the operating income that Soho forgoes by not making Digiteks, is a crucial input into the make-or-buy decision. Consider again Exhibit 11-7, Panel B. On the basis of only the incremental costs that are systematically recorded in accounting systems, it is less costly for Soho to make rather than buy video-system DVD players. Recognizing the opportunity cost of $2,500,000 leads to a different conclusion: Buying video-system DVD players is preferable.

Suppose Soho has sufficient capacity to make Digiteks even if it makes video-system DVD players. In this case, the opportunity cost of making video-system DVD players is $0 because Soho does not give up the $2,500,000 operating income from making Digiteks even if it chooses to make video-system DVD players. The relevant costs are $15,000,000 (incremental costs of $15,000,000 plus opportunity cost of $0). Under these conditions, Soho would prefer to make video-system DVD players, rather than buy them, and also make Digiteks.

Besides quantitative considerations, the make-or-buy decision should also consider strategic and qualitative factors. If Soho decides to buy video-system DVD players from an outside supplier, it should consider factors such as the supplier's reputation for quality and timely delivery. Soho would also want to consider the strategic consequences of selling Digiteks. For example, will selling Digiteks take Soho's focus away from its video-system business?

Carrying Costs of Inventory

To see another example of an opportunity cost, consider the following data for Soho:

Annual estimated video-system DVD player requirements for next year	250,000 units
Cost per unit when each purchase is equal to 2,500 units	$64.00
Cost per unit when each purchase is equal to or greater than 125,000 units; $64 minus 1% discount	$63.36
Cost of a purchase order	$500

Alternatives under consideration:

A. Make 100 purchases of 2,500 units each during next year

B. Make 2 purchases of 125,000 units during the year

Average investment in inventory:	
A. (2,500 units × $64.00 per unit) ÷ 2[a]	$80,000
B. (125,000 units × $63.36 per unit) ÷ 2[a]	$3,960,000
Annual rate of return if cash is invested elsewhere (for example, bonds or stocks) at the same level of risk as investment in inventory)	9%

[a] The example assumes that video-system-DVD-player purchases will be used uniformly throughout the year. The average investment in inventory during the year is the cost of the inventory when a purchase is received plus the cost of inventory just before the next purchase is delivered (in our example, zero) divided by 2.

Soho will pay cash for the video-system DVD players it buys. Which purchasing alternative is more economical for Soho?

The following table presents the analysis using the total alternatives approach recognizing that Soho has, on average, $3,960,000 of cash available to invest. If Soho invests only $80,000 in inventory as in alternative A, it will have $3,880,000 ($3,960,000 – $80,000) of cash available to invest elsewhere, which at a 9% rate of return will yield a total return of $349,200. This income is subtracted from the ordering and purchasing costs incurred under alternative A. If Soho invests all $3,960,000 in inventory as in alternative B, it will have $0 ($3,960,000 – $3,960,000) available to invest elsewhere and will earn no return on the cash.

	Alternative A: Make 100 Purchases of 2,500 Units Each During the Year and Invest Any Excess Cash (1)	**Alternative B: Make 2 Purchases of 125,000 Units Each During the Year and Invest Any Excess Cash (2)**	**Difference (3) = (1) – (2)**
Annual purchase-order costs (100 purch. orders × $500/purch. order; 2 purch. orders × $500/purch. order)	$ 50,000	$ 1,000	$ 49,000
Annual purchase costs (250,000 units × $64.00/unit; 250,000 units × $63.36/unit)	16,000,000	15,840,000	160,000
Deduct annual rate of return earned by investing cash not tied up in inventory elsewhere at the same level of risk [0.09 × ($3,960,000 – $80,000); 0.09 × ($3,960,000 – $3,960,000)	(349,200)	0	(349,200)
Relevant costs	$15,700,800	$15,841,000	$(140,200)

Consistent with the trends toward holding smaller inventories, purchasing smaller quantities of 2,500 units 100 times a year is preferred to purchasing 125,000 units twice a year by $140,200.

The following table presents the two alternatives using the opportunity cost approach. Each alternative is defined only in terms of the two purchasing choices with no explicit reference to investing the excess cash.

	Alternative A: Make 100 Purchases of 2,500 Units Each During the Year (1)	**Alternative B: Make 2 Purchases of 125,000 Units Each During the Year (2)**	**Difference (3) = (1) – (2)**
Annual purchase-order costs (100 purch. orders × $500/purch. order; 2 purch. orders × $500/purch. order)	$ 50,000	$ 1,000	$ 49,000
Annual purchase costs (250,000 units × $64.00/unit; 250,000 units × $63.36/unit)	16,000,000	15,840,000	160,000
Opportunity cost: Annual rate of return that could be earned if investment in inventory were invested elsewhere at the same level of risk (0.09 × $80,000; 0.09 × $3,960,000)	7,200	356,400	(349,200)
Relevant costs	$16,057,200	$16,197,400	$(140,200)

Recall that under the opportunity cost approach, the relevant cost of any alternative is (1) the incremental cost of the alternative plus (2) the opportunity cost of the profit forgone from choosing that alternative. The opportunity cost of holding inventory is the income forgone by tying up money in inventory and not investing it elsewhere. The opportunity cost would not be recorded in the accounting system because, once the money is invested in inventory, there is no money available to invest elsewhere, and hence no return related to this investment to record. On the basis of the costs recorded in the accounting system (purchase-order costs and purchase costs), Soho would erroneously conclude that making two purchases of 125,000 units each is the less costly alternative. Column 3, however, indicates that, as in the total alternatives approach, purchasing smaller quantities of 2,500 units 100 times a year is preferred to purchasing 125,000 units twice during the year by $140,200. Why? Because the lower opportunity cost of holding smaller inventory exceeds the higher purchase and ordering costs. If the opportunity cost of money tied up in inventory were greater than 9% per year, or if other incremental benefits of holding lower inventory were considered—such as lower insurance, materials-handling, storage, obsolescence, and breakage costs—making 100 purchases would be even more economical.

Decision Point

What is an opportunity cost and why should it be included when making decisions?

Product-Mix Decisions with Capacity Constraints

Learning Objective 4

Know how to choose which products to produce when there are capacity constraints

. . . select the product with the highest contribution margin per unit of the limiting resource

We now examine how the concept of relevance applies to **product-mix decisions**—the decisions made by a company about which products to sell and in what quantities. These decisions usually have only a short-run focus, because they typically arise in the context of capacity constraints that can be relaxed in the long run. In the short run, for example, BMW, the German car manufacturer, continually adapts the mix of its different models of cars (for example, 325i, 525i, and 740i) to fluctuations in selling prices and demand.

To determine product mix, a company maximizes operating income, subject to constraints such as capacity and demand. Throughout this section, we assume that as short-run changes in product mix occur, the only costs that change are costs that are variable with respect to the number of units produced (and sold). Under this assumption, the analysis of individual product contribution margins provides insight into the product mix that maximizes operating income.

Example 4: Power Recreation assembles two engines, a snowmobile engine and a boat engine, at its Lexington, Kentucky, plant.

	Snowmobile Engine	Boat Engine
Selling price	$800	$1,000
Variable cost per unit	560	625
Contribution margin per unit	$240	$ 375
Contribution margin percentage ($240 ÷ $800; $375 ÷ $1,000)	30%	37.5%

Assume that only 600 machine-hours are available daily for assembling engines. Additional capacity cannot be obtained in the short run. Power Recreation can sell as many engines as it produces. The constraining resource, then, is machine-hours. It takes two machine-hours to produce one snowmobile engine and five machine-hours to produce one boat engine. What product mix should Power Recreation's managers choose to maximize its operating income?

In terms of contribution margin per unit and contribution margin percentage, boat engines are more profitable than snowmobile engines. The product that Power Recreation should produce and sell, however, is not necessarily the product with the higher individual contribution margin per unit or contribution margin percentage. Managers should choose the product with *the highest contribution margin per unit of the constraining resource (factor)*. That's the resource that restricts or limits the production or sale of products.

	Snowmobile Engine	Boat Engine
Contribution margin per unit	$240	$375
Machine-hours required to produce one unit	2 machine-hours	5 machine-hours
Contribution margin per machine-hour		
$240 per unit ÷ 2 machine-hours/unit	$120/machine-hour	
$375 per unit ÷ 5 machine-hours/unit		$75/machine-hour
Total contribution margin for 600 machine-hours		
$120/machine-hour × 600 machine-hours	$72,000	
$75/machine-hour × 600 machine-hours		$45,000

The number of machine-hours is the constraining resource in this example and snowmobile engines earn more contribution margin per machine-hour ($120/machine-hour) compared to boat engines ($75/machine-hour). Therefore, choosing to produce and sell snowmobile engines maximizes *total* contribution margin ($72,000 versus $45,000 from producing and selling boat engines) and operating income. Other constraints in manufacturing settings can be the availability of direct materials, components, or skilled labor, as well as financial and sales factors. In a retail department store, the constraining resource may be linear feet of display space. Regardless of the specific constraining resource, managers should always focus on maximizing *total* contribution margin by choosing products that give the highest contribution margin per unit of the constraining resource.

In many cases, a manufacturer or retailer has the challenge of trying to maximize total operating income for a variety of products, each with more than one constraining resource. Some constraints may require a manufacturer or retailer to stock minimum quantities of products even if these products are not very profitable. For example, supermarkets must stock less-profitable products because customers will be willing to shop at a supermarket only if it carries a wide range of products that customers desire. To determine the most profitable production schedule and the most profitable product mix, the manufacturer or retailer needs to determine the maximum total contribution margin in the face of many constraints. Optimization techniques, such as linear programming discussed in the appendix to this chapter, help solve these more-complex problems.

Decision Point

When resources are constrained, how should managers choose which of multiple products to produce and sell?

Finally, there is the question of managing the bottleneck constraint to increase output and, therefore, contribution margin. Can the available machine-hours for assembling engines be increased beyond 600, for example, by reducing idle time? Can the time needed to assemble each snowmobile engine (two machine-hours) and each boat engine (five machine-hours) be reduced, for example, by reducing setup time and processing time of assembly? Can quality be improved so that constrained capacity is used to produce only good units rather than some good and some defective units? Can some of the assembly operations be outsourced to allow more engines to be built? Implementing any of these options will likely require Power Recreation to incur incremental costs. Power Recreation will implement only those options where the increase in contribution margins exceeds the increase in costs. *Instructors and students who, at this point, want to explore these issues in more detail can go to the section in Chapter 19, pages 686–688, titled "Theory of Constraints and Throughput Contribution Analysis" and then return to this chapter without any loss of continuity.*

Learning Objective 5

Discuss factors managers must consider when adding or dropping customers or segments

. . . managers should focus on how total costs differ among alternatives and ignore allocated overhead costs

Customer Profitability, Activity-Based Costing, and Relevant Costs

Not only must companies make choices regarding which products and how much of each product to produce, they must often make decisions about adding or dropping a product line or a business segment. Similarly, if the cost object is a customer, companies must make decisions about adding or dropping customers (analogous to a product line) or a branch office (analogous to a business segment). We illustrate relevant-revenue and

relevant-cost analysis for these kinds of decisions using customers rather than products as the cost object.

Example 5: Allied West, the West Coast sales office of Allied Furniture, a wholesaler of specialized furniture, supplies furniture to three local retailers: Vogel, Brenner, and Wisk. Exhibit 11-8 presents expected revenues and costs of Allied West by customer for the upcoming year using its activity-based costing system. Allied West assigns costs to customers based on the activities needed to support each customer. Information on Allied West's costs for different activities at various levels of the cost hierarchy follows:

- Furniture-handling labor costs vary with the number of units of furniture shipped to customers.
- Allied West reserves different areas of the warehouse to stock furniture for different customers. For simplicity, assume that furniture-handling equipment in an area and depreciation costs on the equipment that Allied West has already acquired are identified with individual customers (customer-level costs). Any unused equipment remains idle. The equipment has a one-year useful life and zero disposal value.
- Allied West allocates rent to each customer on the basis of the amount of warehouse space reserved for that customer.
- Marketing costs vary with the number of sales visits made to customers.
- Sales-order costs are batch-level costs that vary with the number of sales orders received from customers; delivery-processing costs are batch-level costs that vary with the number of shipments made.
- Allied West allocates fixed general-administration costs (facility-level costs) to customers on the basis of customer revenues.
- Allied Furniture allocates its fixed corporate-office costs to sales offices on the basis of the square feet area of each sales office. Allied West then allocates these costs to customers on the basis of customer revenues.

In the following sections, we consider several decisions that Allied West's managers face: Should Allied West drop the Wisk account? Should it add a fourth customer, Loral? Should Allied Furniture close down Allied West? Should it open another sales office, Allied South, whose revenues and costs are identical to those of Allied West?

Exhibit 11-8
Customer Profitability Analysis for Allied West

	Customer			
	Vogel	**Brenner**	**Wisk**	**Total**
Revenues	$500,000	$300,000	$400,000	$1,200,000
Cost of goods sold	370,000	220,000	330,000	920,000
Furniture-handling labor	41,000	18,000	33,000	92,000
Furniture-handling equipment cost written off as depreciation	12,000	4,000	9,000	25,000
Rent	14,000	8,000	14,000	36,000
Marketing support	11,000	9,000	10,000	30,000
Sales-order and delivery processing	13,000	7,000	12,000	32,000
General administration	20,000	12,000	16,000	48,000
Allocated corporate-office costs	10,000	6,000	8,000	24,000
Total costs	491,000	284,000	432,000	1,207,000
Operating income	$ 9,000	$ 16,000	$ (32,000)	$ (7,000)

Relevant-Revenue and Relevant-Cost Analysis of Dropping a Customer

Exhibit 11-8 indicates a loss of $32,000 on the Wisk account. Allied West's managers believe the reason for the loss is that Wisk places low-margin orders with Allied, and has relatively high sales-order, delivery-processing, furniture-handling, and marketing costs. Allied West is considering several possible actions with respect to the Wisk account: reducing its own costs of supporting Wisk by becoming more efficient, cutting back on some of the services it offers Wisk; asking Wisk to place larger, less frequent orders; charging Wisk higher prices; or dropping the Wisk account. The following analysis focuses on the operating-income effect of dropping the Wisk account for the year.

To determine what to do, Allied West's managers must answer the question, what are the relevant revenues and relevant costs? Information about the effect of dropping the Wisk account follows:

- Dropping the Wisk account will save cost of goods sold, furniture-handling labor, marketing support, sales-order, and delivery-processing costs incurred on the account.
- Dropping the Wisk account will leave idle the warehouse space and furniture-handling equipment currently used to supply products to Wisk.
- Dropping the Wisk account will have no effect on fixed general-administration costs or corporate-office costs.

Exhibit 11-9, column 1, presents the relevant-revenue and relevant-cost analysis using data from the Wisk column in Exhibit 11-8. Allied West's operating income will be $15,000 lower if it drops the Wisk account—the cost savings from dropping the Wisk account, $385,000, will not be enough to offset the loss of $400,000 in revenues—so Allied West's managers decide to keep the account. Note that there is no opportunity cost of using warehouse space for Wisk because without Wisk, the space and equipment will remain idle.

Depreciation on equipment that Allied West has already acquired is a past cost and therefore irrelevant; rent, general-administration, and corporate-office costs are future costs that will not change if Allied West drops the Wisk account, and hence irrelevant. Overhead costs allocated to the sales office and individual customers are always irrelevant. The only question is, will expected total corporate-office costs decrease as a result of dropping the Wisk account? In our example, they will not, so these costs are irrelevant. *If expected total corporate-office costs* were to decrease by dropping the Wisk account, those savings would be relevant even if *the amount allocated to Allied West did not change*.

Exhibit 11-9

Relevant-Revenue and Relevant-Cost Analysis for Dropping the Wisk Account and Adding the Loral Account

	(Incremental Loss in Revenues) and Incremental Savings in Costs from Dropping Wisk Account (1)	Incremental Revenues and (Incremental Costs) from Adding Loral Account (2)
Revenues	$(400,000)	$400,000
Cost of goods sold	330,000	(330,000)
Furniture-handling labor	33,000	(33,000)
Furniture-handling equipment cost written off as depreciation	0	(9,000)
Rent	0	0
Marketing support	10,000	(10,000)
Sales-order and delivery processing	12,000	(12,000)
General administration	0	0
Corporate-office costs	0	0
Total costs	385,000	(394,000)
Effect on operating income (loss)	$ (15,000)	$ 6,000

Now suppose that if Allied West drops the Wisk account, it could lease the extra warehouse space to Sanchez Corporation for $20,000 per year. Then $20,000 would be Allied's opportunity cost of continuing to use the warehouse to service Wisk. Allied West would gain $5,000 by dropping the Wisk account ($20,000 from lease revenue minus lost operating income of $15,000). Before reaching a decision, Allied West's managers must examine whether Wisk can be made more profitable so that supplying products to Wisk earns more than the $20,000 from leasing to Sanchez. The managers must also consider strategic factors such as the effect of the decision on Allied West's reputation for developing stable, long-run business relationships with its customers.

Relevant-Revenue and Relevant-Cost Analysis of Adding a Customer

Suppose that in addition to Vogel, Brenner, and Wisk, Allied West's managers are evaluating the profitability of adding a customer, Loral. There is no other alternative use of the Allied West facility. Loral has a customer profile much like Wisk's. Suppose Allied West's managers predict revenues and costs of doing business with Loral to be the same as the revenues and costs described under the Wisk column of Exhibit 11-8. In particular, Allied West would have to acquire furniture-handling equipment for the Loral account costing $9,000, with a one-year useful life and zero disposal value. If Loral is added as a customer, warehouse rent costs ($36,000), general-administration costs ($48,000), and *actual total* corporate-office costs will not change. Should Allied West add Loral as a customer?

Exhibit 11-9, column 2, shows incremental revenues exceed incremental costs by $6,000. The opportunity cost of adding Loral is $0 because there is no alternative use of the Allied West facility. On the basis of this analysis, Allied West's managers would recommend adding Loral as a customer. Rent, general-administration, and corporate-office costs are irrelevant because these costs will not change if Loral is added as a customer. However, the cost of new equipment to support the Loral order (written off as depreciation of $9,000 in Exhibit 11-9, column 2), is relevant. That's because this cost can be avoided if Allied West decides not to add Loral as a customer. Note the critical distinction here: *Depreciation cost is irrelevant in deciding whether to drop Wisk as a customer because depreciation on equipment that has already been purchased is a past cost, but the cost of purchasing new equipment in the future, that will then be written off as depreciation, is relevant in deciding whether to add Loral as a customer.*

Relevant-Revenue and Relevant-Cost Analysis of Closing or Adding Branch Offices or Segments

Companies periodically confront decisions about closing or adding branch offices or business segments. For example, given Allied West's expected loss of $7,000 (see Exhibit 11-8), should it be closed for the year? Assume that closing Allied West will have no effect on total corporate-office costs and that there is no alternative use for the Allied West space.

Exhibit 11-10, column 1, presents the relevant-revenue and relevant-cost analysis using data from the "Total" column in Exhibit 11-8. The revenue losses of $1,200,000 will exceed the cost savings of $1,158,000, leading to a decrease in operating income of $42,000. Allied West should not be closed. The key reasons are that closing Allied West will not save depreciation cost or actual total corporate-office costs. Depreciation cost is past or sunk because it represents the cost of equipment that Allied West has already purchased. Corporate-office costs allocated to various sales offices will change *but the total amount of these costs will not decline*. The $24,000 no longer allocated to Allied West will be allocated to other sales offices. Therefore, the $24,000 of allocated corporate-office costs is irrelevant, because it does not represent expected cost savings from closing Allied West.

Now suppose Allied Furniture has the opportunity to open another sales office, Allied South, whose revenues and costs would be identical to Allied West's costs, including a cost of $25,000 to acquire furniture-handling equipment with a one-year useful life and zero disposal value. Opening this office will have no effect on total corporate-office costs.

Decision Point

In deciding to add or drop customers or to add or discontinue branch offices or segments, what should managers focus on and how should they take into account allocated overhead costs?

Exhibit 11-10 Relevant-Revenue and Relevant-Cost Analysis for Closing Allied West and Opening Allied South

	(Incremental Loss in Revenues) and Incremental Savings in Costs from Closing Allied West (1)	Incremental Revenues and (Incremental Costs) from Opening Allied South (2)
Revenues	$(1,200,000)	$1,200,000
Cost of goods sold	920,000	(920,000)
Furniture-handling labor	92,000	(92,000)
Furniture-handling equipment cost written off as depreciation	0	(25,000)
Rent	36,000	(36,000)
Marketing support	30,000	(30,000)
Sales-order and delivery processing	32,000	(32,000)
General administration	48,000	(48,000)
Corporate-office costs	0	0
Total costs	1,158,000	(1,183,000)
Effect on operating income (loss)	$ (42,000)	$ 17,000

Should Allied Furniture open Allied South? Exhibit 11-10, column 2, indicates that it should do so because opening Allied South will increase operating income by $17,000. As before, the cost of new equipment to be purchased in the future (and written off as depreciation) is relevant and *allocated* corporate-office costs should be ignored. Total corporate-office costs will not change if Allied South is opened, therefore these costs are irrelevant.

Irrelevance of Past Costs and Equipment-Replacement Decisions

Learning Objective 6

Explain why book value of equipment is irrelevant in equipment-replacement decisions

. . . it is a past cost

At several points in this chapter, when discussing the concept of relevance, we reasoned that past (historical or sunk) costs are irrelevant to decision making. That's because a decision cannot change something that has already happened. We now apply this concept to decisions about replacing equipment. We stress the idea that **book value**—original cost minus accumulated depreciation—of existing equipment is a past cost that is irrelevant.

Example 6: Toledo Company, a manufacturer of aircraft components, is considering replacing a metal-cutting machine with a newer model. The new machine is more efficient than the old machine, but it has a shorter life. Revenues from aircraft parts ($1.1 million per year) will be unaffected by the replacement decision. Here are the data the management accountant prepares for the existing (old) machine and the replacement (new) machine:

	Old Machine	New Machine
Original cost	$1,000,000	$600,000
Useful life	5 years	2 years
Current age	3 years	0 years
Remaining useful life	2 years	2 years
Accumulated depreciation	$600,000	Not acquired yet
Book value	$400,000	Not acquired yet
Current disposal value (in cash)	$40,000	Not acquired yet
Terminal disposal value (in cash 2 years from now)	$0	$0
Annual operating costs (maintenance, energy, repairs, coolants, and so on)	$800,000	$460,000

Toledo Corporation uses straight-line depreciation. To focus on relevance, we ignore the time value of money and income taxes.[2] Should Toledo replace its old machine?

Exhibit 11-11 presents a cost comparison of the two machines. Consider why each of the four items in Toledo's equipment-replacement decision is relevant or irrelevant:

1. **Book value of old machine, $400,000.** Irrelevant, because it is a past or sunk cost. All past costs are "down the drain." Nothing can change what has already been spent or what has already happened.
2. **Current disposal value of old machine, $40,000.** Relevant, because it is an expected future benefit that will only occur if the machine is replaced.
3. **Loss on disposal, $360,000.** This is the difference between amounts in items 1 and 2. It is a meaningless combination blurring the distinction between the irrelevant book value and the relevant disposal value. Each should be considered separately, as was done in items 1 and 2.
4. **Cost of new machine, $600,000.** Relevant, because it is an expected future cost that will only occur if the machine is purchased.

Exhibit 11-11 should clarify these four assertions. Column 3 in Exhibit 11-11 shows that the book value of the old machine does not differ between the alternatives and could be ignored for decision-making purposes. No matter what the timing of the write-off—whether a lump-sum charge in the current year or depreciation charges over the next two years—the total amount is still $400,000 because it is a past (historical) cost. In contrast, the $600,000 cost of the new machine and the current disposal value of $40,000 for the old machine are relevant because they would not arise if Toledo's managers decided not to replace the machine. Note that the operating income from replacing is $120,000 higher for the two years together.

To provide focus, Exhibit 11-12 concentrates only on relevant items. Note that the same answer—higher operating income as a result of lower costs of $120,000 by replacing the machine—is obtained even though the book value is omitted from the calculations. The only relevant items are the cash operating costs, the disposal value of the old machine, and the cost of the new machine that is represented as depreciation in Exhibit 11-12.

Decision Point

Is book value of existing equipment relevant in equipment replacement decisions?

Exhibit 11-11

Operating Income Comparison: Replacement of Machine, Relevant, and Irrelevant Items for Toledo Company

	Two Years Together		
	Keep (1)	Replace (2)	Difference (3) = (1) – (2)
Revenues	$2,200,000	$2,200,000	—
Operating costs			
Cash operating costs ($800,000/yr. × 2 years; $460,000/yr. × 2 years)	1,600,000	920,000	$ 680,000
Book value of old machine			
Periodic write-off as depreciation or	400,000	—	—
Lump-sum write-off	—	400,000[a]	
Current disposal value of old machine	—	(40,000)[a]	40,000
New machine cost, written off periodically as depreciation	—	600,000	(600,000)
Total operating costs	2,000,000	1,880,000	120,000
Operating income	$ 200,000	$ 320,000	$(120,000)

[a]In a formal income statement, these two items would be combined as "loss on disposal of machine" of $360,000.

[2] See Chapter 21 for a discussion of time-value-of-money and income-tax considerations in capital investment decisions.

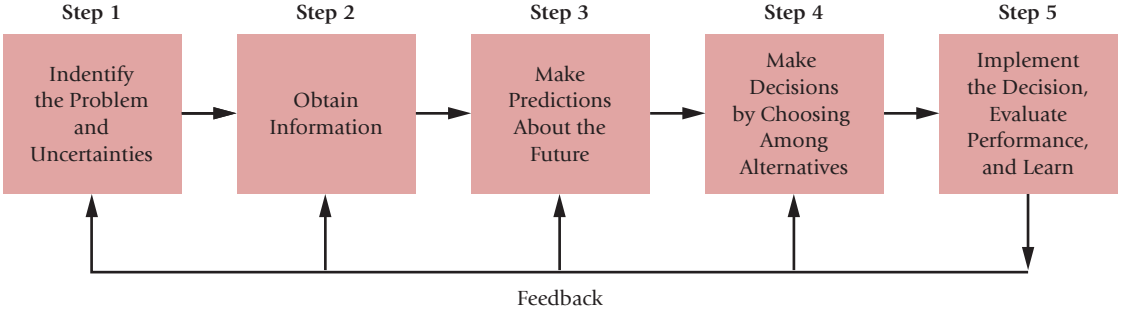
Exhibit 11-12

Cost Comparison: Replacement of Machine, Relevant Items Only, for Toledo Company

	Two Years Together		
	Keep (1)	Replace (2)	Difference (3) = (1) – (2)
Cash operating costs	$1,600,000	$ 920,000	$680,000
Current disposal value of old machine	—	(40,000)	40,000
New machine, written off periodically as depreciation	—	600,000	(600,000)
Total relevant costs	$1,600,000	$1,480,000	$120,000

Decisions and Performance Evaluation

Consider our equipment-replacement example in light of the five-step sequence in Exhibit 11-1 (p. 392):



Learning Objective 7

Explain how conflicts can arise between the decision model used by a manager and the performance-evaluation model used to evaluate the manager

. . . tell managers to take a multiple-year view in decision making but judge their performance only on the basis of the current year's operating income

The decision model analysis (Step 4), which is presented in Exhibits 11-11 and 11-12, dictates replacing the machine rather than keeping it. In the real world, however, would the manager replace it? An important factor in replacement decisions is the manager's perception of whether the decision model is consistent with how the manager's performance will be judged after the decision is implemented (the performance-evaluation model in Step 5).

From the perspective of their own careers, it is no surprise that managers tend to favor the alternative that makes their performance look better. If the performance-evaluation model conflicts with the decision model, the performance-evaluation model often prevails in influencing managers' decisions. For example, if the promotion or bonus of the manager at Toledo hinges on his or her first year's operating income performance under accrual accounting, the manager's temptation *not* to replace will be overwhelming. Why? Because the accrual accounting model for measuring performance will show a higher first-year operating income if the old machine is kept rather than replaced (as the following table shows):

First-Year Results: Accrual Accounting	Keep		Replace	
Revenues		$1,100,000		$1,100,000
Operating costs				
Cash-operating costs	$800,000		$460,000	
Depreciation	200,000		300,000	
Loss on disposal	—		360,000	
Total operating costs		1,000,000		1,120,000
Operating income (loss)		$ 100,000		$ (20,000)

Even though top management's goals encompass the two-year period (consistent with the decision model), the manager will focus on first-year results if his or her evaluation is based on short-run measures such as the first-year's operating income.

Resolving the conflict between the decision model and the performance-evaluation model is frequently a baffling problem in practice. In theory, resolving the difficulty seems obvious: Design models that are consistent. Consider our replacement example. Year-by-year effects on operating income of replacement can be budgeted for the two-year planning horizon. The manager then would be evaluated on the expectation that the first year would be poor and the next year would be much better. Doing this for every decision, however, makes the performance evaluation model very cumbersome. As a result of these practical difficulties, accounting systems rarely track each decision separately. Performance evaluation focuses on responsibility centers for a specific period, not on projects or individual items of equipment over their useful lives. Thus, the impacts of many different decisions are combined in a single performance report and evaluation measure, say operating income. Lower-level managers make decisions to maximize operating income, and top management—through the reporting system—is rarely aware of particular desirable alternatives that were *not* chosen by lower-level managers because of conflicts between the decision and performance-evaluation models.

Consider another conflict between the decision model and the performance-evaluation model. Suppose a manager buys a particular machine only to discover shortly thereafter that a better machine could have been purchased instead. The decision model may suggest replacing the machine that was just bought with the better machine, but will the manager do so? Probably not. Why? Because replacing the machine so soon after its purchase will reflect badly on the manager's capabilities and performance. If the manager's bosses have no knowledge of the better machine, the manager may prefer to keep the recently purchased machine rather than alert them to the better machine.

Chapter 23 discusses performance evaluation models in more detail and ways to reduce conflict between the decision model and the performance evaluation model.

Decision Point

How can conflicts arise between the decision model used by a manager and the performance-evaluation model used to evaluate that manager?

Problem for Self-Study

Wally Lewis is manager of the engineering development division of Goldcoast Products. Lewis has just received a proposal signed by all 15 of his engineers to replace the workstations with networked personal computers (networked PCs). Lewis is not enthusiastic about the proposal.

Data on workstations and networked PCs are as follows:

	Workstations	Networked PCs
Original cost	$300,000	$135,000
Useful life	5 years	3 years
Current age	2 years	0 years
Remaining useful life	3 years	3 years
Accumulated depreciation	$120,000	Not acquired yet
Current book value	$180,000	Not acquired yet
Current disposal value (in cash)	$95,000	Not acquired yet
Terminal disposal value (in cash 3 years from now)	$0	$0
Annual computer-related cash operating costs	$40,000	$10,000
Annual revenues	$1,000,000	$1,000,000
Annual noncomputer-related operating costs	$880,000	$880,000

Lewis's annual bonus includes a component based on division operating income. He has a promotion possibility next year that would make him a group vice president of Goldcoast Products.

Required

1. Compare the costs of workstations and networked PCs. Consider the cumulative results for the three years together, ignoring the time value of money and income taxes.
2. Why might Lewis be reluctant to purchase the networked PCs?

Solution

1. The following table considers all cost items when comparing future costs of workstations and networked PCs:

	Three Years Together		
All Items	Workstations (1)	Networked PCs (2)	Difference (3) = (1) − (2)
Revenues	$3,000,000	$3,000,000	—
Operating costs			
Noncomputer-related operating costs	2,640,000	2,640,000	—
Computer-related cash operating costs	120,000	30,000	$ 90,000
Workstations' book value			
Periodic write-off as depreciation or	180,000	—	—
Lump-sum write-off	—	180,000	
Current disposal value of workstations	—	(95,000)	95,000
Networked PCs, written off periodically as depreciation	—	135,000	(135,000)
Total operating costs	2,940,000	2,890,000	50,000
Operating income	$ 60,000	$ 110,000	$ (50,000)

Alternatively, the analysis could focus on only those items in the preceding table that differ between the alternatives.

	Three Years Together		
Relevant Items	Workstations	Networked PCs	Difference
Computer-related cash operating costs	$120,000	$ 30,000	$90,000
Current disposal value of workstations	—	(95,000)	95,000
Networked PCs, written off periodically as depreciation	—	135,000	(135,000)
Total relevant costs	$120,000	$ 70,000	$ 50,000

The analysis suggests that it is cost-effective to replace the workstations with the networked PCs.

2. The accrual-accounting operating incomes *for the first year* under the keep workstations versus the buy networked PCs alternatives are as follows:

	Keep Workstations	Buy Networked PCs
Revenues	$1,000,000	$1,000,000
Operating costs		
Noncomputer-related operating costs	$880,000	$880,000
Computer-related cash operating costs	40,000	10,000
Depreciation	60,000	45,000
Loss on disposal of workstations	—	85,000[a]
Total operating costs	980,000	1,020,000
Operating income (loss)	$ 20,000	$ (20,000)

[a] $85,000 = Book value of workstations, $180,000 – Current disposal value, $95,000.

Lewis would be less happy with the expected operating loss of $20,000 if the networked PCs are purchased than he would be with the expected operating income of $20,000 if the workstations are kept. Buying the networked PCs would eliminate the component of his bonus based on operating income. He might also perceive the $20,000 operating loss as reducing his chances of being promoted to a group vice president.

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 is the five-step process that managers can use to make decisions?	The five-step decision-making process is (a) identify the problem and uncertainties, (b) obtain information, (c) make predictions about the future, (d) make decisions by choosing among alternatives, and (e) implement the decision, evaluate performance, and learn.
2. When is a revenue or cost item relevant for a particular decision and what potential problems should be avoided in relevant-cost analysis?	To be relevant for a particular decision, a revenue or cost item must meet two criteria: (a) It must be an expected future revenue or expected future cost, and (b) it must differ among alternative courses of action. The outcomes of alternative actions can be quantitative and qualitative. Quantitative outcomes are measured in numerical terms. Some quantitative outcomes can be expressed in financial terms, others cannot. Qualitative factors, such as employee morale, are difficult to measure accurately in numerical terms. Consideration must be given to relevant quantitative and qualitative factors in making decisions. Two potential problems to avoid in relevant-cost analysis are (a) making incorrect general assumptions—such as all variable costs are relevant and all fixed costs are irrelevant—and (b) losing sight of total amounts, focusing instead on unit amounts.
3. What is an opportunity cost and why should it be included when making decisions?	Opportunity cost is the contribution to income that is forgone by not using a limited resource in its next-best alternative use. Opportunity cost is included in decision making because the relevant cost of any decision is (1) the incremental cost of the decision plus (2) the opportunity cost of the profit forgone from making that decision.
4. When resources are constrained, how should managers choose which of multiple products to produce and sell?	When resources are constrained, managers should select the product that yields the highest contribution margin per unit of the constraining or limiting resource (factor). In this way, total contribution margin will be maximized.
5. In deciding to add or drop customers or to add or discontinue branch offices or segments, what should managers focus on and how should they take into account allocated overhead costs?	When making decisions about adding or dropping customers or adding or discontinuing branch offices and segments, managers should focus on only those costs that will change and any opportunity costs. Managers should ignore allocated overhead costs.
6. Is book value of existing equipment relevant in equipment-replacement decisions?	Book value of existing equipment is a past (historical or sunk) cost and, therefore, is irrelevant in equipment-replacement decisions.
7. How can conflicts arise between the decision model used by a manager and the performance-evaluation model used to evaluate that manager?	Top management faces a persistent challenge: making sure that the performance-evaluation model of lower-level managers is consistent with the decision model. A common inconsistency is to tell these managers to take a multiple-year view in their decision making but then to judge their performance only on the basis of the current year's operating income.

Appendix

Linear Programming

In this chapter's Power Recreation example (pp. 405–406), suppose both the snowmobile and boat engines must be tested on a very expensive machine before they are shipped to customers. The available machine-hours for testing are limited. Production data are as follows:

		Use of Capacity in Hours per Unit of Product		Daily Maximum Production in Units	
Department	**Available Daily Capacity in Hours**	**Snowmobile Engine**	**Boat Engine**	**Snowmobile Engine**	**Boat Engine**
Assembly	600 machine-hours	2.0 machine-hours	5.0 machine-hours	300[a] snow engines	120 boat engines
Testing	120 testing-hours	1.0 machine-hour	0.5 machine-hour	120 snow engines	240 boat engines

[a] For example, 600 machine-hours ÷ 2.0 machine-hours per snowmobile engine = 300, the maximum number of snowmobile engines that the assembly department can make if it works exclusively on snowmobile engines.

Exhibit 11-13 summarizes these and other relevant data. In addition, as a result of material shortages for boat engines, Power Recreation cannot produce more than 110 boat engines per day. How many engines of each type should Power Recreation produce and sell daily to maximize operating income?

Because there are multiple constraints, a technique called *linear programming* or *LP* can be used to determine the number of each type of engine Power Recreation should produce. LP models typically assume that all costs are either variable or fixed with respect to a single cost driver (units of output). As we shall see, LP models also require certain other linear assumptions to hold. When these assumptions fail, other decision models should be considered.[3]

Steps in Solving an LP Problem

We use the data in Exhibit 11-13 to illustrate the three steps in solving an LP problem. Throughout this discussion, S equals the number of units of snowmobile engines produced and sold, and B equals the number of units of boat engines produced and sold.

Step 1: Determine the objective function. The **objective function** of a linear program expresses the objective or goal to be maximized (say, operating income) or minimized (say, operating costs). In our example, the objective is to find the combination of snowmobile engines and boat engines that maximizes total contribution margin. Fixed costs remain the same regardless of the product-mix decision and are irrelevant. The linear function expressing the objective for the total contribution margin (TCM) is as follows:

$$TCM = \$240S + \$375B$$

Step 2: Specify the constraints. A **constraint** is a mathematical inequality or equality that must be satisfied by the variables in a mathematical model. The following linear inequalities express the relationships in our example:

Assembly department constraint	$2S + 5B \leq 600$
Testing department constraint	$1S + 0.5B \leq 120$
Materials-shortage constraint for boat engines	$B \leq 110$
Negative production is impossible	$S \geq 0$ and $B \geq 0$

Exhibit 11-13 Operating Data for Power Recreation

	Department Capacity (per Day) In Product Units				
	Assembly	**Testing**	**Selling Price**	**Variable Cost per Unit**	**Contribution Margin per Unit**
Only snowmobile engines	300	120	$ 800	$560	$240
Only boat engines	120	240	$1,000	$625	$375

[3] Other decision models are described in J. Moore and L. Weatherford, *Decision Modeling with Microsoft Excel*, 6th ed. (Upper Saddle River, NJ: Prentice Hall, 2001); and S. Nahmias, *Production and Operations Analysis*, 6th ed. (New York: McGraw-Hill/Irwin, 2008).

The three solid lines on the graph in Exhibit 11-14 show the existing constraints for assembly and testing and the materials-shortage constraint.[4] The feasible or technically possible alternatives are those combinations of quantities of snowmobile engines and boat engines that satisfy all the constraining resources or factors. The shaded "area of feasible solutions" in Exhibit 11-14 shows the boundaries of those product combinations that are feasible.

Step 3: Compute the optimal solution. Linear programming (LP) is an optimization technique used to maximize the *objective function* when there are multiple *constraints*. We present two approaches for finding the optimal solution using LP: trial-and-error approach and graphic approach. These approaches are easy to use in our example because there are only two variables in the objective function and a small number of constraints. Understanding these approaches provides insight into LP. In most real-world LP applications, managers use computer software packages to calculate the optimal solution.[5]

Trial-and-Error Approach

The optimal solution can be found by trial and error, by working with coordinates of the corners of the area of feasible solutions.

First, select any set of corner points and compute the total contribution margin. Five corner points appear in Exhibit 11-14. It is helpful to use simultaneous equations to obtain the exact coordinates in the graph. To illustrate, the corner point (S = 75, B = 90) can be derived by solving the two pertinent constraint inequalities as simultaneous equations:

$$2S + 5B = 600 \quad (1)$$

$$1S + 0.5B = 120 \quad (2)$$

Multiplying (2) *by* 2: $2S + B = 240$ (3)

Subtracting (3) from (1): $4B = 360$

Therefore, $B = 360 \div 4 = 90$

Substituting for B in (2): $1S + 0.5(90) = 120$

$$S = 120 - 45 = 75$$

Given S = 75 snowmobile engines and B = 90 boat engines, TCM = ($240 per snowmobile engine × 75 snowmobile engines) + ($375 per boat engine × 90 boat engines) = $51,750.

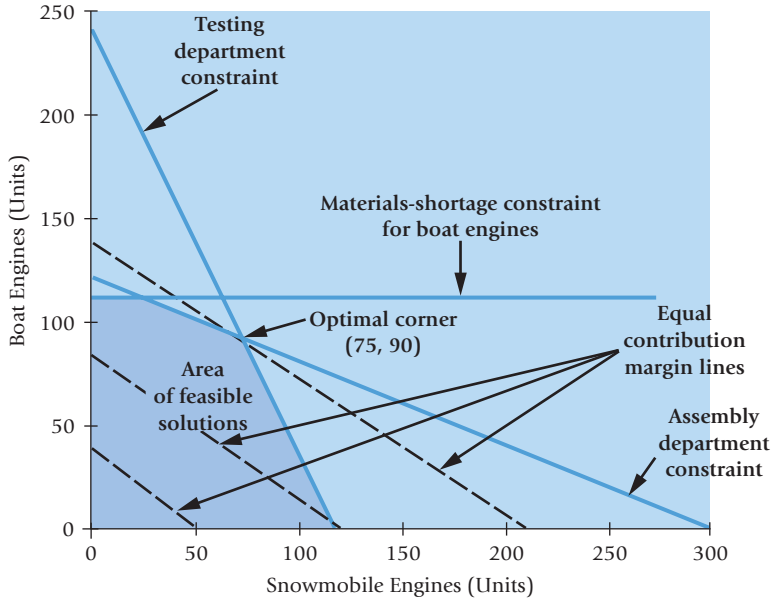


Exhibit 11-14
Linear Programming: Graphic Solution for Power Recreation

[4] As an example of how the lines are plotted in Exhibit 11-14, use equal signs instead of inequality signs and assume for the assembly department that B = 0; then S = 300 (600 machine-hours ÷ 2 machine-hours per snowmobile engine). Assume that S = 0; then B = 120 (600 machine-hours ÷ 5 machine-hours per boat engine). Connect those two points with a straight line.

[5] Standard computer software packages rely on the simplex method. The *simplex method* is an iterative step-by-step procedure for determining the optimal solution to an LP problem. It starts with a specific feasible solution and then tests it by substitution to see whether the result can be improved. These substitutions continue until no further improvement is possible and the optimal solution is obtained.

Second, move from corner point to corner point and compute the total contribution margin at each corner point.

Trial	Corner Point (*S*, *B*)	Snowmobile Engines (*S*)	Boat Engines (*B*)	Total Contribution Margin
1	(0, 0)	0	0	\$240(0) + \$375(0) = \$0
2	(0, 110)	0	110	\$240(0) + \$375(110) = \$41,250
3	(25,110)	25	110	\$240(25) + \$375(110) = \$47,250
4	(75, 90)	75	90	\$240(75) + \$375(90) = \$51,750[a]
5	(120, 0)	120	0	\$240(120) + \$375(0) = \$28,800

[a] The optimal solution.

The optimal product mix is the mix that yields the highest total contribution: 75 snowmobile engines and 90 boat engines. To understand the solution, consider what happens when moving from the point (25,110) to (75,90). Power Recreation gives up \$7,500 [\$375 × (110 – 90)] in contribution margin from boat engines while gaining \$12,000 [\$240 × (75 – 25)] in contribution margin from snowmobile engines. This results in a net increase in contribution margin of \$4,500 (\$12,000 – \$7,500), from \$47,250 to \$51,750.

Graphic Approach

Consider all possible combinations that will produce the same total contribution margin of, say, \$12,000. That is,

$$\$240S + \$375B = \$12{,}000$$

This set of \$12,000 contribution margins is a straight dashed line through [S = 50 (\$12,000 ÷ \$240); B = 0)] and [S = 0, B = 32 (\$12,000 ÷ \$375)] in Exhibit 11-14. Other equal total contribution margins can be represented by lines parallel to this one. In Exhibit 11-14, we show three dashed lines. Lines drawn farther from the origin represent more sales of both products and higher amounts of equal contribution margins.

The optimal line is the one farthest from the origin but still passing through a point in the area of feasible solutions. This line represents the highest total contribution margin. The optimal solution—the number of snowmobile engines and boat engines that will maximize the objective function, total contribution margin—is the corner point (S = 75, B = 90). This solution will become apparent if you put a straight-edge ruler on the graph and move it outward from the origin and parallel with the \$12,000 contribution margin line. Move the ruler as far away from the origin as possible—that is, increase the total contribution margin—without leaving the area of feasible solutions. In general, the optimal solution in a maximization problem lies at the corner where the dashed line intersects an extreme point of the area of feasible solutions. Moving the ruler out any farther puts it outside the area of feasible solutions.

Sensitivity Analysis

What are the implications of uncertainty about the accounting or technical coefficients used in the objective function (such as the contribution margin per unit of snowmobile engines or boat engines) or the constraints (such as the number of machine-hours it takes to make a snowmobile engine or a boat engine)? Consider how a change in the contribution margin of snowmobile engines from \$240 to \$300 per unit would affect the optimal solution. Assume the contribution margin for boat engines remains unchanged at \$375 per unit. The revised objective function will be as follows:

$$TCM = \$300S + \$375B$$

Using the trial-and-error approach to calculate the total contribution margin for each of the five corner points described in the previous table, the optimal solution is still (S = 75, B = 90). What if the contribution margin of snowmobile engines falls to \$160 per unit? The optimal solution remains the same (S = 75, B = 90). Thus, big changes in the contribution margin per unit of snowmobile engines have no effect on the optimal solution in this case. That's because, although the slopes of the equal contribution margin lines in Exhibit 11-14 change as the contribution margin of snowmobile engines changes from \$240 to \$300 to \$160 per unit, the farthest point at which the equal contribution margin lines intersect the area of feasible solutions is still (S = 75, B = 90).

Terms to Learn

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

book value (**p. 410**)
business function costs (**p. 395**)
constraint (**p. 416**)
decision model (**p. 391**)
differential cost (**p. 399**)
differential revenue (**p. 399**)
full costs of the product (**p. 395**)
incremental cost (**p. 399**)
incremental revenue (**p. 399**)

insourcing (**p. 397**)
linear programming (LP) (**p. 417**)
make-or-buy decisions (**p. 397**)
objective function (**p. 416**)
one-time-only special order (**p. 394**)
opportunity cost (**p. 402**)
outsourcing (**p. 397**)
product-mix decisions (**p. 405**)
qualitative factors (**p. 394**)
quantitative factors (**p. 394**)
relevant costs (**p. 393**)
relevant revenues (**p. 393**)
sunk costs (**p. 393**)

Assignment Material

Questions

MyAccountingLab

11-1 Outline the five-step sequence in a decision process.
11-2 Define relevant costs. Why are historical costs irrelevant?
11-3 "All future costs are relevant." Do you agree? Why?
11-4 Distinguish between quantitative and qualitative factors in decision making.
11-5 Describe two potential problems that should be avoided in relevant-cost analysis.
11-6 "Variable costs are always relevant, and fixed costs are always irrelevant." Do you agree? Why?
11-7 "A component part should be purchased whenever the purchase price is less than its total manufacturing cost per unit." Do you agree? Why?
11-8 Define opportunity cost.
11-9 "Managers should always buy inventory in quantities that result in the lowest purchase cost per unit." Do you agree? Why?
11-10 "Management should always maximize sales of the product with the highest contribution margin per unit." Do you agree? Why?
11-11 "A branch office or business segment that shows negative operating income should be shut down." Do you agree? Explain briefly.
11-12 "Cost written off as depreciation on equipment already purchased is always irrelevant." Do you agree? Why?
11-13 "Managers will always choose the alternative that maximizes operating income or minimizes costs in the decision model." Do you agree? Why?
11-14 Describe the three steps in solving a linear programming problem.
11-15 How might the optimal solution of a linear programming problem be determined?

Exercises

MyAccountingLab

11-16 **Disposal of assets.** Answer the following questions.

1. A company has an inventory of 1,100 assorted parts for a line of missiles that has been discontinued. The inventory cost is $78,000. The parts can be either (a) remachined at total additional costs of $24,500 and then sold for $33,000 or (b) sold as scrap for $6,500. Which action is more profitable? Show your calculations.
2. A truck, costing $101,000 and uninsured, is wrecked its first day in use. It can be either (a) disposed of for $17,500 cash and replaced with a similar truck costing $103,500 or (b) rebuilt for $89,500, and thus be brand-new as far as operating characteristics and looks are concerned. Which action is less costly? Show your calculations.

11-17 **Relevant and irrelevant costs.** Answer the following questions.

1. DeCesare Computers makes 5,200 units of a circuit board, CB76 at a cost of $280 each. Variable cost per unit is $190 and fixed cost per unit is $90. Peach Electronics offers to supply 5,200 units of CB76 for $260. If DeCesare buys from Peach it will be able to save $10 per unit in fixed costs but continue to incur the remaining $80 per unit. Should DeCesare accept Peach's offer? Explain.
2. LN Manufacturing is deciding whether to keep or replace an old machine. It obtains the following information:

	Old Machine	New Machine
Original cost	$10,700	$9,000
Useful life	10 years	3 years
Current age	7 years	0 years
Remaining useful life	3 years	3 years
Accumulated depreciation	$7,490	Not acquired yet
Book value	$3,210	Not acquired yet
Current disposal value (in cash)	$2,200	Not acquired yet
Terminal disposal value (3 years from now)	$0	$0
Annual cash operating costs	$17,500	$15,500

LN Manufacturing uses straight-line depreciation. Ignore the time value of money and income taxes. Should LN Manufacturing replace the old machine? Explain.

11-18 Multiple choice. (CPA) Choose the best answer.

1. The Woody Company manufactures slippers and sells them at $10 a pair. Variable manufacturing cost is $4.50 a pair, and allocated fixed manufacturing cost is $1.50 a pair. It has enough idle capacity available to accept a one-time-only special order of 20,000 pairs of slippers at $6 a pair. Woody will not incur any marketing costs as a result of the special order. What would the effect on operating income be if the special order could be accepted without affecting normal sales: (a) $0, (b) $30,000 increase, (c) $90,000 increase, or (d) $120,000 increase? Show your calculations.
2. The Reno Company manufactures Part No. 498 for use in its production line. The manufacturing cost per unit for 20,000 units of Part No. 498 is as follows:

Direct materials	$ 6
Direct manufacturing labor	30
Variable manufacturing overhead	12
Fixed manufacturing overhead allocated	16
Total manufacturing cost per unit	$64

The Tray Company has offered to sell 20,000 units of Part No. 498 to Reno for $60 per unit. Reno will make the decision to buy the part from Tray if there is an overall savings of at least $25,000 for Reno. If Reno accepts Tray's offer, $9 per unit of the fixed overhead allocated would be eliminated. Furthermore, Reno has determined that the released facilities could be used to save relevant costs in the manufacture of Part No. 575. For Reno to achieve an overall savings of $25,000, the amount of relevant costs that would have to be saved by using the released facilities in the manufacture of Part No. 575 would be which of the following: (a) $80,000, (b) $85,000, (c) $125,000, or (d) $140,000? Show your calculations.

11-19 Special order, activity-based costing. (CMA, adapted) The Award Plus Company manufactures medals for winners of athletic events and other contests. Its manufacturing plant has the capacity to produce 10,000 medals each month. Current production and sales are 7,500 medals per month. The company normally charges $150 per medal. Cost information for the current activity level is as follows:

Variable costs that vary with number of units produced	
Direct materials	$ 262,500
Direct manufacturing labor	300,000
Variable costs (for setups, materials handling, quality control, and so on) that vary with number of batches, 150 batches × $500 per batch	75,000
Fixed manufacturing costs	275,000
Fixed marketing costs	175,000
Total costs	$1,087,500

Award Plus has just received a special one-time-only order for 2,500 medals at $100 per medal. Accepting the special order would not affect the company's regular business. Award Plus makes medals for its existing customers in batch sizes of 50 medals (150 batches × 50 medals per batch = 7,500 medals). The special order requires Award Plus to make the medals in 25 batches of 100 each.

Required

1. Should Award Plus accept this special order? Show your calculations.
2. Suppose plant capacity were only 9,000 medals instead of 10,000 medals each month. The special order must either be taken in full or be rejected completely. Should Award Plus accept the special order? Show your calculations.
3. As in requirement 1, assume that monthly capacity is 10,000 medals. Award Plus is concerned that if it accepts the special order, its existing customers will immediately demand a price discount of $10 in the month in which the special order is being filled. They would argue that Award Plus's capacity costs are now being spread over more units and that existing customers should get the benefit of these lower costs. Should Award Plus accept the special order under these conditions? Show your calculations.

11-20 Make versus buy, activity-based costing. The Svenson Corporation manufactures cellular modems. It manufactures its own cellular modem circuit boards (CMCB), an important part of the cellular modem. It reports the following cost information about the costs of making CMCBs in 2011 and the expected costs in 2012:

	Current Costs in 2011	Expected Costs in 2012
Variable manufacturing costs		
Direct material cost per CMCB	$ 180	$ 170
Direct manufacturing labor cost per CMCB	50	45
Variable manufacturing cost per batch for setups, materials handling, and quality control	1,600	1,500
Fixed manufacturing cost		
Fixed manufacturing overhead costs that can be avoided if CMCBs are not made	320,000	320,000
Fixed manufacturing overhead costs of plant depreciation, insurance, and administration that cannot be avoided even if CMCBs are not made	800,000	800,000

Svenson manufactured 8,000 CMCBs in 2011 in 40 batches of 200 each. In 2012, Svenson anticipates needing 10,000 CMCBs. The CMCBs would be produced in 80 batches of 125 each.

The Minton Corporation has approached Svenson about supplying CMCBs to Svenson in 2012 at $300 per CMCB on whatever delivery schedule Svenson wants.

Required

1. Calculate the total expected manufacturing cost per unit of making CMCBs in 2012.
2. Suppose the capacity currently used to make CMCBs will become idle if Svenson purchases CMCBs from Minton. On the basis of financial considerations alone, should Svenson make CMCBs or buy them from Minton? Show your calculations.
3. Now suppose that if Svenson purchases CMCBs from Minton, its best alternative use of the capacity currently used for CMCBs is to make and sell special circuit boards (CB3s) to the Essex Corporation. Svenson estimates the following incremental revenues and costs from CB3s:

Total expected incremental future revenues	$2,000,000
Total expected incremental future costs	$2,150,000

On the basis of financial considerations alone, should Svenson make CMCBs or buy them from Minton? Show your calculations.

11-21 Inventory decision, opportunity costs. Lawn World, a manufacturer of lawn mowers, predicts that it will purchase 264,000 spark plugs next year. Lawn World estimates that 22,000 spark plugs will be required each month. A supplier quotes a price of $7 per spark plug. The supplier also offers a special discount option: If all 264,000 spark plugs are purchased at the start of the year, a discount of 2% off the $7 price will be given. Lawn World can invest its cash at 10% per year. It costs Lawn World $260 to place each purchase order.

Required

1. What is the opportunity cost of interest forgone from purchasing all 264,000 units at the start of the year instead of in 12 monthly purchases of 22,000 units per order?
2. Would this opportunity cost be recorded in the accounting system? Why?
3. Should Lawn World purchase 264,000 units at the start of the year or 22,000 units each month? Show your calculations.

11-22 Relevant costs, contribution margin, product emphasis. The Seashore Stand is a take-out food store at a popular beach resort. Susan Sexton, owner of the Seashore Stand, is deciding how much refrigerator space to devote to four different drinks. Pertinent data on these four drinks are as follows:

	Cola	Lemonade	Punch	Natural Orange Juice
Selling price per case	$18.75	$20.50	$27.75	$39.30
Variable cost per case	$13.75	$15.60	$20.70	$30.40
Cases sold per foot of shelf space per day	22	12	6	13

Sexton has a maximum front shelf space of 12 feet to devote to the four drinks. She wants a minimum of 1 foot and a maximum of 6 feet of front shelf space for each drink.

Required

1. Calculate the contribution margin per case of each type of drink.
2. A coworker of Sexton's recommends that she maximize the shelf space devoted to those drinks with the highest contribution margin per case. Evaluate this recommendation.
3. What shelf-space allocation for the four drinks would you recommend for the Seashore Stand? Show your calculations.

11-23 Selection of most profitable product. Body-Builders, Inc., produces two basic types of weight-lifting equipment, Model 9 and Model 14. Pertinent data are as follows:

	A	B	C
1		Per Unit	
2		Model 9	Model 14
3	Selling price	$100.00	$70.00
4	Costs		
5	Direct material	28.00	13.00
6	Direct manufacturing labor	15.00	25.00
7	Variable manufacturing overhead*	25.00	12.50
8	Fixed manufacturing overhead*	10.00	5.00
9	Marketing (all variable)	14.00	10.00
10	Total cost	92.00	65.50
11	Operating income	$ 8.00	$ 4.50
12			
13	*Allocated on the basis of machine-hours		

The weight-lifting craze is such that enough of either Model 9 or Model 14 can be sold to keep the plant operating at full capacity. Both products are processed through the same production departments.

Required Which products should be produced? Briefly explain your answer.

11-24 Which center to close, relevant-cost analysis, opportunity costs. Fair Lakes Hospital Corporation has been operating ambulatory surgery centers in Groveton and Stockdale, two small communities each about an hour away from its main hospital. As a cost control measure the hospital has decided that it needs only one of those two centers permanently, so one must be shut down. The decision regarding which center to close will be made on financial considerations alone. The following information is available:

a. The Groveton center was built 15 years ago at a cost of $5 million on land leased from the City of Groveton at a cost of $40,000 per year. The land and buildings will immediately revert back to the city if the center is closed. The center has annual operating costs of $2.5 million, all of which will be saved if the center is closed. In addition, Fair Lakes allocates $800,000 of common administrative costs to the Groveton center. If the center is closed, these costs would be reallocated to other ambulatory centers. If the center is kept open, Fair Lakes plans to invest $1 million in a fixed income note, which will earn the $40,000 that Fair Lakes needs for the lease payments.

b. The Stockdale center was built 20 years ago at a cost of $4.8 million, of which Fair Lakes and the City of Stockdale each paid half, on land donated by a hospital benefactor. Two years ago, Fair Lakes spent $2 million to renovate the facility. If the center is closed, the property will be sold to developers for $7 million. The operating costs of the center are $3 million per year, all of which will be saved if the center is closed. Fair Lakes allocates $1 million of common administrative costs to the Stockdale center. If the center is closed, these costs would be reallocated to other ambulatory centers.

c. Fair Lakes estimates that the operating costs of whichever center remains open will be $3.5 million per year.

Required The City Council of Stockdale has petitioned Fair Lakes to close the Groveton facility, thus sparing the Stockdale center. The Council argues that otherwise the $2 million spent on recent renovations would be wasted. Do you agree with the Stockdale City Council's arguments and conclusions? In your answer, identify and explain all costs that you consider relevant and all costs that you consider irrelevant for the center-closing decision.

11-25 Closing and opening stores. Sanchez Corporation runs two convenience stores, one in Connecticut and one in Rhode Island. Operating income for each store in 2012 is as follows:

	Connecticut Store	Rhode Island Store
Revenues	$1,070,000	$860,000
Operating costs		
Cost of goods sold	750,000	660,000
Lease rent (renewable each year)	90,000	75,000
Labor costs (paid on an hourly basis)	42,000	42,000
Depreciation of equipment	25,000	22,000
Utilities (electricity, heating)	43,000	46,000
Allocated corporate overhead	50,000	40,000
Total operating costs	1,000,000	885,000
Operating income (loss)	$ 70,000	$ (25,000)

The equipment has a zero disposal value. In a senior management meeting, Maria Lopez, the management accountant at Sanchez Corporation, makes the following comment, "Sanchez can increase its profitability by closing down the Rhode Island store or by adding another store like it."

Required

1. By closing down the Rhode Island store, Sanchez can reduce overall corporate overhead costs by $44,000. Calculate Sanchez's operating income if it closes the Rhode Island store. Is Maria Lopez's statement about the effect of closing the Rhode Island store correct? Explain.
2. Calculate Sanchez's operating income if it keeps the Rhode Island store open and opens another store with revenues and costs identical to the Rhode Island store (including a cost of $22,000 to acquire equipment with a one-year useful life and zero disposal value). Opening this store will increase corporate overhead costs by $4,000. Is Maria Lopez's statement about the effect of adding another store like the Rhode Island store correct? Explain.

11-26 Choosing customers. Broadway Printers operates a printing press with a monthly capacity of 2,000 machine-hours. Broadway has two main customers: Taylor Corporation and Kelly Corporation. Data on each customer for January follows:

	Taylor Corporation	Kelly Corporation	Total
Revenues	$120,000	$80,000	$200,000
Variable costs	42,000	48,000	90,000
Contribution margin	78,000	32,000	110,000
Fixed costs (allocated)	60,000	40,000	100,000
Operating income	$ 18,000	$ (8,000)	$ 10,000
Machine-hours required	1,500 hours	500 hours	2,000 hours

Kelly Corporation indicates that it wants Broadway to do an *additional* $80,000 worth of printing jobs during February. These jobs are identical to the existing business Broadway did for Kelly in January in terms of variable costs and machine-hours required. Broadway anticipates that the business from Taylor Corporation in February will be the same as that in January. Broadway can choose to accept as much of the Taylor and Kelly business for February as its capacity allows. Assume that total machine-hours and fixed costs for February will be the same as in January.

What action should Broadway take to maximize its operating income? Show your calculations.

Required

11-27 Relevance of equipment costs. The Auto Wash Company has just today paid for and installed a special machine for polishing cars at one of its several outlets. It is the first day of the company's fiscal year. The machine costs $20,000. Its annual cash operating costs total $15,000. The machine will have a four-year useful life and a zero terminal disposal value.

After the machine has been used for only one day, a salesperson offers a different machine that promises to do the same job at annual cash operating costs of $9,000. The new machine will cost $24,000 cash, installed. The "old" machine is unique and can be sold outright for only $10,000, minus $2,000 removal cost. The new machine, like the old one, will have a four-year useful life and zero terminal disposal value.

Revenues, all in cash, will be $150,000 annually, and other cash costs will be $110,000 annually, regardless of this decision.

For simplicity, ignore income taxes and the time value of money.

Required

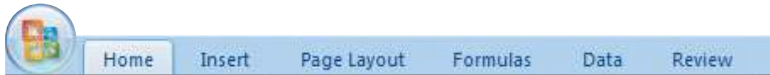
1. **a.** Prepare a statement of cash receipts and disbursements for each of the four years under each alternative. What is the cumulative difference in cash flow for the four years taken together?

b. Prepare income statements for each of the four years under each alternative. Assume straight-line depreciation. What is the cumulative difference in operating income for the four years taken together?

c. What are the irrelevant items in your presentations in requirements a and b? Why are they irrelevant?

2. Suppose the cost of the "old" machine was $1 million rather than $20,000. Nevertheless, the old machine can be sold outright for only $10,000, minus $2,000 removal cost. Would the net differences in requirements 1a and 1b change? Explain.
3. Is there any conflict between the decision model and the incentives of the manager who has just purchased the "old" machine and is considering replacing it a day later?

11-28 Equipment upgrade versus replacement. (A. Spero, adapted) The TechGuide Company produces and sells 7,500 modular computer desks per year at a selling price of $750 each. Its current production equipment, purchased for $1,800,000 and with a five-year useful life, is only two years old. It has a terminal disposal value of $0 and is depreciated on a straight-line basis. The equipment has a current disposal price of $450,000. However, the emergence of a new molding technology has led TechGuide to consider either upgrading or replacing the production equipment. The following table presents data for the two alternatives:



	A	B	C
1		**Upgrade**	**Replace**
2	One-time equipment costs	$3,000,000	$4,800,000
3	Variable manufacturing cost per desk	$ 150	$ 75
4	Remaining useful life of equipment (years)	3	3
5	Terminal disposal value of equipment	$ 0	$ 0

All equipment costs will continue to be depreciated on a straight-line basis. For simplicity, ignore income taxes and the time value of money.

Required

1. Should TechGuide upgrade its production line or replace it? Show your calculations.
2. Now suppose the one-time equipment cost to replace the production equipment is somewhat negotiable. All other data are as given previously. What is the maximum one-time equipment cost that TechGuide would be willing to pay to replace the old equipment rather than upgrade it?
3. Assume that the capital expenditures to replace and upgrade the production equipment are as given in the original exercise, but that the production and sales quantity is not known. For what production and sales quantity would TechGuide (i) upgrade the equipment or (ii) replace the equipment?
4. Assume that all data are as given in the original exercise. Dan Doria is TechGuide's manager, and his bonus is based on operating income. Because he is likely to relocate after about a year, his current bonus is his primary concern. Which alternative would Doria choose? Explain.

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Problems

11-29 Special Order. Louisville Corporation produces baseball bats for kids that it sells for $32 each. At capacity, the company can produce 50,000 bats a year. The costs of producing and selling 50,000 bats are as follows:

	Cost per Bat	Total Costs
Direct materials	$12	$ 600,000
Direct manufacturing labor	3	150,000
Variable manufacturing overhead	1	50,000
Fixed manufacturing overhead	5	250,000
Variable selling expenses	2	100,000
Fixed selling expenses	4	200,000
Total costs	$27	$1,350,000

Required

1. Suppose Louisville is currently producing and selling 40,000 bats. At this level of production and sales, its fixed costs are the same as given in the preceding table. Ripkin Corporation wants to place a one-time special order for 10,000 bats at $25 each. Louisville will incur no variable selling costs for this special order. Should Louisville accept this one-time special order? Show your calculations.

2. Now suppose Louisville is currently producing and selling 50,000 bats. If Louisville accepts Ripkin's offer it will have to sell 10,000 fewer bats to its regular customers. (a) On financial considerations alone, should Louisville accept this one-time special order? Show your calculations. (b) On financial considerations alone, at what price would Louisville be indifferent between accepting the special order and continuing to sell to its regular customers at $32 per bat. (c) What other factors should Louisville consider in deciding whether to accept the one-time special order?

11-30 International outsourcing. Bernie's Bears, Inc., manufactures plush toys in a facility in Cleveland, Ohio. Recently, the company designed a group of collectible resin figurines to go with the plush toy line. Management is trying to decide whether to manufacture the figurines themselves in existing space in the Cleveland facility or to accept an offer from a manufacturing company in Indonesia. Data concerning the decision follows:

Expected annual sales of figurines (in units)	400,000
Average selling price of a figurine	$5
Price quoted by Indonesian company, in Indonesian Rupiah (IDR), for each figurine	27,300 IDR
Current exchange rate	9,100 IDR = $1
Variable manufacturing costs	$2.85 per unit
Incremental annual fixed manufacturing costs associated with the new product line	$200,000
Variable selling and distribution costs[a]	$0.50 per unit
Annual fixed selling and distribution costs[a]	$285,000

[a] Selling and distribution costs are the same regardless of whether the figurines are manufactured in Cleveland or imported.

Required

1. Should Bernie's Bears manufacture the 400,000 figurines in the Cleveland facility or purchase them from the Indonesian supplier? Explain.
2. Bernie's Bears believes that the US dollar may weaken in the coming months against the Indonesian Rupiah and does not want to face any currency risk. Assume that Bernie's Bears can enter into a forward contract today to purchase 27,300 IDRs for $3.40. Should Bernie's Bears manufacture the 400,000 figurines in the Cleveland facility or purchase them from the Indonesian supplier? Explain.
3. What are some of the qualitative factors that Bernie's Bears should consider when deciding whether to outsource the figurine manufacturing to Indonesia?

11-31 Relevant costs, opportunity costs. Larry Miller, the general manager of Basil Software, must decide when to release the new version of Basil's spreadsheet package, Easyspread 2.0. Development of Easyspread 2.0 is complete; however, the diskettes, compact discs, and user manuals have not yet been produced. The product can be shipped starting July 1, 2011.

The major problem is that Basil has overstocked the previous version of its spreadsheet package, Easyspread 1.0. Miller knows that once Easyspread 2.0 is introduced, Basil will not be able to sell any more units of Easyspread 1.0. Rather than just throwing away the inventory of Easyspread 1.0, Miller is wondering if it might be better to continue to sell Easyspread 1.0 for the next three months and introduce Easyspread 2.0 on October 1, 2011, when the inventory of Easyspread 1.0 will be sold out.

The following information is available:

	Easyspread 1.0	Easyspread 2.0
Selling price	$160	$195
Variable cost per unit of diskettes, compact discs, user manuals	25	30
Development cost per unit	70	100
Marketing and administrative cost per unit	35	40
Total cost per unit	130	170
Operating income per unit	$ 30	$ 25

Development cost per unit for each product equals the total costs of developing the software product divided by the anticipated unit sales over the life of the product. Marketing and administrative costs are fixed costs in 2011, incurred to support all marketing and administrative activities of Basil Software. Marketing and administrative costs are allocated to products on the basis of the budgeted revenues of each product. The preceding unit costs assume Easyspread 2.0 will be introduced on October 1, 2011.

Required

1. On the basis of financial considerations alone, should Miller introduce Easyspread 2.0 on July 1, 2011, or wait until October 1, 2011? Show your calculations, clearly identifying relevant and irrelevant revenues and costs.
2. What other factors might Larry Miller consider in making a decision?

11-32 Opportunity costs. (H. Schaefer) The Wild Boar Corporation is working at full production capacity producing 13,000 units of a unique product, Rosebo. Manufacturing cost per unit for Rosebo is as follows:

Direct materials	$ 5
Direct manufacturing labor	1
Manufacturing overhead	7
Total manufacturing cost	$13

Manufacturing overhead cost per unit is based on variable cost per unit of $4 and fixed costs of $39,000 (at full capacity of 13,000 units). Marketing cost per unit, all variable, is $2, and the selling price is $26.

A customer, the Miami Company, has asked Wild Boar to produce 3,500 units of Orangebo, a modification of Rosebo. Orangebo would require the same manufacturing processes as Rosebo. Miami has offered to pay Wild Boar $20 for a unit of Orangebo and share half of the marketing cost per unit.

Required

1. What is the opportunity cost to Wild Boar of producing the 3,500 units of Orangebo? (Assume that no overtime is worked.)
2. The Buckeye Corporation has offered to produce 3,500 units of Rosebo for Wolverine so that Wild Boar may accept the Miami offer. That is, if Wild Boar accepts the Buckeye offer, Wild Boar would manufacture 9,500 units of Rosebo and 3,500 units of Orangebo and purchase 3,500 units of Rosebo from Buckeye. Buckeye would charge Wild Boar $18 per unit to manufacture Rosebo. On the basis of financial considerations alone, should Wild Boar accept the Buckeye offer? Show your calculations.
3. Suppose Wild Boar had been working at less than full capacity, producing 9,500 units of Rosebo at the time the Miami offer was made. Calculate the minimum price Wild Boar should accept for Orangebo under these conditions. (Ignore the previous $20 selling price.)

11-33 Product mix, special order. (N. Melumad, adapted) Pendleton Engineering makes cutting tools for metalworking operations. It makes two types of tools: R3, a regular cutting tool, and HP6, a high-precision cutting tool. R3 is manufactured on a regular machine, but HP6 must be manufactured on both the regular machine and a high-precision machine. The following information is available.

	R3	HP6
Selling price	$ 100	$ 150
Variable manufacturing cost per unit	$ 60	$ 100
Variable marketing cost per unit	$ 15	$ 35
Budgeted total fixed overhead costs	$350,000	$550,000
Hours required to produce one unit on the regular machine	1.0	0.5

Additional information includes the following:

a. Pendleton faces a capacity constraint on the regular machine of 50,000 hours per year.
b. The capacity of the high-precision machine is not a constraint.
c. Of the $550,000 budgeted fixed overhead costs of HP6, $300,000 are lease payments for the high-precision machine. This cost is charged entirely to HP6 because Pendleton uses the machine exclusively to produce HP6. The lease agreement for the high-precision machine can be canceled at any time without penalties.
d. All other overhead costs are fixed and cannot be changed.

Required

1. What product mix—that is, how many units of R3 and HP6—will maximize Pendleton's operating income? Show your calculations.
2. Suppose Pendleton can increase the annual capacity of its regular machines by 15,000 machine-hours at a cost of $150,000. Should Pendleton increase the capacity of the regular machines by 15,000 machine-hours? By how much will Pendleton's operating income increase? Show your calculations.
3. Suppose that the capacity of the regular machines has been increased to 65,000 hours. Pendleton has been approached by Carter Corporation to supply 20,000 units of another cutting tool, S3, for $120 per unit. Pendleton must either accept the order for all 20,000 units or reject it totally. S3 is exactly like R3 except that its variable manufacturing cost is $70 per unit. (It takes one hour to produce one unit of S3 on the regular machine, and variable marketing cost equals $15 per unit.) What product mix should Pendleton choose to maximize operating income? Show your calculations.

11-34 Dropping a product line, selling more units. The Northern Division of Grossman Corporation makes and sells tables and beds. The following estimated revenue and cost information from the division's activity-based costing system is available for 2011.

	4,000 Tables	5,000 Beds	Total
Revenues ($125 × 4,000; $200 × 5,000)	$500,000	$1,000,000	$1,500,000
Variable direct materials and direct manufacturing labor costs ($75 × 4,000; $105 × 5,000)	300,000	525,000	825,000
Depreciation on equipment used exclusively by each product line	42,000	58,000	100,000
Marketing and distribution costs			
$40,000 (fixed) + ($750 per shipment × 40 shipments)	70,000		
$60,000 (fixed) + ($750 per shipment × 100 shipments)		135,000	205,000
Fixed general-administration costs of the division allocated to product lines on the basis of revenue	110,000	220,000	330,000
Corporate-office costs allocated to product lines on the basis of revenues	50,000	100,000	150,000
Total costs	572,000	1,038,000	1,610,000
Operating income (loss)	$ (72,000)	$ (38,000)	$ (110,000)

Additional information includes the following:

a. On January 1, 2011, the equipment has a book value of $100,000, a one-year useful life, and zero disposal value. Any equipment not used will remain idle.
b. Fixed marketing and distribution costs of a product line can be avoided if the line is discontinued.
c. Fixed general-administration costs of the division and corporate-office costs will not change if sales of individual product lines are increased or decreased or if product lines are added or dropped.

Required

1. On the basis of financial considerations alone, should the Northern Division discontinue the tables product line for the year, assuming the released facilities remain idle? Show your calculations.
2. What would be the effect on the Northern Division's operating income if it were to sell 4,000 more tables? Assume that to do so the division would have to acquire additional equipment costing $42,000 with a one-year useful life and zero terminal disposal value. Assume further that the fixed marketing and distribution costs would not change but that the number of shipments would double. Show your calculations.
3. Given the Northern Division's expected operating loss of $110,000, should Grossman Corporation shut it down for the year? Assume that shutting down the Northern Division will have no effect on corporate-office costs but will lead to savings of all general-administration costs of the division. Show your calculations.
4. Suppose Grossman Corporation has the opportunity to open another division, the Southern Division, whose revenues and costs are expected to be identical to the Northern Division's revenues and costs (including a cost of $100,000 to acquire equipment with a one-year useful life and zero terminal disposal value). Opening the new division will have no effect on corporate-office costs. Should Grossman open the Southern Division? Show your calculations.

11-35 Make or buy, unknown level of volume. (A. Atkinson) Oxford Engineering manufactures small engines. The engines are sold to manufacturers who install them in such products as lawn mowers. The company currently manufactures all the parts used in these engines but is considering a proposal from an external supplier who wishes to supply the starter assemblies used in these engines.

The starter assemblies are currently manufactured in Division 3 of Oxford Engineering. The costs relating to the starter assemblies for the past 12 months were as follows:

Direct materials	$200,000
Direct manufacturing labor	150,000
Manufacturing overhead	400,000
Total	$750,000

Over the past year, Division 3 manufactured 150,000 starter assemblies. The average cost for each starter assembly is $5 ($750,000 ÷ 150,000).

Further analysis of manufacturing overhead revealed the following information. Of the total manufacturing overhead, only 25% is considered variable. Of the fixed portion, $150,000 is an allocation of general overhead that will remain unchanged for the company as a whole if production of the starter assemblies is discontinued. A further $100,000 of the fixed overhead is avoidable if production of the starter assemblies is discontinued. The balance of the current fixed overhead, $50,000, is the division manager's salary. If production of the starter assemblies is discontinued, the manager of Division 3 will be transferred to Division 2 at the same salary. This move will allow the company to save the $40,000 salary that would otherwise be paid to attract an outsider to this position.

Required

1. Tidnish Electronics, a reliable supplier, has offered to supply starter-assembly units at $4 per unit. Because this price is less than the current average cost of $5 per unit, the vice president of manufacturing is eager to accept this offer. On the basis of financial considerations alone, should the outside offer be accepted? Show your calculations. (*Hint:* Production output in the coming year may be different from production output in the past year.)
2. How, if at all, would your response to requirement 1 change if the company could use the vacated plant space for storage and, in so doing, avoid $50,000 of outside storage charges currently incurred? Why is this information relevant or irrelevant?

11-36 Make versus buy, activity-based costing, opportunity costs. The Weaver Company produces gas grills. This year's expected production is 20,000 units. Currently, Weaver makes the side burners for its grills. Each grill includes two side burners. Weaver's management accountant reports the following costs for making the 40,000 burners:

	Cost per Unit	Costs for 40,000 Units
Direct materials	$5.00	$200,000
Direct manufacturing labor	2.50	100,000
Variable manufacturing overhead	1.25	50,000
Inspection, setup, materials handling		4,000
Machine rent		8,000
Allocated fixed costs of plant administration, taxes, and insurance		50,000
Total costs		$412,000

Weaver has received an offer from an outside vendor to supply any number of burners Weaver requires at $9.25 per burner. The following additional information is available:

a. Inspection, setup, and materials-handling costs vary with the number of batches in which the burners are produced. Weaver produces burners in batch sizes of 1,000 units. Weaver will produce the 40,000 units in 40 batches.
b. Weaver rents the machine used to make the burners. If Weaver buys all of its burners from the outside vendor, it does not need to pay rent on this machine.

Required

1. Assume that if Weaver purchases the burners from the outside vendor, the facility where the burners are currently made will remain idle. On the basis of financial considerations alone, should Weaver accept the outside vendor's offer at the anticipated volume of 40,000 burners? Show your calculations.
2. For this question, assume that if the burners are purchased outside, the facilities where the burners are currently made will be used to upgrade the grills by adding a rotisserie attachment. (Note: Each grill contains two burners and one rotisserie attachment.) As a consequence, the selling price of grills will be raised by $30. The variable cost per unit of the upgrade would be $24, and additional tooling costs of $100,000 per year would be incurred. On the basis of financial considerations alone, should Weaver make or buy the burners, assuming that 20,000 grills are produced (and sold)? Show your calculations.
3. The sales manager at Weaver is concerned that the estimate of 20,000 grills may be high and believes that only 16,000 grills will be sold. Production will be cut back, freeing up work space. This space can be used to add the rotisserie attachments whether Weaver buys the burners or makes them in-house. At this lower output, Weaver will produce the burners in 32 batches of 1,000 units each. On the basis of financial considerations alone, should Weaver purchase the burners from the outside vendor? Show your calculations.

11-37 Multiple choice, comprehensive problem on relevant costs. The following are the Class Company's unit costs of manufacturing and marketing a high-style pen at an output level of 20,000 units per month:

Manufacturing cost	
Direct materials	$1.00
Direct manufacturing labor	1.20
Variable manufacturing overhead cost	0.80
Fixed manufacturing overhead cost	0.50
Marketing cost	
Variable	1.50
Fixed	0.90

Required

The following situations refer only to the preceding data; there is *no connection* between the situations. Unless stated otherwise, assume a regular selling price of $6 per unit. Choose the best answer to each question. Show your calculations.

1. For an inventory of 10,000 units of the high-style pen presented in the balance sheet, the appropriate unit cost to use is (a) $3.00, (b) $3.50, (c) $5.00, (d) $2.20, or (e) $5.90.

2. The pen is usually produced and sold at the rate of 240,000 units per year (an average of 20,000 per month). The selling price is $6 per unit, which yields total annual revenues of $1,440,000. Total costs are $1,416,000, and operating income is $24,000, or $0.10 per unit. Market research estimates that unit sales could be increased by 10% if prices were cut to $5.80. Assuming the implied cost-behavior patterns continue, this action, if taken, would
   a. decrease operating income by $7,200.
   b. decrease operating income by $0.20 per unit ($48,000) but increase operating income by 10% of revenues ($144,000), for a net increase of $96,000.
   c. decrease fixed cost per unit by 10%, or $0.14, per unit, and thus decrease operating income by $0.06 ($0.20 – $0.14) per unit.
   d. increase unit sales to 264,000 units, which at the $5.80 price would give total revenues of $1,531,200 and lead to costs of $5.90 per unit for 264,000 units, which would equal $1,557,600, and result in an operating loss of $26,400.
   e. None of these
3. A contract with the government for 5,000 units of the pens calls for the reimbursement of all manufacturing costs plus a fixed fee of $1,000. No variable marketing costs are incurred on the government contract. You are asked to compare the following two alternatives:

Sales Each Month to	Alternative A	Alternative B
Regular customers	15,000 units	15,000 units
Government	0 units	5,000 units

   Operating income under alternative B is greater than that under alternative A by (a) $1,000, (b) $2,500, (c) $3,500, (d) $300, or (e) none of these.
4. Assume the same data with respect to the government contract as in requirement 3 except that the two alternatives to be compared are as follows:

Sales Each Month to	Alternative A	Alternative B
Regular customers	20,000 units	15,000 units
Government	0 units	5,000 units

   Operating income under alternative B relative to that under alternative A is (a) $4,000 less, (b) $3,000 greater, (c) $6,500 less, (d) $500 greater, or (e) none of these.
5. The company wants to enter a foreign market in which price competition is keen. The company seeks a one-time-only special order for 10,000 units on a minimum-unit-price basis. It expects that shipping costs for this order will amount to only $0.75 per unit, but the fixed costs of obtaining the contract will be $4,000. The company incurs no variable marketing costs other than shipping costs. Domestic business will be unaffected. The selling price to break even is (a) $3.50, (b) $4.15, (c) $4.25, (d) $3.00, or (e) $5.00.
6. The company has an inventory of 1,000 units of pens that must be sold immediately at reduced prices. Otherwise, the inventory will become worthless. The unit cost that is relevant for establishing the minimum selling price is (a) $4.50, (b) $4.00, (c) $3.00, (d) $5.90, or (e) $1.50.
7. A proposal is received from an outside supplier who will make and ship the high-style pens directly to the Class Company's customers as sales orders are forwarded from Class's sales staff. Class's fixed marketing costs will be unaffected, but its variable marketing costs will be slashed by 20%. Class's plant will be idle, but its fixed manufacturing overhead will continue at 50% of present levels. How much per unit would the company be able to pay the supplier without decreasing operating income? (a) $4.75, (b) $3.95, (c) $2.95, (d) $5.35, or (e) none of these.

11-38 Closing down divisions. Belmont Corporation has four operating divisions. The budgeted revenues and expenses for each division for 2011 follows:

	Division			
	A	B	C	D
Sales	$630,000	$ 632,000	$960,000	$1,240,000
Cost of goods sold	550,000	620,000	765,000	925,000
Selling, general, and administrative expenses	120,000	135,000	144,000	210,000
Operating income/loss	$ (40,000)	$(123,000)	$ 51,000	$ 105,000

Further analysis of costs reveals the following percentages of variable costs in each division:

Cost of goods sold	90%	80%	90%	85%
Selling, general, and administrative expenses	50%	50%	60%	60%

Closing down any division would result in savings of 40% of the fixed costs of that division.

Top management is very concerned about the unprofitable divisions (A and B) and is considering closing them for the year.

Required

1. Calculate the increase or decrease in operating income if Belmont closes division A.
2. Calculate the increase or decrease in operating income if Belmont closes division B.
3. What other factors should the top management of Belmont consider before making a decision?

11-39 Product mix, constrained resource. Westford Company produces three products, A110, B382, and C657. Unit data for the three products follows:

	Product		
	A110	**B382**	**C657**
Selling price	$84	$56	70
Variable costs			
Direct materials	24	15	9
Labor and other costs	28	27	40
Quantity of Bistide per unit	8 lb.	5 lb.	3 lb.

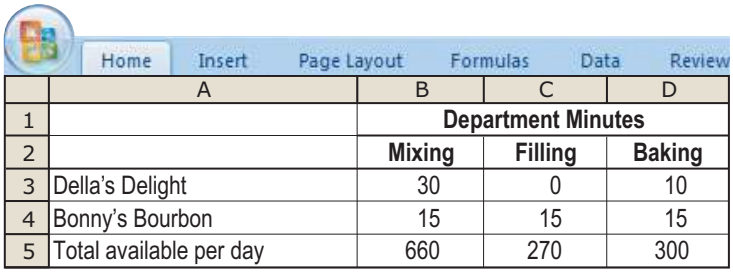
All three products use the same direct material, Bistide. The demand for the products far exceeds the direct materials available to produce the products. Bistide costs $3 per pound and a maximum of 5,000 pounds is available each month. Westford must produce a minimum of 200 units of each product.

Required

1. How many units of product A110, B382, and C657 should Westford produce?
2. What is the maximum amount Westford would be willing to pay for another 1,000 pounds of Bistide?

11-40 Optimal product mix. (CMA adapted) Della Simpson, Inc., sells two popular brands of cookies: Della's Delight and Bonny's Bourbon. Della's Delight goes through the Mixing and Baking departments, and Bonny's Bourbon, a filled cookie, goes through the Mixing, Filling, and Baking departments.

Michael Shirra, vice president for sales, believes that at the current price, Della Simpson can sell all of its daily production of Della's Delight and Bonny's Bourbon. Both cookies are made in batches of 3,000. In each department, the time required per batch and the total time available each day are as follows:



	A	B	C	D
1		**Department Minutes**		
2		**Mixing**	**Filling**	**Baking**
3	Della's Delight	30	0	10
4	Bonny's Bourbon	15	15	15
5	Total available per day	660	270	300

Revenue and cost data for each type of cookie are as follows:

	A	B	C
7		**Della's**	**Bonny's**
8		**Delight**	**Bourbon**
9	Revenue per batch	$ 475	$ 375
10	Variable cost per batch	175	125
11	Contribution margin per batch	$ 300	$ 250
12	Monthly fixed costs		
13	(allocated to each product)	$18,650	$22,350

Required

1. Using *D* to represent the batches of Della's Delight and *B* to represent the batches of Bonny's Bourbon made and sold each day, formulate Shirra's decision as an LP model.
2. Compute the optimal number of batches of each type of cookie that Della Simpson, Inc., should make and sell each day to maximize operating income.

11-41 Dropping a customer, activity-based costing, ethics. Jack Arnoldson is the management accountant for Valley Restaurant Supply (VRS). Bob Gardner, the VRS sales manager, and Jack are meeting to discuss the profitability of one of the customers, Franco's Pizza. Jack hands Bob the following analysis of Franco's activity during the last quarter, taken from Valley's activity-based costing system:

Sales	$15,600
Cost of goods sold (all variable)	9,350
Order processing (25 orders processed at $200 per order)	5,000
Delivery (2,500 miles driven at $0.50 per mile)	1,250
Rush orders (3 rush orders at $110 per rush order)	330
Sales calls (3 sales calls at $100 per call)	300
Profits	($ 630)

Bob looks at the report and remarks, "I'm glad to see all my hard work is paying off with Franco's. Sales have gone up 10% over the previous quarter!"

Jack replies, "Increased sales are great, but I'm worried about Franco's margin, Bob. We were showing a profit with Franco's at the lower sales level, but now we're showing a loss. Gross margin percentage this quarter was 40%, down five percentage points from the prior quarter. I'm afraid that corporate will push hard to drop them as a customer if things don't turn around."

"That's crazy," Bob responds. "A lot of that overhead for things like order processing, deliveries, and sales calls would just be allocated to other customers if we dropped Franco's. This report makes it look like we're losing money on Franco's when we're not. In any case, I am sure you can do something to make its profitability look closer to what we think it is. No one doubts that Franco is a very good customer."

Required

1. Assume that Bob is partly correct in his assessment of the report. Upon further investigation, it is determined that 10% of the order processing costs and 20% of the delivery costs would not be avoidable if VRS were to drop Franco's. Would VRS benefit from dropping Franco's? Show your calculations.
2. Bob's bonus is based on meeting sales targets. Based on the preceding information regarding gross margin percentage, what might Bob have done last quarter to meet his target and receive his bonus? How might VRS revise its bonus system to address this?
3. Should Jack rework the numbers? How should he respond to Bob's comments about making Franco look more profitable?

Collaborative Learning Problem

11-42 Equipment replacement decisions and performance evaluation. Bob Moody manages the Knoxville plant of George Manufacturing. He has been approached by a representative of Darda Engineering regarding the possible replacement of a large piece of manufacturing equipment that George uses in its process with a more efficient model. While the representative made some compelling arguments in favor of replacing the 3-year old equipment, Moody is hesitant. Moody is hoping to be promoted next year to manager of the larger Chicago plant, and he knows that the accrual-basis net operating income of the Knoxville plant will be evaluated closely as part of the promotion decision. The following information is available concerning the equipment replacement decision:

- The historic cost of the old machine is $300,000. It has a current book value of $120,000, two remaining years of useful life, and a market value of $72,000. Annual depreciation expense is $60,000. It is expected to have a salvage value of $0 at the end of its useful life.
- The new equipment will cost $180,000. It will have a two-year useful life and a $0 salvage value. George uses straight-line depreciation on all equipment.
- The new equipment will reduce electricity costs by $35,000 per year, and will reduce direct manufacturing labor costs by $30,000 per year.

For simplicity, ignore income taxes and the time value of money.

Required

1. Assume that Moody's priority is to receive the promotion, and he makes the equipment replacement decision based on next year's accrual-based net operating income. Which alternative would he choose? Show your calculations.
2. What are the relevant factors in the decision? Which alternative is in the best interest of the company over the next two years? Show your calculations.
3. At what cost of the new equipment would Moody be willing to purchase it? Explain.