The CVP (cost-volume-profit) analysis that I learned in Chapter 3 was really helpful in understanding my business when I first started and I still use it for quick assessments when I am considering new ideas. But as U-Develop has expanded beyond photo developing and now includes other photo services and frames, I find myself making decisions about pricing and production routinely. I would like to have a structured way to analyze some of the common decisions I face almost daily about pricing and operations.

U-Develop, the photo-finishing business introduced in Chapter 3, has grown and expanded. Jamaal Kidd, the owner and founder of U-Develop, has added a second store downtown. Some common decisions that he must make include:

- How much business is required to be profitable?
- How should I price special orders?
- Should I do something myself or outsource it to another firm?
- Should I drop one of the products?
- What is the right product mix?

As an owner of a small business, I will have to be especially careful managing costs. Recently, I read an article describing how small-business managers like me were able to save money by analyzing costs to identify better, more efficient ways of doing business. After learning more about cost analysis, I expect to be able to do the same.

What do all of these decisions have in common? They all require an understanding of (1) the effect of the decision on the organization's revenues and costs and (2) the business and competitive environment. In this chapter, we will build on the CVP analysis of Chapter 3 by considering some common business decisions managers face. We will focus on the use of *differential analysis,* which compares alternative actions with the status quo to make decisions.

Our purpose in this chapter is simple. By understanding the types of decisions managers make and how they think about the issues, you will be ready in later chapters to ensure that the cost accounting systems you design will be useful for managers. As a manager who makes the decisions, you will have a better understanding of the strengths and weaknesses of the cost accounting data you will use.

Cost Analysis and the Choice of Office Space for a Small Business *In Action*

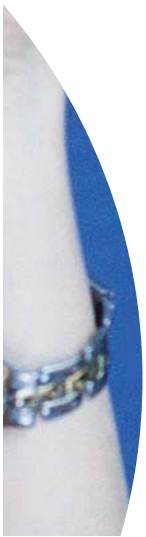
Economic recessions often prompt managers to consider alternatives to current operations that will allow their organizations to continue their business and remain competitive. How much cost can be saved, however, depends in part on the size of the organization. Managers in small organizations must be especially creative in identifying cost-saving ideas. One reporter comments that:

> When it comes to cutting costs during tough economic times, many small businesses start out with a disadvantage: They don't have all that many costs to cut. Even during good times, small businesses tend to keep expenses pretty tight.
>
> The result is that small companies often have to get creative in their efforts to find waste in places where little exists.

An example is Alliance Home Mortgage, a small mortgage provider in Florida. With the slowdown in the housing market and office rental expenses of $10,500 each month, the president considered alternatives to staying in the current location. At first, he looked into a lower-cost alternative, executive suites, which are small offices that house one or two desks and cost about $800 per month. But he would have needed two or three to fit all of the company's staff, an arrangement that wasn't ideal. Instead, the president decided to forgo office space altogether. He signed up with CES Virtual Offices, a company that offers clients a receptionist to answer calls, a corporate mailing address, and e-mail and fax services—all while the staff members work from their homes.

[He] spends about $500 per month altogether for the virtual-office setup. He doesn't cover employees' home-office expenses, but he does offer an extra 5 percent commission to his salespeople as compensation—which generally comes to between $1,000 and $2,000 per month. Because that expense is correlated with sales, it's easier to manage than extra rent, he adds.

Source: Simona Coval, "Looking for Cost Cuts in Lots of New Places," *The Wall Street Journal,* October 16, 2008.



Differential Analysis

L.O. 1
Use differential analysis to analyze decisions.

We start by describing the general approach of differential analysis and identifying decision situations in which it is appropriate. We then illustrate its use with two general applications, pricing and production decisions.

Every decision that a manager makes requires comparing one or more proposed alternatives with the status quo. (If there is only one alternative and the status quo is unacceptable, there really is no decision to make.) The task is to determine how costs in particular and profits in general will be affected if one alternative is chosen over another. This process is called **differential analysis.** Although decision makers are usually interested in all differences between alternatives, including financial and nonfinancial ones, we focus on financial decisions involving costs and revenues.

differential analysis
Process of estimating revenues and costs of alternative actions available to decision makers and of comparing these estimates to the status quo.

Differential analysis is used for both short-run decisions, such as the ones we discuss in this chapter, and long-run decisions, such as those discussed in the Appendix to the book. Generally, when the term **short run** is applied to decision horizons over which capacity will be unchanged, one year is used for convenience..

short run
Period of time over which capacity will be unchanged, usually one year.

One important distinction between short-run and long-run decisions is whether the timing of cash receipts and cash disbursements is important, that is, whether the time value of money is a significant factor. Short-run decisions affect cash flow for such a short period of time that the time value of money is immaterial and hence ignored. Thus, the amount of cash flows is important for short-run analysis, but the timing of the flows is assumed to be unimportant. If an action affects cash flows over a longer period of time (usually more than one year), the time value of money is considered, as discussed in the Appendix to this book.

Decisions by companies to enter markets in China involve long-run differential analysis. Decisions by automobile companies to offer incentives and rebates to boost sales are generally made as if they are short run (companies often discover, however, that these decisions have long-run pricing implications).

differential costs
With two or more alternatives, costs that differ among or between alternatives.

Differential costs change in response to alternative courses of action. Both variable costs and fixed costs may be differential costs. Variable costs are differential when a decision involves possible changes in volume. For example, a decision to close a plant reduces variable costs and usually some fixed costs. All of the affected costs are termed *differential.* On the other hand, if a machine replacement does not affect either the volume of output or the variable cost per unit, variable costs are not differential.

sunk costs
Costs incurred in the past that cannot be changed by present or future decisions.

An important category of costs to identify when making decisions includes costs that were incurred in the past and cannot be changed regardless of the decision made. These costs are called **sunk costs** and are not relevant for the decision. By definition, they cannot be differential because they will be the same for all decisions. Examples of sunk costs include material and equipment already purchased, for which there are no markets for used or preowned goods.

As the examples in this chapter are presented, you will find that differential analysis requires examining the facts for each option relevant to the decision to determine which costs will be affected. Differential and variable costs have independent meanings and applications and should not be considered interchangeable.

Differential Costs versus Total Costs

Although we are focusing on differential costs, the information presented to management can show the detailed costs that are included for making a decision, or it can show just the differences between alternatives, as in the following right-hand column (in thousands).

	Status Quo	Alternative	Difference
Sales revenue	$750	$900	$150
Variable costs	(250)	(300)	(50)
Contribution margin	500	600	100
Fixed costs	(350)	(350)	–0–
Operating profit	$150	$250	$100

The first two columns show the total operating profit under the status quo and the alternative. This part of the presentation is referred to as the *total format.* The third column shows only the differences; this presentation is called the *differential format.* An advantage of the total format is that, first, all the information is available so it is easy to derive the differential format if desired. Second, the total format provides information to managers about the total resources required if one alternative is chosen. The advantage of the differential format is that it highlights the differences between alternatives.

Differential Analysis and Pricing Decisions

L.O. 2
Understand how to apply differential analysis to pricing decisions.

The differential approach is useful for many decisions that managers make about pricing because it provides information about the likely impact of these decisions on profit. We learn in economics that prices are determined by supply and demand. Why do we study pricing decisions in cost accounting? Managers make pricing decisions in part to determine whether they wish to participate in the market, that is, whether to make their products and services available. This is where the supply curve comes from. Thus, we do not say that managers (or firms) set the price; we say that they decide at what price they would be willing to enter the market.

The Full-Cost Fallacy in Setting Prices

In making pricing decisions, it is tempting to consider all costs incurred by the firm, divide them by total volume, and consider the resulting number a minimum price. The terms **full cost** or *full product cost* describe a product's cost that includes both (1) the variable costs of producing and selling the product and (2) a share of the organization's fixed costs. Sometimes decision makers use these full costs, mistakenly thinking that they are variable costs, and fall victim to the full-cost fallacy.

full cost
Sum of all fixed and variable costs of manufacturing and selling a unit.

For example, during the first year of business an employee of U-Develop claimed that accepting a **special order** from a customer for 40 cents a copy would be a mistake. "Since our variable costs are $.36 per print and our fixed costs are $1,500 per month, our total costs for the month without the special order are $5,100 for 10,000 prints. That is 51 cents per print ($5,100 ÷ 10,000), which is more than the 40 cents per copy offered by the customer. We'd be losing 11 cents per print!"

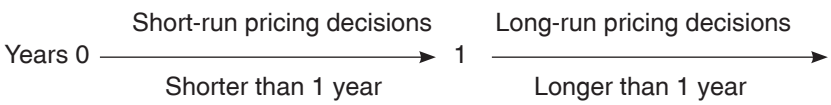
special order
Order that will not affect other sales and is usually a short-run occurrence.

By considering fixed costs in the analysis, the employee might be including irrelevant information. If the fixed costs will be incurred whether the special order is accepted or rejected, these costs should not bear on the decision. Instead, the employee should focus on the variable costs of 36 cents per print in deciding whether to accept the special order from the customer.

This is a common mistake in short-run decisions. All costs must be covered in the long run or the company will fail. In the short run, it will be profitable to accept the order because the price of 40 cents per print exceeds variable costs of 36 cents per print, assuming that this price does not affect other business at the company. Full product costs serve a wide variety of important purposes, but they are generally not relevant to the type of short-run operating decision described in this example.

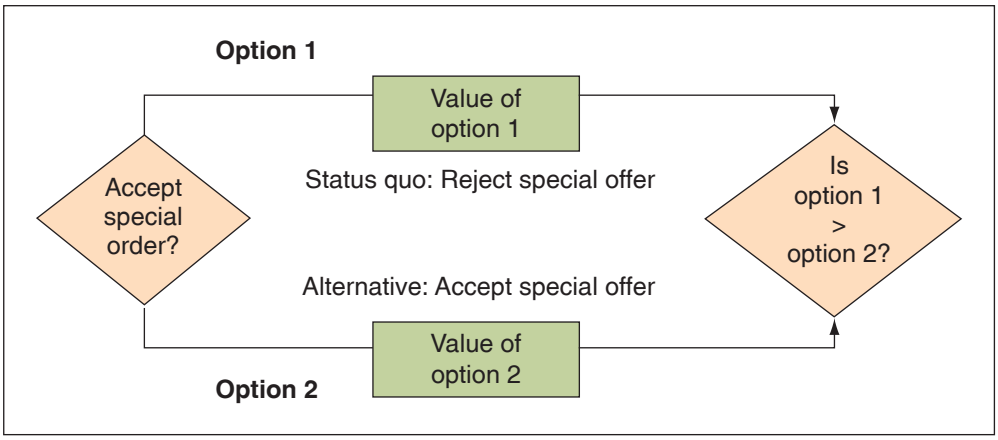
Short-Run versus Long-Run Pricing Decisions

The time horizon of the decision is critical in computing the relevant costs in a pricing decision. The two ends of the time-horizon spectrum are as follows:



Short-run decisions include (1) pricing for a one-time-only special order with no long-term implications and (2) adjusting product mix and volume in a competitive

Exhibit 4.1
Framework for Decision Making



market. The time horizon is typically one year or less. Long-run decisions include pricing a main product in a large market in which there is considerable leeway to set prices. Managers often use a time horizon of longer than a year for these long-run decisions.

For example, a college's order for shipping athletic equipment to a football bowl site involves a short-run pricing decision by FedEx. Determining prices for a new ground package delivery service is, however, a long-run pricing decision.

Short-Run Pricing Decisions: Special Orders

The differential approach particularly helps in making decisions regarding special orders where the order will not affect other sales and is not expected to recur. Determining which costs are relevant depends on the decision being considered. A framework for decision making, based on a company that receives a special order, is diagrammed in Exhibit 4.1. Each alternative is stated as a branch of a decision tree and then the value of each alternative is determined. Finally, the alternative with the highest value is chosen.

U-Develop now has a machine in a stand-alone kiosk where customers can bring various digital photo media (cartridges, sticks, etc.) and make paper prints of their pictures. The machine is usually idle about two hours each day. The art teacher at the local high school asks U-Develop to allow the students in the photography club to come in during idle periods to print pictures taken for a school contest. U-Develop has idle capacity adequate for this job, which will not affect other sales. The teacher, who has a limited budget, asks Jamaal Kidd, the U-Develop owner, for a special price of 40 cents a print for the 500 pictures the students have taken. The regular price is 50 cents.

In deciding whether to accept the special order, Jamaal estimates the following operating data for the week in question:

	A	B	C
1	Sales (5,000 prints at 50¢)	$ 2,500	
2	Variable costs, including paper, maintenance, and usage payment to machine owner (5,000 copies at 20¢)	1,000	
3	Total contribution margin	$ 1,500	
4	Fixed costs (supplies, plus allocated costs of the print shop)	1,200	
5	Operating profit	$ 300	
6			

	A	B	C	D	E
1		**Status Quo:**	**Alternative:**		
2		**Reject Special Order**	**Accept Special Order**	**Difference**	
3	*Comparison of Totals*				
4	Sales revenue	$ 2,500	$ 2,700	$ 200	
5	Variable costs	(1,000)	(1,100)	(100)	
6	Total contribution	$ 1,500	$ 1,600	$ 100	
7	Fixed costs	(1,200)	(1,200)	–0–	
8	Operating profit	$ 300	$ 400	$ 100	
9	*Alternative Presentation: Differential Analysis*				
10	Differential sales, 500 at 40¢		$ 200		
11	Less differential costs, 500 at 20¢		100		
12	Differential operating profit (before taxes)		$ 100		
13					

Exhibit 4.2
Analysis of Special Order—U-Develop

To make the decision, the owner identifies the alternatives, determines the value of each alternative to the company, and selects the alternative with the highest value to the company.

The values of the alternatives are shown in Exhibit 4.2. The best economic decision is to accept the order because the company will gain $100 from it. Fixed costs are not affected by the decision because they are not differential in this situation. Therefore, they are not relevant.

The differential approach to pricing works well for special orders, but some criticize its use for pricing a firm's regular products. Critics suggest that following the differential approach in the short run leads to underpricing in the long run because the contribution to covering fixed costs and generating profits will be inadequate.

A second criticism of the differential approach is that it may be difficult to sell a product to a customer at a reduced price on a particular day when capacity utilization happens to be low if that customer might return on another day when capacity utilization happens to be high. For example, many analysts worry that the U.S. auto industry's cycle of discounting cars will be difficult to break, even after capacity is cut to be more in line with demand. We see similar behavior in the airline industry, where customers strategically withhold purchases until the last minute, expecting carriers to discount fares. The root of the problem is that pricing is dynamic, not just a static optimization of profits during the period of low demand.

Others respond to these criticisms in two ways. First, the differential approach does lead to correct short-run pricing decisions. Once the firm has set plant capacity and incurred fixed costs, the fixed costs become irrelevant to the short-run pricing decision. Clearly, airlines understand this with their discount fares. The firm must attempt to set a price that at least equals the differential, or variable, costs.

Second, in both the short and long runs, the differential approach indicates only the minimum acceptable price. The firm always can charge a higher amount, depending on its customers and competitors. Some of these issues are pursued in this chapter's questions and exercises.

The U-Develop example also illustrates a limitation in using financial analyses for many business decisions. There are several benefits that are difficult to quantify and are, therefore, excluded from the analysis. By offering this discount to the school club, Jamaal is encouraging an interest in photography and contributing to the development of the students. These are factors that Jamaal can and should consider before deciding whether to accept the offer.

Self-Study Question

1. Live Oak Products has an annual plant capacity to produce 50,000 units. Its predicted operations for the year follow:

Sales revenue (40,000 units at $20 each)	$800,000
Manufacturing costs	
Variable	$8 per unit
Fixed	$200,000
Selling and administrative costs	
Variable (commissions on sales)	$2 per unit
Fixed	$40,000

Should the company accept a special order for 4,000 units at a selling price of $15 each, which is subject to half the usual sales commission rate per unit? Assume no effect on fixed costs or regular sales at regular prices. What is the effect of the decision on the company's operating profit?

The solution to this question is at the end of the chapter on page 152.

Long-Run Pricing Decisions

L.O. 3 Understand several approaches for establishing prices based on costs for long-run pricing decisions.

Most firms rely on full cost information reports when setting prices. *Full cost* is the total cost to produce and sell a unit; it includes all costs incurred by the activities that make up the value chain. Typically, the accounting department provides cost reports to the marketing department, which then adds appropriate markups to determine benchmark or target prices for all products the firm normally sells. This approach is often called cost-plus.

Using full costs for pricing decisions can be justified in three circumstances:

- When a firm enters into a long-term contractual relationship to supply a product, most activity costs depend on the production decisions under the long-term contract. Therefore, full costs are relevant for the long-term pricing decision.
- Many contracts for developing and producing customized products and those entered into with governmental agencies specify prices as full costs plus a markup. Prices set in regulated industries such as electric utilities also are based on full costs.
- Firms initially can set prices based on full costs and then make short-term adjustments to reflect market conditions. Accordingly, they adjust the prices of the product downward to acquire additional business. Conversely, when demand for their products is high, firms recognize the greater likelihood that the existing capacity of activity resources is inadequate to satisfy all of the demand. Accordingly, they adjust the prices upward based on the higher incremental costs when capacity is fully utilized.

Long-Run versus Short-Run Pricing: Is There a Difference?

When used in pricing decisions, the differential costs required to sell and/or produce a product provide a floor. In the short run, differential costs may be very low, as when selling one additional seat on an already scheduled airline flight or allowing one more student into an already scheduled college course.

In the long run, however, differential costs are much higher than in the short run. For an airline, long-run differential costs include the costs to buy and maintain the aircraft and to pay crew salaries, landing fees, and so forth. In the long run, these costs must be covered. To simplify this type of analysis, the full product costs to make and/or sell a product are often used to estimate long-run differential costs. Hence, a common saying in business is: I can drop my prices to just cover variable costs in the short run, but in the long run, my prices have to cover full product costs.

Cost Analysis for Pricing

To this point, we have discussed differential analysis and its usefulness for short-run and long-run pricing decisions. Several other approaches are used, however, to establish prices based on costs. In addition to the cost-plus or full-cost approach described earlier,

two approaches—life-cycle product costing and pricing and target costing from target pricing—are discussed here. In general, these approaches are especially useful in making long-run pricing decisions.

Life-Cycle Product Costing and Pricing

The **product life cycle** covers the time from initial research and development to the time at which support to the customer is withdrawn. For pharmaceuticals, this time span may be several years. For some electronic goods, it may be less than one year.

product life cycle
Time from initial research and development to the time that support to the customer ends.

Managers estimate the revenues and costs for each product from its initial research and development to its final customer support. Life-cycle costing tracks costs attributable to each product from start to finish. The term *cradle-to-grave costing* conveys the sense of capturing all life-cycle costs associated with a product.

Life-cycle costs provide important information for pricing. For some companies, such as Merck and Pfizer in pharmaceuticals and Boeing and Airbus in aircraft, the development period is relatively long, and many costs are incurred prior to manufacturing.

The life-cycle costs for aircraft include many costs incurred prior to manufacturing.

A product life-cycle budget highlights for managers the importance of setting prices that will cover costs in all value-chain categories, not just in the production through customer service categories. To be profitable, companies must generate enough revenue to cover costs incurred in all categories of the value chain.

Life-cycle costing is becoming increasingly important as environmental regulations that require firms to "take back" and dispose of the product at the end of the life cycle are adopted. These regulations give literal meaning to the phrase "cradle-to-grave." The costs of recycling used products are especially important for certain companies—for example, refrigerator manufacturers, such as Whirlpool and GE, and producers of toner cartridges for printers, such as Hewlett-Packard and Epson. These firms need to consider these additional costs at the end of the useful life of the product in making pricing decisions.

Life-cycle costing includes the cost of taking back used products.

As described in the *In Action* feature, Take-Back Laws in Europe, these laws make the costs of recycling and disposal of products the responsibility of the manufacturer. This, in turn, can affect product design as manufacturers trade off the cost of manufacture and disposal. For example,

Take-Back Laws in Europe *In Action*

In 2003, the European Union approved a directive on Waste Electrical and Electronic Equipment (WEEE). Under this directive, which member states were supposed to implement by 2004, producers must pay the cost of taking back old equipment and recycling a large percentage of its weight. Only one member state (Cyprus) met the deadline. Other states have developed or are developing guidelines for meeting the directive. For example, as of July 1, 2007, producers in the U.K. will be responsible "for the costs of treating household WEEE."

One result of these laws is that firms are looking at cost information for ways to economically reclaim, recondition, and resell products that have been used by consumers. Guide and Wassenhove describe how Bosch remanufactures and resells power hand tools. Due to this "reverse supply chain," Bosch considers the cost to reclaim and remanufacture the tool in the initial product design.

Sources: *Economist,* March 15, 2003; V.D.R. Guide, Jr., and L.N. Wassenhove, "The Reverse Supply Chain," *Harvard Business Review,* 2002; and http://www.netregs.gov.uk/netregs/legislation/380525/473094/?lang=_e.

some materials may be easier to work with in manufacturing the product but are more difficult to dispose of or recycle.

target price
Price based on customers' perceived value for the product and the price that competitors charge.

target cost
Equals the target price minus the desired profit margin.

Target Costing from Target Pricing Simply stated, target costing is the concept of "price-based costing" instead of "cost-based pricing." A **target price** is the estimated price for a product or service that potential customers will be willing to pay. A **target cost** is the estimated long-run cost of a product or service whose sale enables the company to achieve targeted profit. We derive the target cost by subtracting the target profit from the target price. For instance, assume that Dell can sell an MP3 player for $200 and wants profits of at least $20; this means that Dell needs to find a way to limit costs to $180. Target costing is widely used by companies including Mercedes Benz and Toyota in the automobile industry, Panasonic and Sharp in the electronics industry, and Apple and Toshiba in the personal computer industry.

Legal Issues Relating to Costs and Sales Prices

Predatory Pricing

predatory pricing
Practice of setting price below cost with the intent to drive competitors out of business.

Laws in many countries, including the United States, require managers to take costs into account when they set sales prices. For example, managers will face charges of predatory pricing if they set prices below costs. **Predatory pricing** is the practice of setting the selling price of a product at a low price with the intent of driving competitors out of the market or creating a barrier to entry for new competitors. For the practice to be predatory, managers must set the price below cost and intend to harm competition. In many countries, including the United States, predatory pricing is anticompetitive and illegal under antitrust laws.

At first, you might wonder what is wrong with setting prices low and intending to harm competition. It sounds like free enterprise, and setting prices low is normally good for consumers. The legal problem arises when prices are set sufficiently low to drive competitors out of the market or keep competitors out of the market. With little competition left in the market, the company that has set predatory prices is able to act like a monopolist and hit consumers with high prices. From the consumers' point of view, they benefit in the short run when the "predators" set prices low, but these same consumers suffer in the long run when they face monopoly prices.

One usually finds evidence of predatory pricing when larger companies drive out smaller companies. For example, a small airline recently added several routes to compete with one of the large, international airlines. In response, the large airline dropped its prices below those of the small airline. The small airline went bankrupt and stopped flying those routes. The large airline then raised its prices.

To qualify as predatory pricing, the "predator" must drop its prices below costs. In theory, pricing below marginal costs is irrational because the marginal revenue from each unit sold is less than the marginal cost. Why would a manager set prices below marginal cost, thereby incurring a loss on each unit sold? Regulators argue that managers who set prices below marginal costs are likely to do so to drive out competition so they can later raise prices to recoup the losses. If you combine the act of setting prices below costs with intent to harm competition, then you have predatory pricing.

In theory, setting prices below marginal costs is one of the tests for predatory pricing. In practice, however, marginal costs are difficult to measure. Therefore, courts have generally used average variable costs as the floor below which prices should not be set.[1]

Dumping

dumping
Exporting a product to another country at a price below domestic cost.

Dumping occurs when a company exports its product to consumers in another country at an export price that is below the domestic price. The harm to consumers is similar to that imposed by predatory pricing. For example, suppose an electronics company in a foreign

[1] For an authoritative work on antitrust law, see P.E. Areeda and H. Hovenkamp, *Antitrust Law: An Analysis of Antitrust Principles and Their Application* (Aspen Publishers, 2006).

country sells its products in the United States at a price below what it charges in its domestic market. Eventually, U.S. electronics companies will be unable to compete and will go out of business. Now the foreign company has an opportunity to raise its prices *above* what consumers in the United States paid prior to the foreign company's practice of dumping. Consumers may appear to have a good deal when foreign companies dump their products at a discount, but these same consumers would suffer if the U.S. companies no longer existed. Market prices would no longer be competitive.

Many industries, such as airlines, steel, and navigational electronics equipment, provide goods and services that are important to the U.S. national defense. The U.S. federal government considers it important to keep at least the capability to produce such goods and services in the United States.

Policymakers disagree on the merits of prohibiting dumping. On the one hand, protection of domestic industry has national security benefits and it benefits the employees of those protected industries. On the other hand, dumping is simply a practice of free trade and free markets. Restrictions that create oligopoly power generally hurt consumers. Managers in many industries have sought protection against dumping, including producers of semiconductors, shoes, automobiles, textiles, computers, and lumber. The remedies to domestic producers are usually tariffs on the dumped products that bring their prices up to the level of prices charged by domestic companies.

While we have used the United States to demonstrate how dumping works, many countries must deal with dumping. For example, the European Union (EU) recently assigned tariffs to shoes imported from China and Vietnam because shoe producers in those countries were dumping their goods in the EU.

Price Discrimination

Price discrimination is the practice of selling identical goods or services to different customers at different prices. Price discrimination requires market segmentation. For example, a movie theater may sell tickets to the same movie at the same time to students for $7 and nonstudents for $14. In this case, student status segments the market.

price discrimination
Practice of selling identical goods to different customers at different prices.

Airlines use price discrimination when they sell tickets to different customers at different prices for the same flight. Customers who stay at a destination over Saturday night are sometimes charged a lower fare than customers who fly the same flights but do not stay over Saturday night. The airlines' idea is to segment customers into a group that is more price sensitive and a group that is less price sensitive. Business travelers are usually less price sensitive than pleasure travelers and generally do not stay over Saturday night at their destinations. Managers of movie theaters segment the market of movie goers into a price-sensitive segment—students—and a less price-sensitive segment—nonstudents.

Price discrimination benefits companies because it enables them to sell products to customers who might not otherwise purchase them. For example, if an airline has empty seats, it would rather sell those seats at a discount than not at all.

Certain types of price discrimination are illegal. For example, price discrimination on the basis of race, religion, disability, or gender is illegal. Some companies take advantage of people who have been struck by tragedies, such as tornadoes, hurricanes, or personal disasters. Even if not illegal, discriminating against victims of natural or personal disasters is often considered to be unethical.

Peak-Load Pricing

Peak-load pricing is the practice of setting prices highest when the quantity demanded for the product approaches the physical capacity to produce it. Many companies, such as electrical and telephone utilities, engage in peak-load pricing in providing service at high demand levels. For example, in warm weather geographic locations, peak loads for electricity occur in the late afternoon hours when the temperature is highest. For providers of telephone services, the peak loads are often during the weekdays and daytime hours. Prices are highest per unit of service at those times and lower at other times. Hence, you can get lower rates for telephone and electricity services at off-peak times.

peak-load pricing
Practice of setting prices highest when the quantity demanded for the product approaches capacity.

Price Fixing

price fixing
Agreement among business competitors to set prices at a particular level.

Price fixing is the agreement among business competitors to set prices at a particular level. Generally, the idea is to "fix" prices at a level higher than equilibrium prices in competitive markets. The Organization for Petroleum Exporting Countries (OPEC) provides us with a daily reminder of the effects of price fixing. OPEC sets prices for its members that are likely above equilibrium prices in a competitive market for oil.

Price fixing is a particular legal and ethical problem because it is not universally illegal. In many developing countries, price fixing is not illegal. Companies with business units in both developed and developing countries face different sets of rules depending on where managers are doing business. OPEC, for example, operates legally in setting oil prices because its activities are not illegal in its member countries.

Managers must be particularly alert to price fixing because the activities that law enforcement officials regard as illegal include even informal or unspoken agreements to fix prices. This appears to be the case in recent allegations of price fixing in the market for dynamic random access memory (DRAM) chips. Companies from Germany, South Korea, and Japan were charged with price fixing in their U.S. operations.

Use of Differential Analysis for Production Decisions

L.O. 4
Understand how to apply differential analysis to production decisions.

We now apply our cost analysis concepts to production and operating decisions. The following are typical production and operating questions that managers often ask:

- Should we make the product internally or buy it from an outside source (called *outsourcing*)?
- Should we add to or drop parts of our operations?
- Which products should we continue to produce and which should we drop?

This chapter provides several approaches to addressing these questions. As you go through each, ask yourself what costs and revenues will differ as a result of the choices made and which course of action would be the most profitable for the company.

Make-It or Buy-It Decisions

make-or-buy decision
Decision concerning whether to make needed goods internally or purchase them from outside sources.

A **make-or-buy decision** is any decision by a company to acquire goods or services internally or externally. A restaurant that uses its own ingredients in preparing meals "makes"; one that serves meals from frozen entrees "buys." A steel company that mines its own iron ore and processes it into pig iron makes; one that purchases it for further processing buys.

The make-or-buy decision is often part of a company's long-run strategy. Some companies choose to integrate vertically (own the firms in the supply chain) to control the activities that lead to the final product; others prefer to rely on outsiders for some inputs and specialize in only certain steps of the total manufacturing process. Aside from strategic issues, the make-or-buy decision is ultimately a question of which firm in the value chain can produce the product or service at the lowest cost.

Whether to rely on outsiders for a substantial amount of materials depends on both differential cost comparisons and other factors that are not easily quantified, such as suppliers' dependability and quality control. Although make-or-buy decisions sometimes appear to be simple one-time choices, frequently they are part of a more strategic analysis in which top management makes a policy decision to move the company toward more or less vertical integration.

Make-or-Buy Decisions Involving Differential Fixed Costs

After several years in the business, U-Develop has grown significantly and offers a broad range of photographic supplies and services. Among other services, it continues

to develop prints from film (nondigital) cameras. The current cost of developing prints follows:

	Per Unit	100,000 Units
Costs that can be directly assigned to the product:		
Direct materials	$0.05	$ 5,000
Direct labor	0.12	12,000
Variable manufacturing overhead	.03	3,000
Fixed manufacturing overhead		4,000
Common costs allocated to this product line		10,000
Total costs		$34,000

This year's expected volume is 100,000 units, so the full cost of processing a print is $.34 (= $34,000 ÷ 100,000 units).

U-Develop has received an offer from an outside developer to process any desired volume of prints for $.25 each. The accounting department prepared this differential cost analysis for management:

- Differential costs are materials, labor, and variable overhead and definitely will be saved by outsourcing the processing of the prints.
- The direct fixed cost is the cost of leasing the machine to process the prints. Although the machine cost is fixed for levels of production ranging from 1 to 200,000 units, we can eliminate it if we stop processing prints. Thus, although the machine cost is a fixed cost of processing prints, it is a differential cost if we eliminate the product.
- No other costs are affected.

The accounting department also prepared cost analyses at volume levels of 50,000 and 100,000 units per year (see Exhibit 4.3). At a volume of 100,000 units, it is less costly

Exhibit 4.3
Make-or-Buy Analysis
U-Develop

	Status Quo: Process Prints	Alternative: Outsource Processing	Difference
100,000 Units			
Direct materials	$ 5,000	$25,000[a]	$20,000 higher
Labor	12,000	–0–	12,000 lower
Variable overhead	3,000	–0–	3,000 lower
Fixed overhead	4,000	–0–	4,000 lower
Common costs	10,000[b]	10,000[b]	–0–
Total costs	$34,000	$35,000	$ 1,000 higher
Differential costs *increase* by $1,000, so reject alternative to *buy*.			
50,000 Units			
Direct materials	$ 2,500[c]	$12,500[d]	$10,000 higher
Labor	6,000[c]	–0–	6,000 lower
Variable overhead	1,500[c]	–0–	1,500 lower
Fixed overhead	4,000	–0–	4,000 lower
Common costs	10,000[b]	10,000[b]	–0–
Total costs	$24,000	$22,500	$ 1,500 lower
Differential costs *decrease* by $1,500, so accept alternative to *buy*.			

[a] 100,000 units purchased at $.25 = $25,000.

[b] These common costs remain unchanged for these volumes. Because they do not change, they could be omitted from the analysis.

[c] Total variable costs reduced by half because volume was reduced by half.

[d] 50,000 units purchased at $.25 = $12,500.

for U-Develop to process the prints, but if the volume drops to 50,000, U-Develop would save money by outsourcing the processing.

This decision is sensitive to volume. To see why, consider only the costs affected by the make-or-buy decision: direct materials, direct labor, variable overhead, and fixed overhead. By setting the costs to make equal to the costs to buy, we find that a unique volume exists at which U-Develop is indifferent (in terms of costs):

Make				Buy
Direct Fixed Overhead	+	Variable Manufacturing Costs	=	Cost to Outsource Processing
$4,000	+	$.20X	=	$.25X

where X equals the number of prints processed.

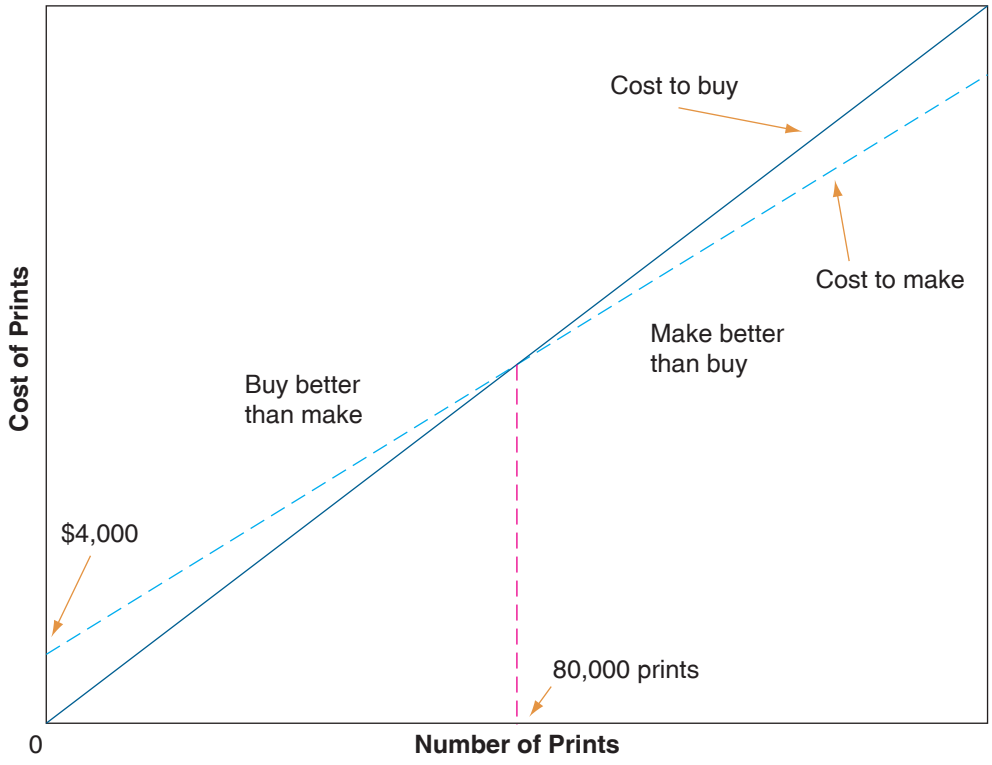
Solve for X:

$$\$4{,}000 + \$.20X = \$.25X$$
$$\$4{,}000 = \$.05X$$
$$\$4{,}000 \div \$.05 = X$$
$$X = 80{,}000$$

Exhibit 4.4 shows the result graphically. At a volume higher than 80,000, the preferred alternative is to make; at a volume less than 80,000, the preferred alternative is to buy (i.e., outsource).

We can also find the volume where the cost to make is the same as the cost to buy by using the Goal Seek formula in Microsoft Excel®. The method is the same one we used to solve for the break-even point in Chapter 3. We want to find the point at which the difference between the cost to make and the cost to buy is equal to zero. Exhibit 4.5, Panel A, shows how the spreadsheet is set up.

Exhibit 4.4
Graphical Analysis of Make-or-Buy Analysis—U-Develop



	A	B	C
1	Quantity	10,000	
2			
3	Cost to make:		
4	Fixed cost	$ 4,000	
5	Variable cost per unit	0.20	
6	Total cost to make	$ 6,000	
7			
8			
9	Cost to buy:		
10	Fixed cost	$ –	
11	Variable cost per unit	0.25	
12	Total cost to buy	$ 2,500	
13			
14	Difference (Cost to make – Cost to buy)	$ 3,500	
15			

Exhibit 4.5, Panel A Using Excel to Find the Quantity Where the Cost to Make Equals the Cost to Buy

We then use the Goal Seek function in Excel to find the quantity (in cell B1) that makes the difference between the cost to make and the cost to buy (in cell B14) exactly equal to zero. This is shown in Exhibit 4.5, Panel B.

	A	B	C	D	E	F
1	Quantity	10,000				
2						
3	Cost to make:					
4	Fixed cost	$ 4,000				
5	Variable cost per unit	0.20				
6	Total cost to make	$ 6,000				
7						
8						
9	Cost to buy:					
10	Fixed cost	$ –				
11	Variable cost per unit	0.25				
12	Total cost to buy	$ 2,500				
13						
14	Difference (Cost to make – Cost to buy)	$ 3,500				
15						

Goal Seek

Set cell: B14

To value: 0

By changing cell: B1

OK Cancel

Exhibit 4.5, Panel B Setting Up the Goal Seek Solution

The solution is shown in Exhibit 4.5, Panel C.

	A	B	C	D	E	F
1	Quantity	80,000				
2						
3	Cost to make:					
4	Fixed cost	$ 4,000				
5	Variable cost per unit	0.20				
6	Total cost to make	$ 20,000				
7						
8						
9	Cost to buy:					
10	Fixed cost	$ –				
11	Variable cost per unit	0.25				
12	Total cost to buy	$ 20,000				
13						
14	Difference (Cost to make – Cost to buy)	$ –				
15						

Goal Seek Status

Goal Seeking with Cell B14 found a solution.

Target value: 0

Current value: $-

OK Cancel Step Pause

Exhibit 4.5, Panel C The Goal Seek Solution

Note the importance of separating fixed and variable costs for this analysis. Although determining differential costs usually requires a special analysis, the work can be made simpler if the accounting system routinely separates costs into fixed and variable components. The previous analysis would not have been possible for U-Develop had overhead costs not been separated into fixed and variable components.

Opportunity Costs of Making

Suppose that U-Develop's volume is projected to be 100,000 prints. If it is expected to be more than 80,000 prints, the preceding analysis indicates that U-Develop should continue to produce them. However, that analysis has not considered the opportunity cost of using the facilities to process prints. Recall that opportunity costs are the forgone returns from not employing a resource in its best alternative use. Theoretically, determining opportunity cost requires considering every possible use of the resource in question. If U-Develop has no alternative beneficial use for its facilities, the opportunity cost is zero, in which case the previous analysis would stand.

Suppose, however, that the facilities to process prints could be used to take passport and visa photos. This new service would provide a $2,000 differential contribution. If the passport and visa service is the best alternative use of the facility, the opportunity cost of using the facility to process prints is $2,000. In that case, U-Develop would be better off outsourcing the processing and using the facilities to offer the passport and visa service, as shown by the two alternative analyses of the problem in Exhibit 4.6.

Exhibit 4.6
Make-or-Buy Analysis with Opportunity Cost of Facilities—U-Develop

Panel A

	Status Quo: Process Prints	Alternative: Outsource Processing; Use Facilities for Passport and Visa Service	Difference
Method 1			
Total cost of 100,000 prints	$34,000	$35,000	$1,000 higher[a]
Opportunity cost of using facilities to process prints . . .	2,000	–0–	2,000 lower[a]
Total costs, including opportunity costs	$36,000	$35,000	$1,000 lower[a]

Differential costs decrease by $1,000, so accept the alternative.

Panel B

	Status Quo: Process Prints	Alternative: Outsource Processing; Use Facilities for Passport and Visa Service	Difference
Method 2			
Total cost of 100,000 prints	$34,000	$35,000	$1,000 higher[a]
Opportunity cost of using facilities to process prints . . .	–0–	(2,000)	2,000 lower[a]
Total costs, including opportunity costs	$34,000	$33,000	$1,000 lower[a]

Differential costs decrease by $1,000, so accept the alternative.

[a] These indicate whether the alternative is higher or lower than the status quo.

Determining opportunity cost is typically very difficult and involves considerable subjectivity. Opportunity costs are not routinely reported with other accounting cost data because they are not the result of completed transactions. Some opportunity costs, such as the alternative use of plant facilities as just described, can be estimated in monetary terms; others, like the loss of control over production, might not be so readily quantified. When a benefit is forgone, it is not possible to determine whether the opportunity cost estimate is realistic.

The fact that they are difficult to estimate or subject to considerable uncertainty does not mean opportunity costs should be ignored (as they often are). Opportunity costs can represent a substantial part of the cost of an alternative, and the financial analyst has to be aware of the forgone opportunities when preparing the analysis.

Self-Study Question

2. EZ Stor, Inc., produces hard disk drives of various sizes for use in computer and electronic equipment. Costs for one product, EZ-5, follow for the normal volume of 5,000 per month.

Unit manufacturing costs		
Variable materials	$30	
Variable labor	5	
Variable overhead	5	
Fixed overhead	50	
Total unit manufacturing costs		$ 90
Unit nonmanufacturing costs		
Variable	$10	
Fixed	20	
Total unit nonmanufacturing costs		30
Total unit costs		$120

A proposal is received from an outside supplier who will test, produce, and ship 1,000 units per month directly to EZ Stor's customers as orders are received from EZ's sales force. EZ Stor's fixed and variable nonmanufacturing costs would be unaffected, but its variable manufacturing costs would be cut by 20 percent per unit for those 1,000 units shipped by the contractor. EZ Stor's plant would operate at 80 percent of its normal level, and total fixed manufacturing costs per month would be cut by 10 percent. Should the proposal be accepted for a payment to the contractor of $38 per unit? (Revenue information is not needed to answer this question.)

The solution to this question is at the end of the chapter on page 153.

Decision to Add or Drop a Product Line or Close a Business Unit

Managers often must decide whether to add or drop a product line or close a business unit. Product lines that were formerly profitable may be losing market share to newer products. For example, VCR production may be having difficulty competing with new DVD technology. As a result, companies are forced to rethink their approach to the market.

Today, U-Develop sells film processing (prints), cameras, and frames. Jamaal Kidd, the owner, is deciding whether to drop processing because the volume of their sales has declined. Exhibit 4.7 shows the financial statements prepared by U-Develop's accountant.

Although the economics of dropping the prints appeared favorable, the manager asked the accountant to investigate which costs were differential (that is, avoidable in this case) if the prints were dropped. The accountant reported the following:

- All variable costs of goods sold for that line could be avoided.
- All salaries presently charged to prints, $1,000, could be avoided.
- None of the rent could be avoided.
- Marketing and administrative costs of $250 could be saved.

Exhibit 4.7
Fourth Quarter Product Line Income Statement—U-Develop

	Total	Prints	Cameras	Frames
Sales revenue	$80,000	$10,000	$50,000	$20,000
Cost of sales (all variable)	53,000	8,000	30,000	15,000
Contribution margin	$27,000	$ 2,000	$20,000	$ 5,000
Less fixed costs:				
Rent	4,000	1,000	2,000	1,000
Salaries	5,000	1,000	2,500	1,500
Marketing and administrative	3,000	500	1,500	1,000
Operating profit (loss)	$15,000	$ (500)	$14,000	$ 1,500

Exhibit 4.8
Differential Analysis—U-Develop

	Status Quo: Keep Prints	Alternative: Drop Prints	Difference
Sales revenue	$80,000	$70,000	$10,000 decrease
Cost of sales (all variable)	53,000	45,000	8,000 decrease
Contribution margin	$27,000	$25,000	$ 2,000 decrease
Less fixed costs:			
Rent	4,000	4,000	–0–
Salaries	5,000	4,000	1,000 decrease
Marketing and administrative	3,000	2,750	250 decrease
Operating profit (loss)	$15,000	$14,250	$ 750 decrease

The accountant prepared the differential cost and revenue analysis shown in Exhibit 4.8 and observed the following:

- Assuming that the sales of the other product lines would be unaffected, sales would decrease by $10,000 from dropping the prints.
- Variable cost of goods sold of $8,000 would be saved by dropping the product line.
- Fixed costs of $1,250 ($1,000 in salaries and $250 in marketing and administrative expenses) would be saved.
- In total, the lost revenue of $10,000 exceeds the total differential cost saving by $750. Thus, the net income for U-Develop for the fourth quarter would have been $750 lower if prints had been dropped.

The discrepancy between what is shown on the product line financial statements and the differential analysis stems from the assumptions about differential cost. The financial statement presented in Exhibit 4.7 was designed to calculate department profits, not to identify the differential costs for this decision. Thus, managers relying on operating profit calculated after all cost allocations, including some that are not differential to this decision, would incorrectly conclude that the product line should be dropped. Financial statements prepared in accordance with generally accepted accounting principles do not routinely provide differential cost information. Differential cost estimates depend on unique information that usually requires separate analysis.

The financial statement that was prepared on a contribution margin basis clearly reveals the revenues and variable costs that are differential to this decision. A separate analysis was required, however, to determine which fixed costs were differential. It is possible, of course, to prepare reports that reflect each division's contribution to companywide costs and profits. This segment margin would include division revenues less all direct costs of the division and would exclude allocated costs.

Nonfinancial Considerations of Closing a Business Unit Dropping a product line in some companies is equivalent to closing a business unit. For example,

many auto assembly plants are used for specific models and if those models are dropped, managers will consider closing the plant. In the analysis of U-Develop's product line decision, we focused primarily on the financial aspects of the decision. When a business unit is closed, important nonfinancial impacts need to be considered. Plant closures, for example, have serious effects for the employees and communities involved. For example, when General Motors phased out the Oldsmobile brand, Lansing, Michigan, suffered thousands of job cuts. These nonfinancial considerations are often so important that they outweigh the financial issues.

Product Choice Decisions

Another common managerial decision is determining what products or services to offer. This choice directly affects costs. Many companies are capable of producing a large variety of goods and services but may be limited in the short run by available capacity. For instance, U-Develop had to decide whether to use its limited space to continue to sell prints or expand its sale of frames. In another case, staffing issues may cause a hospital to decide between adding a new intensive care unit and expanding its obstetrics ward.

We usually think of product choices as short-run decisions because we have adopted the definition that in the short run, capacity is fixed, but in the long run, it can be changed. In the long run, the constraints on available capacity can be overcome by capacity addition, but, in the short run, capacity limitations require choices.

For example, U-Develop makes two kinds of picture frames, wood and metal. For now, assume that the company can sell all the frames it produces. Its cost and revenue information is presented in Exhibit 4.9.

As production processes become more flexible, companies can change the product mix at lower cost.

U-Develop can sell 150 metal frames or 150 wooden frames or any combination totaling 150 to break even. The contribution margin of each product is the same, so the profit-volume relationship is the same regardless of the mix of products produced and sold.

U-Develop's objective is to maximize the contribution from its sale of frames, but which should it produce, metal or wood? Without knowing either U-Develop's maximum production capacity or the amount of that capacity used to produce one product or the other, we might say that it doesn't matter because both products are equally profitable. But because capacity is limited, that answer is incorrect if U-Develop uses its capacity at a different rate for each product.

Suppose that U-Develop's capacity is limited to 200 machine-hours per month. This limitation is known as a **constraint.** Further assume that machines may be used to produce either two metal frames or one wooden frame per machine-hour.

constraint
Activity, resource, or policy that limits or bounds the attainment of an objective.

	A	B	C	D	E	F	G	H	
1			Metal Frames			Wood Frames			
2	Price		$ 50			$ 80			
3	Less variable costs per unit								
4	Material		8			22			
5	Labor		8			24			
6	Overhead		4			4			
7	Contribution margin per unit		$ 30			$ 30			
8									
9	Fixed costs								
10	Manufacturing							$ 3,000	
11	Marketing and administrative							1,500	
12	Total							$ 4,500	
13									

Exhibit 4.9
Revenue and Cost Information—U-Develop

Exhibit 4.10
Screenshot of the Data for Metal and Wooden Frames

	A	B	C	D	E	F	G	H	I
1			Metal Frames			Wood Frames			
2	Price		$ 50			$ 80			
3	Less variable costs per unit								
4	Material		8			22			
5	Labor		8			24			
6	Overhead		4			4			
7	Contribution margin per unit		$ 30			$ 30			
8									
9	Fixed costs								
10	Manufacturing							$ 3,000	
11	Marketing and administrative							1,500	
12	Total							$ 4,500	
13									
14									
15	Machine-hours per unit		0.5			1.0			
16	Machine-hours used							200	
17	Machine-hours available							200	
18									
19	Quantity		150			125			
20									
21	Profit		$ 3,750						
22									

contribution margin per unit of scarce resource
Contribution margin per unit of a particular input with limited availability.

With a constrained resource, the important measure of profitability is the **contribution margin per unit of scarce resource** used, not the contribution margin per unit of product. In this case, metal frames are more profitable than wooden frames because metal frames contribute $60 per machine-hour (= $30 per metal frame × 2 metal frames per hour), but wooden frames contribute only $30 per machine-hour (= $30 per wooden frame × 1 wooden frame per machine-hour). The hours required to produce one frame times the contribution per hour equals the contribution per frame.

For the month, U-Develop could produce 400 metal frames (= 2 per hour × 200 hours) or 200 wooden frames (= 1 per hour × 200 hours). If it produces only metal frames, U-Develop's operating profit would be $7,500 (= 400 metal frames × a contribution of $30 each − fixed costs of $4,500). If only wooden frames are produced, U-Develop's operating profit would be only $1,500 (= 200 wooden frames × a contribution margin of $30 each − $4,500). By concentrating on the product that yields the higher contribution per unit of scarce resource, U-Develop can maximize its profit.

We can also use Microsoft Excel's Solver function to find the optimal product mix when there are constraining resources, such as a limited number of machine-hours. Exhibit 4.10 shows the data for U-Develop's decision regarding the production of wooden and metal frames. The data on machine-hours and the profit calculation are added to the basic product data in Exhibit 4.9.

Before we use Solver to find the optimum product mix, we need to ensure that the Solver Add-In is installed in Excel. Click on the Data Tab. If "Solver" appears as an option, it is installed and you do not need to do anything. If Solver is not installed, click on the Office button and choose Excel options. Click on Add-ins. Select Solver Add-in in the section, "Inactive Application Add-ins." Select "Go." A dialog box will open as shown in Exhibit 4.11. Check the "Solver Add-in" box and click OK. You will be guided through the process required to add the Solver module.

With Solver installed, we can use it to find the optimum product mix. The spreadsheet in Panel A of Exhibit 4.12 shows the setup for the problem. Click Tools ⇒ Solver . . . from the menu bar and the dialog box shown in Panel A of Exhibit 4.12 will open. In the edit box "Set Target Cell" enter the cell address for the profit formula. In the next line, click the radio button "Max," signifying you want to maximize profit. In the edit box "By Changing

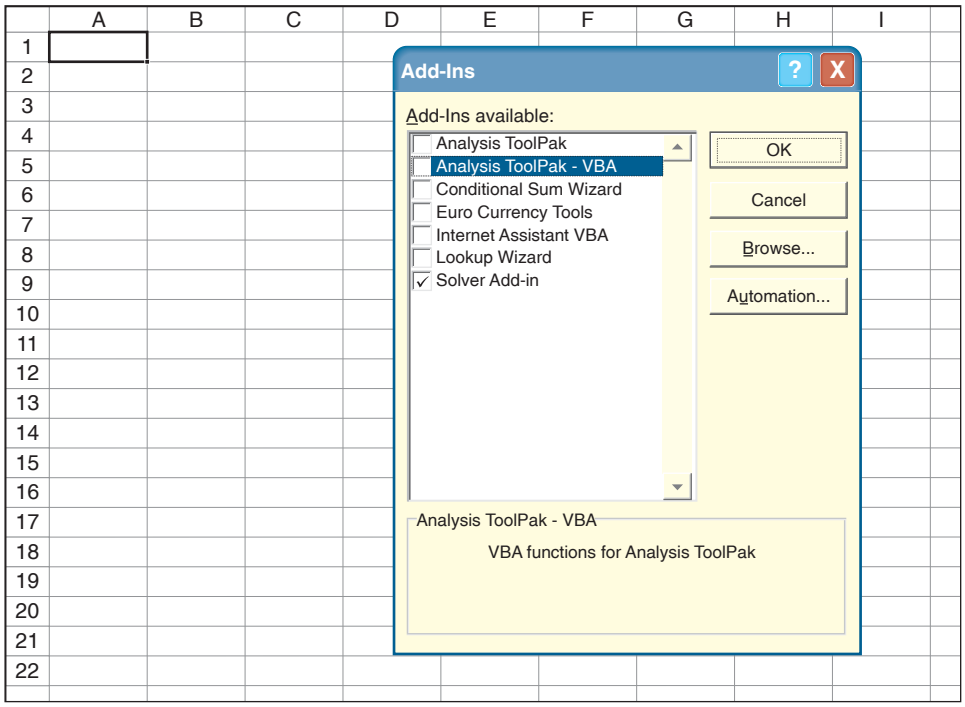


Exhibit 4.11
Installing the Solver Module

Exhibit 4.12 The Solver Solution to the Optimum Product Mix

Panel A

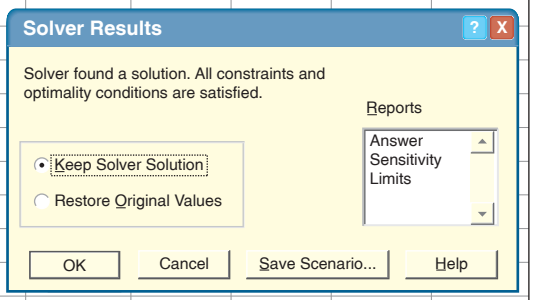
	A	B	C	D	E	F	G	H	I	J	K	L
1			Metal Frames			Wood Frames						
2	Price		$ 50			$ 80						
3	Less variable costs per unit											
4	Material		8			22						
5	Labor		8			24						
6	Overhead		4			4						
7	Contribution margin per unit		$ 30			$ 30						
8												
9	Fixed costs											
10	Manufacturing											
11	Marketing and administrative											
12												
13												
14												
15	Machine-hours per unit		0.5			1.0						
16	Machine-hours used							200				
17	Machine-hours available							200				
18												
19	Quantity		150			125						
20												
21	Profit		$ 3,750									
22												

(*Continued*)

Exhibit 4.12 (*Continued*)

Panel B

	A	B	C	D	E	F	G	H	I	J	K	L
1			Metal Frames			Wood Frames						
2	Price		$ 50			$ 80						
3	Less variable costs per unit											
4	Material		8			22						
5	Labor		8			24						
6	Overhead		4			4						
7	Contribution margin per unit		$ 30			$ 30						
8												
9	Fixed costs											
10	Manufacturing											
11	Marketing and administrative											
12								$ 4,500				
13												
14												
15	Machine-hours per unit		0.5			1.0						
16	Machine-hours used							200				
17	Machine-hours available							200				
18												
19	Quantity		400			0						
20												
21	Profit		$ 7,500									



Cells," enter the cell addresses of the quantities for the two products. In the edit box, "Subject to the Constraints," enter the constraints on the problem.

For U-Develop's decision problem of metal versus wooden frames, there are three constraints. The first two require that quantity produced be greater than or equal to zero. The third constraint states that the total machine-hours required for the selected production quantities be less than or equal to the total machine-hours available (200). Click SOLVE.

The results are shown in Panel B of Exhibit 4.12. The optimum solution is to produce 400 metal frames and no wooden frames, which is exactly what our earlier analysis recommended.

Solver can be used if there are additional constraints. For example, if there is limited demand for a particular product, we could add a constraint that limits production to the maximum demand. If there is more than one machine, we could add constraints for the time on the additional machines.

The Theory of Constraints

L.O. 5
Understand the theory of constraints.

theory of constraints (TOC)
Focuses on revenue and cost management when faced with bottlenecks.

Organizations often have constraints, or limits, on what they can accomplish. The **theory of constraints (TOC)** is a management method for dealing with constraints that is based on the ideas in the chapter: In the face of constraints, the optimal product mix is that which maximizes contribution margin per unit of constraining resources as we just saw in the previous section.

When we considered the problem of U-Develop in the previous section, we had to adapt to a resource that was fully utilized in the short run, for example, a machine that was operating full time. In other situations, the constraint might be a person with unique skills who is working full time (and perhaps even overtime) or a key supplier who is delivering all of a key input that is possible.

These constraints can create imbalances in which the constrained resource is working full time while other, complementary resources are less than fully utilized and cannot be redeployed in the specialized task that is constrained. In effect, this means that the "cost" of operating the constrained resource can be thought of as the marginal cost of operating that resource plus the additional costs of idle capacity of other resources.

In the theory of constraints, we learn that maximizing the output of the constrained resource is the best route to increased marginal revenues. Even if one could increase the output of other processes it would not matter (and would produce no incremental revenue) because the constrained resource is acting as an impediment that limits the system's ability to produce output.

When decision makers consider alternative investments, the "benefits" associated with increased bottleneck output are much greater than what those managers might estimate if they were to consider only the specific bottleneck resource. Decision makers also must consider the cost of idle resources that are being constrained by the bottleneck.

Our example of metal and wooden frames was an example of a single constraint (machine time) in a small firm. Consider now a large, complex organization and you can imagine that the number of constraining resources is much greater and that managing these constraints would be more complicated. An important insight of the theory is that the organization is made up of many processes and that optimizing production at each machine (locally) is unlikely to result in the optimal production schedule for the entire organization (globally).

A thorough treatment of the theory of constraints is beyond the scope of this book, but the essence of the theory can be described by considering two concepts: bottlenecks and throughput contribution.[2]

The theory of constraints focuses on increasing the excess of differential revenue over differential costs when faced with bottlenecks. A **bottleneck** is an operation where the work required to be performed limits production. In other words, the bottleneck is the constraining resource. With multiple parts of a production process, each operation depends on the preceding operations. One operation cannot be started until the previous one has completed its work.

bottleneck
Operation where the work required limits production.

For example, U-Develop has a single machine used to produce two products (metal and wooden frames). At peak times, when both types of frames are being produced, it is likely that one of the products will have to wait for the machine. The machine is the bottleneck in the system.

The theory of constraints focuses on such bottlenecks. It encourages managers to find ways to increase profits by relaxing constraints and increasing throughput. At U-Develop, this means finding ways to process frames at peak times.

The theory of constraints focuses on three factors:

- *The rate of throughput contribution.* **Throughput contribution** equals sales dollars minus direct materials costs and other variable costs such as energy and piecework labor.
- *Minimizing investments.* Investments are inventories, equipment, buildings, and other assets used to generate throughput contribution.
- *Minimizing other operating costs.* Other operating costs are all operating costs other than direct materials and other variable costs. Other operating costs are incurred to earn throughput contribution; they include most salaries and wages, rent, utilities, and depreciation.

throughput contribution
Sales dollars minus direct materials costs and variables such as energy and piecework labor.

[2] For a more complete treatment of the theory of constraints, see E.M. Goldratt and J. Cox, *The Goal* (North River Press, 1992). For the role of the cost accountant in the theory of constraints, see Institute of Management Accountants, *Statements on Management Accounting,* "Theory of Constraints (TOC) Management System Fundamentals" (IMA, 1999).

The objective of the theory of constraints is to maximize throughput contribution given investments and operating costs. The theory of constraints assumes a short-run time horizon and few variable costs. In most versions of the theory, only materials, purchased parts, piecework labor, and energy to run machines are considered variable. Most direct labor and overhead costs are assumed fixed. This is consistent with the ideas that the shorter the time period, the more costs are fixed and that the theory of constraints focuses on the short run. Generally, this assumption about cost behavior seems reasonable, but it is important to remember that the approach is ultimately to maximize the contribution margin (the difference between price and all variable costs) per unit of the constraining resource.

Self-Study Question

3. On-the-Move, Inc., manufactures two types of roof racks for automobiles: BikeRac and KayakRac. Data concerning selling prices and costs for each unit follow:

	BikeRac	KayakRac
Selling price	$100	$80
Materials (variable)	26	23
Direct labor (variable)	5	4
Overhead (90% fixed)	50	40
Gross margin	$ 19	$13
Marketing costs (variable)	4	4
Administrative costs (fixed)	10	8
Profit	$ 5	$ 1

Management decided that at least 5,000 BikeRacs and at least 2,000 KayakRacs must be manufactured and sold each month.

The company's production facilities are limited by machine capacity in the Assembly Department. Each BikeRac requires 6 minutes and each KayakRac requires 3 minutes in the Assembly Department. A total of 650 hours (39,000 minutes) is available per month in the Assembly Department; there are no other relevant constraints on production.

a. What is the contribution per unit for BikeRacs? For KayakRacs?

b. At the required monthly levels of production (5,000 BikeRacs and 2,000 KayakRacs), how many minutes are used in the Assembly Department?

c. Suppose there is unlimited demand for BikeRacs and KayakRacs at current prices. What production schedule (number of BikeRacs and number of KayakRacs) should On-the-Move adopt to maximize profit while meeting its constraint to produce and sell at least 5,000 BikeRacs and 2,000 KayakRacs.

d. Suppose demand is limited to 2,500 units of KayakRacs. What production schedule should On-the-Move adopt to maximize profit while meeting its constraint on the minimum levels for the two products?

The solution to this question is at the end of the chapter on page 153.

The Debrief

Jamaal Kidd discusses how the concepts of differential cost analysis have helped him make business decisions:

> The photo business is extremely competitive and my survival depends on making sound business decisions. There is not much room for errors in pricing. If I price too high, my customers go down the street to one of my competitors. If I price too low, I lose money. The concept of differential cost analysis makes sense in this business because many of my decisions are relatively short term. However, I now know that understanding when short-run methods are appropriate and when I need to consider the longer-term impacts of my decisions is just as important. Applying the concepts of differential costs to my operations has been just as useful. Like all business owners, I want to grow. The concepts in this chapter will help me make decisions that will lead to profitable growth.