Cost Planning for the Product Life Cycle: Target Costing, Theory of Constraints, and Strategic Pricing

After studying this chapter, you should be able to . . .

LO 13-1 Explain how to use target costing to facilitate strategic management.

LO 13-2 Apply the theory of constraints to strategic management.

LO 13-3 Describe how life-cycle costing facilitates strategic management.

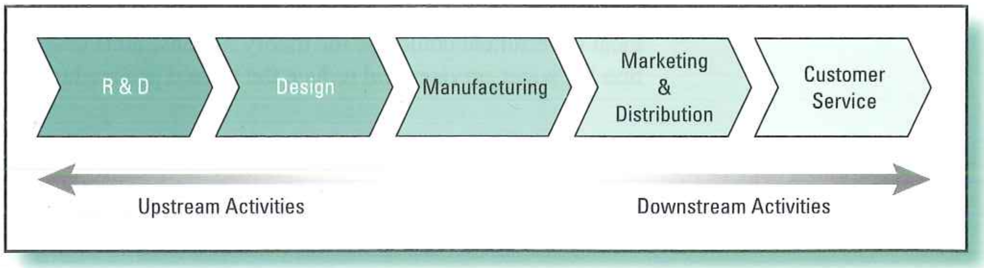
LO 13-4 Outline the objectives and techniques of strategic pricing.

Having some of the world's best-selling cars, including the Camry, the Corolla, and the Prius, Toyota is among the world's most successful automakers. This distinction can be attributed, in part, to Toyota's success in consistently producing high-quality cars with attractive features and competitive prices. Target costing, a method Toyota pioneered in the 1960s, is one method used to provide high quality and desirable features at a competitive price. As we will see in this chapter, the method is a design approach in which cost management plays a large part. Using target costing, a company designs a product to achieve a desired profit while satisfying the customer's expectations for quality and product features. The balancing of costs, features, and quality takes place throughout the design, manufacturing, sale, and service of the car but has the strongest influence in the design phase. When design alternatives are being examined and selected, Toyota, like most any manufacturer, has the maximum flexibility for choosing options that affect manufacturing and all other product costs such as customer service and warranty work.

Once the design is complete, manufacturing begins. The cost consequences of the choice of features and manufacturing methods are set until the next model change, meaning cost-effective design is critical. Target costing places a strong focus on using the design process to improve the product and reduce its cost. For example, in the redesign of the Camry, Toyota made the running lamps part of the headlamp assembly and made the grill part of the bumper, which saves time and materials in manufacturing and produces a more crash-resistant bumper—a win/win for Toyota and the car buyer.

Target costing is only the first of four costing methods covered in this chapter. Each of the methods is used for cost planning during the product (or service) life cycle. For example, target costing is used at an early phase in the product's life cycle to help create a product designed to achieve a desired profit. The other methods, which are used at different phases in the life cycle, are the theory of constraints, life-cycle costing, and strategic pricing. While managers once

EXHIBIT 13.1
The Cost Life Cycle of a Product or Service



focused only on manufacturing costs, they now look at costs both before manufacturing (upstream) and after manufacturing (downstream) to obtain a comprehensive analysis of product cost and profitability over a product's cost life cycle.

The **cost life cycle** is the sequence of activities within the firm that begins with research and development followed by design, manufacturing, marketing/distribution, and customer service.

The **cost life cycle** is the sequence of activities within the organization that begins with research and development followed by design, manufacturing (or providing the service), marketing/distribution, and customer service. It is the life cycle of the product or service from the viewpoint of costs incurred. The cost life cycle is illustrated in Exhibit 13.1.[1]

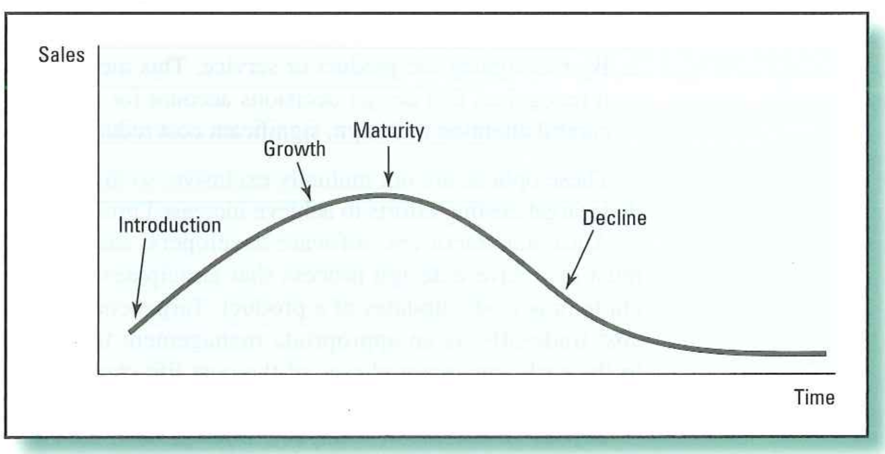
Of the four methods used for cost planning, target costing, the theory of constraints, and life-cycle costing are based on the product or service's cost life cycle. For example, target costing considers the role of product design (an upstream activity) in reducing costs in the manufacturing and downstream phases of the life cycle. Then, the theory of constraints can be used in the manufacturing phase to reduce manufacturing costs and to speed up delivery downstream. Next, life-cycle costing provides a comprehensive evaluation of the profitability of the different products, including costs throughout the product life cycle. The fourth method used for cost planning, strategic pricing, uses both cost life cycle and sales life cycle concepts in pricing decisions.

The **sales life cycle** is the sequence of phases in the product or service's life in the market from the introduction of the product or service to the market, growth in sales, and finally maturity, decline, and withdrawal from the market.

The **sales life cycle** is the sequence of phases in the product or service's life in the market from the introduction of the product or service to the market, growth in sales, and finally maturity, decline, and withdrawal from the market. Sales are at first small, peak in the maturity phase, and decline thereafter, as illustrated in Exhibit 13.2.

These four methods are commonly used by manufacturing firms, where new product development, manufacturing speed, and efficiency are important. Because a product with physical characteristics is involved, applications in manufacturing firms are more intuitive and easily

EXHIBIT 13.2
The Sales Life Cycle of a Product or Service



[1] The *cost life cycle* also is called a *value chain* by many writers to emphasize that each activity must add value for the ultimate consumer (Michael Porter, *Competitive Advantage* [New York: Free Press, 1985]). Note that this concept of the value chain differs from that introduced in Chapter 2. Chapter 2 describes the industry-level value chain; the cost life-cycle concept in this chapter describes the firm-level value chain. We use the broader concept of the industry-level value chain in Chapter 2 to facilitate the strategic focus in that chapter. For a discussion of the two types of value chains, see "Value Chain Analysis for Assessing Competitive Advantage," *Statement on Management Accounting*, Institute of Management Accountants, 1996.

understood. However, each method can also be used in service organizations. For example, a local government could use the theory of constraints to speed the process of billing and collection for water services and reduce the related processing costs.

Target Costing

To start this section, consider the words of Henry Ford.

> Our policy is to reduce the price, extend the operations, and improve the article. You will notice that the reduction of price comes first. We have never considered costs as fixed. Therefore we first reduce the price to the point where we believe more sales result. Then we go ahead and try to make the prices. We do not bother about the costs. The new price forces the costs down. The more usual way is to take the costs and then determine the price, and although that method may be scientific in the narrow sense, it is not scientific in the broad sense, because what earthly use is it to know the cost if it tells you that you cannot manufacture at a price at which the article can be sold? But more to the point is the fact that although one may calculate what a cost is, and of course all of our costs are carefully calculated, no one knows what a cost ought to be. One of the ways of discovering . . . is to name a price so low as to force everybody in the place to the highest point of efficiency. The low price makes everybody dig for profits. We make more discoveries concerning manufacturing and selling under this forced method than by any method of leisurely investigation.
>
> *Henry Ford,* My Life and My Work, *1923*

LO 13-1

Explain how to use target costing to facilitate strategic management.

Henry Ford's thinking would fit well in today's corporate boardrooms, where global competition, increased customer expectations, and competitive pricing in many industries have forced companies to look for ways to reduce costs year after year while producing products with increased levels of quality and functionality.

What Ford is describing is a technique called *target costing,* in which the firm determines the allowable (i.e., target) cost for the product or service, given a competitive market price, so the firm can earn a desired profit. The formula is

$$\text{Target cost} = \text{Competitive price} - \text{Desired profit}$$

The target cost is just that, a target, and the firm has two options for managing costs to reach the target level:

1. By integrating new manufacturing technology, using advanced cost management techniques such as activity-based costing, and seeking higher productivity.
2. By redesigning the product or service. This method is beneficial for many firms because it recognizes that design decisions account for much of total product life-cycle costs. By careful attention to design, significant cost reductions are possible.

These options are not mutually exclusive, so firms may choose to employ both options in their target costing efforts to achieve increased productivity and a low-cost design.

Auto manufacturers, software developers, and other consumer product manufacturers must also have a design process that anticipates the number and types of features to include in periodic updates of a product. Target costing, based on analysis of functionality/cost trade-offs, is an appropriate management tool for these firms. With its positioning in the early, upstream phases of the cost life cycle, target costing can clearly help a firm reduce total costs (see Exhibit 13.3).

Toyota, Honda Motor Company, Boeing, Intel, Inc., and many other firms worldwide use target costing. Many firms find it difficult to compete successfully on cost leadership or differentiation alone; they must compete on both price and functionality. Target costing uses the following five-step process to manage the trade-offs between functionality and cost:

1. Determine the market price.
2. Determine the desired profit.
3. Calculate the target cost at market price less desired profit.

Cost Management in Action Why Go Abroad?

In competitive industries such as computers, consumer electronics, and autos, manufacturers continuously look for ways to reduce cost and increase value throughout the value chain. Because of intense pricing pressures and increased customer expectations, target costing methods can help identify and analyze the options for competitive advantage. Going abroad is the solution for many firms but for different reasons. We look at the practices in two industries: apparel companies, and consumer electronics and computer products.

APPAREL COMPANIES

Apparel manufacturers such as Ralph Lauren and Liz Claiborne have moved much of their product development as well as manufacturing to China. Fashion designers, fabric suppliers, button makers, and other parts of the product development process work together in the single location in China. What is the advantage to these companies?

CONSUMER ELECTRONICS AND COMPUTER PRODUCTS

Computer and electronics companies like Apple and Hewlett-Packard have outsourced manufacturing to plants operated by contract manufacturers, such as Foxconn in China. Why is this an advantage to these companies?

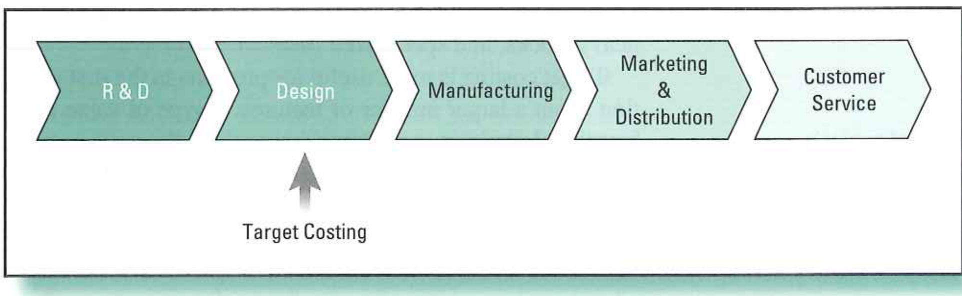
(Refer to Comments on Cost Management in Action at the end of the chapter.)

REAL-WORLD FOCUS Product Designed to Meet a Price Target

Ford Motor Company believes competitive returns can be earned in emerging markets like India and China by selling cars for prices much lower than those charged in Europe and North America. The president of Ford's Asian Pacific and African operations stated that Ford can profitably sell low-cost cars and that forthcoming models for India and China will be designed from the ground up to earn a desired margin at a low selling price.

Source: Jeff Bennett, "Ford Ramps Asian Car Plans," *The Wall Street Journal*, June 17, 2011, p. B7.

EXHIBIT 13.3
Target Costing in the Cost Life Cycle



4. Use value engineering to identify ways to reduce product cost.
5. Use kaizen costing and operational control to further reduce costs.

The first three steps require little additional explanation. However, the determination of desired profit can be done in a variety of ways. A common approach is to set a desired per-unit profit, meaning that, if the product's price falls and target costs fall by the same dollar amount, then profits will remain the same after the price change, assuming the firm meets the new price and sales in units do not change. Another approach is to set the desired profit as a percentage of sales dollars. The section on pricing at the end of this chapter gives some additional examples of pricing methods. The following sections explain the fourth and fifth steps: the use of value engineering, kaizen costing, and operational control.

Value engineering
is used in target costing to reduce product cost by analyzing the trade-offs between different types of product functionality and total product cost.

Value Engineering

Value engineering is used in target costing to reduce product cost by analyzing the trade-offs between different types of product functionality (different types of product features) and total product cost. An important first step in value engineering is performing a consumer analysis

REAL-WORLD FOCUS Backup Cameras Will Be Mandatory

There are new rules that will require automakers to install backup cameras in all vehicles by May 2018. The reason is safety. As part of the justification for the new rules, there are more than 200 deaths and another 15,000 injuries annually due to backover accidents. The largest concern of manufacturers is the increase in both fixed and variable costs, as it will necessitate installing new machinery in the manufacturing process as well as increase the time and materials required during assembly. Moving forward, the increased costs will have to be accounted for in production planning by manufacturers.

A related issue will be the pricing of cars. Up until the passage of the regulation, rear-view cameras have been considered a luxury add-on subject to premium pricing. Meanwhile, other manufacturers, like Honda, have been using the cameras as a differentiator, offering them as standard equipment on more economical models of cars.

Source: David Undercoffler, "U.S. Orders Rear Cameras for New Cars; Safety Device Must Be Standard in Vehicles by May 2018. Critics Say It's Long Overdue," *Los Angeles Times*, April 1, 2014, p. B1.

during the design stage to identify critical consumer preferences that define the desired functionality for the new product.

The type of value engineering used depends on the product's functionality. For one group of products—including automobiles, computer software, and many consumer electronic products such as cameras and audio and video equipment—functionality can be added or deleted relatively easily. These products have frequent new models or updates, and customer preferences may change frequently. The manufacturer in effect chooses the particular bundle of features to include with each new model of the product. For automobiles, this can mean new performance and safety features; for computer software, it might mean the ability to perform certain new tasks or analyses.

In contrast, for a product in which customer preferences are relatively stable, the functionality must be designed into the product rather than added on. Products in this group are best represented by specialized equipment and industrial products such as construction equipment, heavy trucks, and specialized medical equipment.

Target costing is more useful for products in the first group because the firm has some discretion about a larger number of features. A type of value engineering employed in these firms is **functional analysis,** a process of examining the performance and cost of each major function or feature of the product. The objective of the analysis is to determine a desired balance of functionality and cost. An overall desired level of performance achievement for each function is obtained while keeping the cost of all functions below the target cost.

Functional analysis
is a type of value engineering in which the performance and cost of each major function or feature of the product is examined.

Benchmarking is often used at this step to determine which features give the firm a competitive advantage. In a release of new software, for example, each desired feature of the updated version is reviewed against the cost and time required for its development. The objective is an overall bundle of features for the software that achieves the desired balance of meeting customer preferences while keeping costs below targeted levels. In another example, auto manufacturers must decide which performance and safety features to add to the new model. This decision is based on consumer analysis and a functional analysis of the feature's contribution to consumer preferences compared to its cost. For instance, improved safety air bags could be added, but target cost constraints could delay an improved sound system until a later model year. As noted in the Real-World Focus item, regulatory requirements may also dictate which features must be added.

Design analysis is a form of value engineering for products in the second group, industrial and specialized products. The design team prepares several possible designs of the product, each having similar features with different levels of both performance and cost. Benchmarking and value-chain analysis help guide the design team in preparing designs that are both low cost and competitive. The design team works with cost management personnel to select the one design that best meets customer preferences while not exceeding the target cost.

Design analysis
is a form of value engineering in which the design team prepares several possible designs of the product, each having similar features with different levels of both performance and cost.

A useful comparison of different target costing and cost-reduction strategies in three Japanese firms, based on the field research of Robin Cooper, is illustrated in Exhibit 13.4. Note that the different market demands for functionality result in different cost-reduction approaches. Where customers' expectations for functionality are increasing, as for Nissan and Olympus,

EXHIBIT 13.4 Target Costing in Three Japanese Firms

Firm/Industry	Functionality	Cost-Reduction Approach	Strategy
Olympus/Cameras	Increasing rapidly; is designed in	Target costing using value engineering; the concept of distinctive functionality for the **price point**, plus supportive functionality	Heavy focus on managing functionality
Nissan/Autos	Rapidly increasing; easy to add or delete functionality	**Value engineering** by product and by each component of each product; then increase price or reduce functionality	Prices are set by desired customers' expectations about functionality; after functionality is set, target cost is used to find savings, especially from suppliers
Komatsu/Construction equipment	Static; must be designed in	**Design analysis** to determine alternative designs; **functional analysis** to develop cost/functionality trade-offs; **productivity programs** to reduce the remaining costs	Primary focus is on cost control rather than redesign or functionality analysis

there is more significant use of target costing. In contrast, at Komatsu, the emphasis is on value engineering and productivity improvement. Note also that firms such as Nissan, which use both internal and external sourcing for parts and components, use target costing at both the product level and the component level. The overall product-level target cost is achieved when targeted costs for all components are achieved.[2]

Cost tables are computer-based databases that include comprehensive information about the firm's cost drivers.

Other cost-reduction approaches include cost tables and group technology. **Cost tables** are computer-based databases that include comprehensive information about the firm's cost drivers. Cost drivers include, for example, the size of the product, the materials used in its manufacture, and the number of features. Firms that manufacture parts of different sizes from the same design (pipe fittings, tools, and so on) use cost tables to show the difference in cost for parts of different sizes and different types of materials.

Group technology is a method of identifying similarities in the parts of products manufactured so the same part can be used in two or more products, thereby reducing costs.

Group technology is a method of identifying similarities in the parts of products manufactured so the same parts can be used in two or more products, thereby reducing costs. Large manufacturers of diverse product lines, such as in the automobile industry, use group technology in this way. A point of concern in the use of group technology is that it reduces manufacturing costs but might increase service and warranty costs if a failed part is used in many different models. The combination of group technology and total quality management can, however, result in lower manufacturing and service/warranty costs.

Concurrent engineering, or *simultaneous engineering,* is an important method that integrates product design with manufacturing and marketing throughout the product's life cycle.

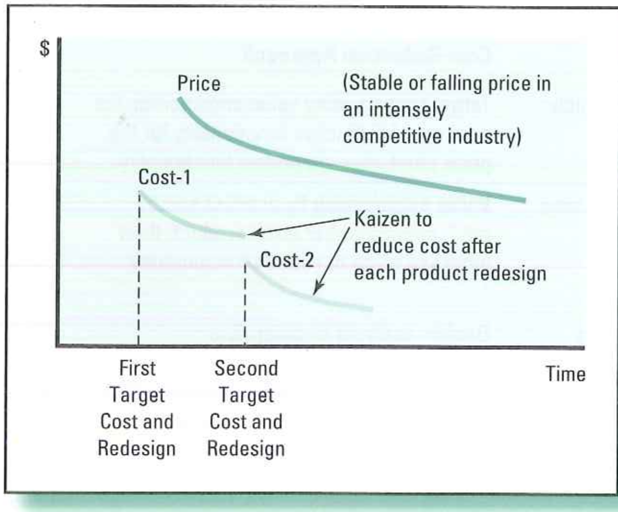
Concurrent engineering, or *simultaneous engineering,* is an important development in the design of products that is replacing the traditional approach of product designers working in isolation on specialized components of the overall design project. In contrast, concurrent engineering relies on an integrated approach. The engineering/design process takes place throughout the cost life cycle using cross-functional teams. Information is solicited from and used at each phase of the value chain to improve the product design. For example, customer feedback in the service phase is used directly in product design. Manufacturers such as Toyota Motor Corp. and Moen, Inc., are increasingly using product design in a very flexible manner by continuously incorporating product improvements. Some experts argue that this approach has saved firms as much as 20% of total product cost.

An important part of value engineering is the use of advanced costing methods, such as ABC costing, to accurately determine the product cost for each feature of the product, each function of the product, or each design option that is being considered. ABC costing is particularly useful for helping managers in product design, purchasing, manufacturing, and marketing to work together with a common understanding of the costs of different features and options.[3]

[2] Robin Cooper and Regine Slagmulder, "Develop Profitable New Products with Target Costing," *Sloan Management Review,* Summer 1999, pp. 23–33; and Robin Cooper and Regine Slagmulder, "Target Costing for New Product Development; Component-Level Target Costing," *Journal of Cost Management,* September–October, 2001, pp. 36–43.

[3] Gary Cokins, "Integrating Target Costing and ABC," *Journal of Cost Management,* July/August 2002, pp. 13–22.

EXHIBIT 13.5
Price, Cost, Kaizen, and Target Costing



Target Costing and Kaizen

The fifth step in target costing is to use continuous improvement (kaizen) and operational control to further reduce costs. Kaizen occurs at the manufacturing stage where the effects of value engineering and improved design are already in place; the role for cost reduction at this phase is to develop new manufacturing methods (such as flexible manufacturing systems) and to use new management techniques such as operational control (Chapters 14, 15, and 16), total quality management (Chapter 17), and the theory of constraints (next section) to further reduce costs. *Kaizen* means *continuous* improvement, that is, the ongoing search for new ways to reduce costs in the manufacturing process of a product with a given design and functionality. Toyota, for example, uses kaizen to reduce manufacturing costs on its hybrid vehicles, so that it can bring down the premium it must now charge for these vehicles.

Exhibit 13.5 shows the relationship between target costing and kaizen. Price is assumed to be stable or decreasing over time for firms for which target costing is appropriate because of intense competition on price, product quality, and product functionality. These firms respond to the competitive pressure by periodically redesigning their products using target costing to simultaneously reduce price and improve value. Consider the two points in Exhibit 13.5 labeled first and second target cost. The time period between product redesigns is approximately the product's sales life cycle. In the time between product redesigns, the firm uses kaizen to reduce product cost in the manufacturing process by streamlining the supply chain and improving both manufacturing methods and productivity programs. Thus, target costing and kaizen are complementary methods used to continually reduce cost and improve value.

An Illustration: Target Costing in Health Product Manufacturing

Health Products International, Inc. (HPI), is conducting a target costing analysis of a major product, a hearing aid. The HPI-2 is a reliable second-generation hearing aid that has 30% of the worldwide market. HPI-2 sells for $750 and costs $650 to produce, generating a profit of $100 per unit. A competitor has, however, recently introduced a third-generation product that incorporates a computer chip, thereby significantly improving performance. The competitor's price is $1,200. Customer analysis has revealed that cost-conscious consumers will still buy the HPI-2, but HPI can maintain market share only if the price is lowered to $600. The target profit for HPI-2, however, remains at $100, so redesigning the product and/or the manufacturing process is required.

With a price of $600 and a target profit of $100, the target cost for HPI-2 is $500. Management must find a way to reduce costs by $150 ($650 − $500), and because the product has no add-on features, design analysis is the preferred approach. The following table summarizes the three alternatives being considered.

Alternative A	Projected Impact
Reduce R&D expenditures	($ 50)
Replace microphone with one of nearly equal sensitivity	($ 30)
Replace power switch with a cheaper and almost as reliable version	($ 30)
Replace current inspection procedure with an integrated quality review process at each assembly station	($ 40)
Total impact	($150)

Alternative B	Projected Impact
Replace the amplifier with one having slightly less power but not enough difference to be noticed by most users	($ 50)
Replace microphone with one of nearly equal sensitivity	($ 30)
Replace power switch with a cheaper and almost as reliable version	($ 30)
Replace current inspection procedure with an integrated quality review process at each assembly station	($ 40)
Total impact	($150)

Alternative C	Projected Impact
Increase R&D expenditures to develop a third-generation computer chip–based hearing aid	$ 40
Replace the amplifier with one having slightly less power but not enough difference to be noticed by most users	($ 50)
Replace microphone with one of nearly equal sensitivity	($ 30)
Replace power switch with a cheaper and almost as reliable version	($ 30)
Replace current inspection procedure with an integrated quality review process at each assembly station	($ 40)
Renegotiate contract with supplier of plastic casings	($ 20)
Replace plastic earpiece material with a lower quality material that will still meet user's expectations of a 6- to 10-year useful life	($ 20)
Total impact	($150)

Manufacturing and marketing managers agree that the design changes proposed in all the options would not significantly alter the market appeal of the current product. After a review of its alternatives, HPI chooses alternative C, primarily because it includes an increase in research and development expenditures that will start to position the firm to compete in the market for the new type of hearing aid. Key managers also determine that this alternative is strategically important because the new technology, while only a fraction of the market now, could be dominant in the next 10 to 15 years as prices come down on the new units and users become more aware of the benefits of the computer chip.

An Illustration Using Quality Function Deployment (QFD)

Quality function deployment (QFD)
is the integration of value engineering, marketing analysis, and target costing to assist in determining which components of the product should be targeted for redesign.

Quality function deployment (QFD) is the integration of value engineering, marketing analysis, and target costing to assist in determining which components of the product should be targeted for redesign or cost reduction. QFD helps designers and managers break down the total product target cost into the components that make up the product. There are four steps in QFD and we will use the example of a table saw product to explain those steps.

1. Determine the customer's purchasing criteria for this product and how these criteria are ranked. For the saw, the customer criteria could be safety, performance, and economy.
2. Identify the components of the product and the manufacturing cost of each component. For simplicity, assume the components of the table saw are the motor, the saw, and the frame.
3. Determine how each component contributes to customer satisfaction. How much does the motor contribute to the customer's desired safety, performance, and economy? What about the contribution of the saw or the frame? Recognize that in actual practice there are likely to be more components and more criteria.
4. The final step is to determine the importance index of each component, by combining the information in steps one and three and then comparing this to the cost information in step 2.

To illustrate, suppose customers were asked to use a scale of 1 to 100 to rate the importance of each criterion. It is the relative rather than the absolute importance that is significant. Calculate the relative importance by dividing the score for each criterion by the total points awarded. The customer ranking and relative importance results appear in the following table.

First: Customer Criteria and Ranking

	Importance	Relative Importance	
Safety	95	46.3%	= 95 ÷ 205
Performance	60	29.3	= 60 ÷ 205
Economy	50	24.4	= 50 ÷ 205
Total	205	100.0%	

Second, identify the components and both the absolute and relative cost of each:

Second: Product Components and Cost

	Cost	Percent of Total
Motor	$40	53.3%
Saw	20	26.7
Frame	15	20.0
Total	$75	100.0%

Third, determine the contribution of each component to satisfying customer criteria. This step usually requires a cross-functional team that may include marketing, operations, and cost management analysts. In this example, the desired criteria of safety is achieved primarily by the frame (60%) and then by the saw (30%) and motor (10%).

Third: Determine How Components Contribute to Customer Satisfaction

	Customer Criteria		
Components	**Safety**	**Performance**	**Economy**
Motor	10%	10%	60%
Saw	30	50	10
Frame	60	40	30
	100%	100%	100%

Fourth, determine the importance index for each component, which reflects the value of the component to the customer. To compute the importance index, multiply the relative importance of each criterion by each component's percentage contribution and then sum those amounts. For example, the 22.2% index for the motor is determined as follows:

$$(46.3\% \times 10\%) + (29.3\% \times 10\%) + (24.4\% \times 60\%) = 22.2\%$$

Fourth: Determine Importance Index for Each Component

	Customer Criteria			Importance Index
	Safety	**Performance**	**Economy**	
Relative importance of each criterion (step one)	**46.3%**	**29.3%**	**24.4%**	
The % contribution of each component to each customer criterion (from step 3):				
Motor	10%	10%	60%	22.2%
Saw	30	50	10	31.0
Frame	60	40	30	46.8
	100%	100%	100%	100.0%

The importance index can now be compared to the cost information in step two to identify components where cost reductions are needed and components where additional design features might be appropriate.

Components	Importance Index	Relative Cost
Motor	22.2%	53.3%
Saw	31.0	26.7
Frame	46.8	20.0
	100.0%	100.0%

The comparison above shows that far too much is being spent on the motor relative to its value to the customer. In contrast, not enough is being spent on the frame, relative to customer criteria.

This information is a guide to both the redesign of the product and the determination of the target cost for each component.

Benefits of Target Costing

Target costing can be beneficial because it

- Orients the organization toward the customer, as design is focused on customer values.
- Reduces costs, through more effective and efficient design.
- Helps the firm achieve desired profitability on new or redesigned products.
- Can decrease the total time required for product development, through improved coordination of design, manufacturing, and marketing functions.
- Can increase communication and cooperation among departments.
- Can improve overall product quality, as the design is carefully developed and manufacturing issues are considered explicitly in the design phase.

Target costing also involves costs due to the:

- Need to develop detailed cost data.
- Time demands associated with cooperation and coordination throughout the organization.

The Theory of Constraints

> Remember that time is money.
>
> *Benjamin Franklin*

LO 13-2

Apply the theory of constraints to strategic management.

Benjamin Franklin must be right. Most strategic initiatives undertaken by firms today focus on improving the speed of their operations throughout the cost life cycle because speed can provide a competitive edge. Customers expect quick response to inquiries and fast delivery of the product. Shorter sales life cycles in many industries mean that manufacturers are working to reduce product development and delivery time. One of the most successful business models of recent years, used by Amazon.com, was built on speed.

In this part of the chapter, we present one of the key methods used to improve speed, the theory of constraints (TOC). Before looking closely at TOC, consider the issue of how speed is measured and improved throughout the cost life cycle, as illustrated in Exhibit 13.6. The measures are defined in different ways by different firms, depending on the nature of the firm's operations. For example, manufacturing **cycle time** (or manufacturing *lead time* or *throughput time*) is commonly defined as follows:

Cycle time
is the amount of time between the receipt of a customer order and the shipment of the order.

$$\text{Cycle time} = \text{Amount of time between the receipt of a customer order and the shipment of the order}$$

Recognize that some firms may define start time as the time a production batch is scheduled, the time the raw materials are ordered, or the time that production on the order is started. Similarly, the finish time of the cycle can be defined as the time that production is completed or the time the order is ready for shipping.

Another useful measure is **manufacturing cycle efficiency (MCE)**:

Manufacturing cycle efficiency (MCE)
is the ratio of processing time to total cycle time.

$$\text{MCE} = \frac{\text{Processing time}}{\text{Total cycle time}}$$

EXHIBIT 13.6 Measures of Speed and How to Improve Speed at Each Step of the Cost Life Cycle

	R & D	Design	Manufacturing	Marketing & Distribution	Customer Service
Measures of Speed	Product development time (months)		Cycle time (hours or days), manufacturing cycle efficiency (a ratio)	Delivery time (days)	Customer response time for inquiries and service problems
How to Improve Speed	Design software, web-based engineering tools		**The theory of constraints (TOC)**	Reduce complexity, automate the shipping function	Customer service software, such as that provided by Oracle's Siebel unit

For example, if the processing time is 2 days and the cycle time is 10 days, then the MCE ratio is 2/10, or 20%.

MCE separates total cycle time into the time required for each of the various activities: processing (value-adding work on the product), inspection, materials handling, waiting, and so on. Most firms would like to see their MCE close to 1, which reflects less time wasted on moving, waiting, inspecting, and other non-value-adding activities.[4]

Constraints
are those activities that slow the product's cycle time.

The theory of constraints (TOC) was developed to help managers reduce cycle times and operating costs.[5] Prior to TOC, managers often devoted efforts to improve efficiency and speed *throughout* the manufacturing process instead of focusing attention on just those activities that were constraints (i.e., bottlenecks) in the process. **Constraints** are activities that slow a product's total cycle time. Goldratt and Cox use as an example a troop of boy scouts on a hike. The goal is to have every scout complete the hike, so the slowest hiker is the constraint and sets the overall pace for the troop. Manufacturers have learned that increased efficiency and speed with activities that are not constraints could be dysfunctional. Using resources to increase the efficiency of nonconstraints is likely to result in the buildup of work-in-process inventory for activities prior to the constraint (just as the faster scouts would be "bunched up" behind the slowest scout) and to divert attention and resources from the actual slowdown in cycle time. TOC focuses attention on improving speed at the constraints, which causes a favorable decrease in the overall cycle time and inventory. TOC can be compared to just-in-time manufacturing (JIT) in that both are aimed at reducing cycle time and reducing inventory levels. JIT accomplishes this by methods that coordinate manufacturing processes so that materials are available just in time for the process, thereby increasing processing speed and reducing or eliminating inventory.

The Use of the Theory of Constraints Analysis in Health Product Manufacturing

To illustrate the five steps of TOC, return to the example involving Health Products International, Inc. (HPI). Suppose that HPI adopts alternative C from the list of alternatives on page 507 and is currently manufacturing both the second generation (HPI-2) and a new third

[4] While 100% is a theoretical maximum for MCE, many firms find their MCE ratios somewhat smaller because of delays and wasted time in the manufacturing process. For example, statistics from the auto industry show that some firms have cycle times of over 30 days and product assembly times of 1 to 2 days—an MCE of approximately 5%. Also, note that the terms used here are *manufacturing* measurements and that similar measures are used by firms to examine the firm's progress in *filling customer orders*. For example, customer lead time (or customer cycle time) is usually defined as the time from the receipt of an order to the delivery of the product.

[5] E. Goldratt and J. Cox, *The Goal* (New York: Free Press, 1986); and E. Goldratt, *The Theory of Constraints* (New York: North River Press, 1990). See also Thomas Corbett, *Throughput Accounting* (New York: North River Press, 1998).

generation (HPI-3) hearing aid. The prices for the HPI-2 and HPI-3 are competitive at $600 and $1,200, respectively, and are not expected to change. However, increasing cycle times have led to a backlog of orders for both products. Orders average 3,000 units for the HPI-2 and 1,800 units for the HPI-3 and new customers are told they may have to wait three or more weeks for their orders. Management is concerned about the need to improve speed in the manufacturing process and is planning to use TOC. Here are the steps HPI would take to use TOC.

Steps in the Theory of Constraints Analysis

TOC analysis has five steps:

1. Identify the constraint.
2. Determine the most profitable product mix given the constraint.
3. Maximize the flow through the constraint.
4. Add capacity to the constraint.
5. Redesign the manufacturing process for flexibility and fast cycle time.

Step 1: Identify the Constraint

A **flow diagram** is a flowchart of the work done that shows the sequence of processes and the amount of time required for each.

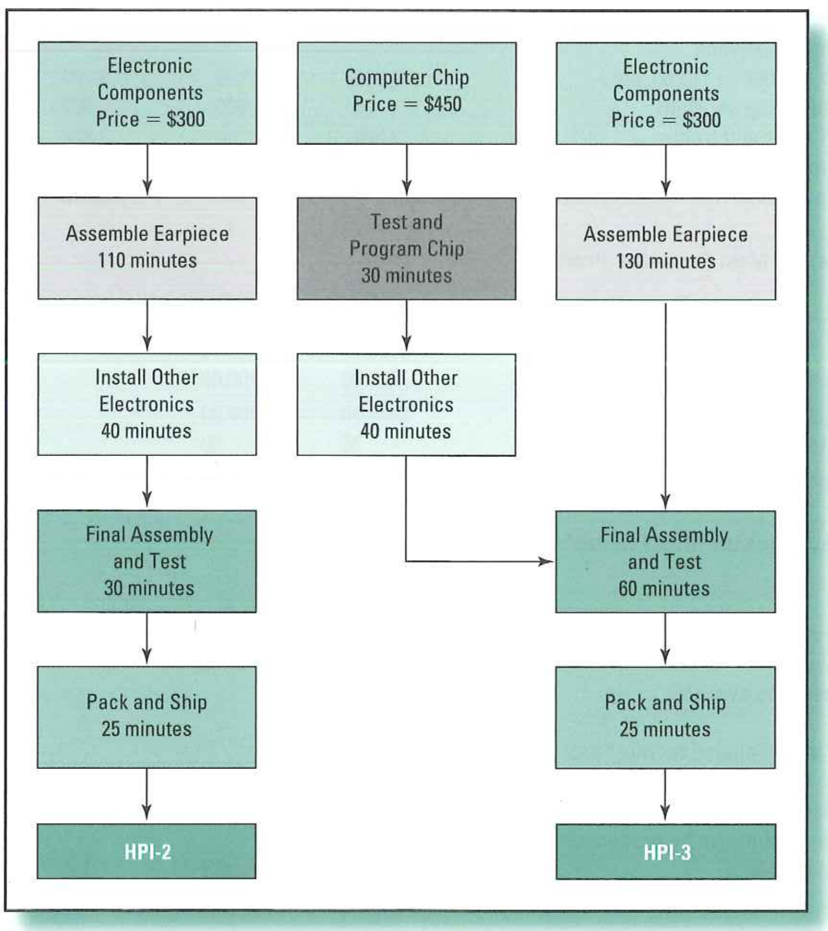
The management accountant works with manufacturing managers and engineers to identify any constraint in the manufacturing process by developing a **flow diagram** of the work done. The flow diagram shows the sequence of processes and the amount of time each requires. The five processes for HPI follow, and their flow diagram is shown in Exhibit 13.7.

Process 1. Assemble earpiece.

Process 2. Test and program computer chip (product HPI-3 only).

Process 3. Install other electronics.

EXHIBIT 13.7
Flow Diagram for HPI, Inc.



Process 4. Perform final assembly and test.

Process 5. Pack and ship.

The raw materials cost for each unit is $300 for the HPI-2 and $750 for the HPI-3 ($450 for the computer chip and $300 for other electronics).

The constraint is identified by using the flow diagram to analyze the total time required for each process given the current level of demand. Exhibit 13.8 shows a summary of the data for this analysis, including the number of employees available for each process and the total time

EXHIBIT 13.8 Summary of Data for HPI, Inc., TOC Analysis

	HPI-2	HPI-3
Demand (per month)	3,000	1,800
Price	$600	$1,200
Materials cost	$300	$750

Process	Minutes Required for Each Product per Unit: HPI-2	HPI-3	Number of Employees	Total Hours Available per Month
1: Assemble earpiece	110	130	80	9,600
2: Test and program computer chip	0	30	8	960
3: Install other electronics	40	40	30	3,600
4: Perform final assembly and test	30	60	20	2,400
5: Pack and ship	25	25	18	2,160

Step 1: Identify the Constraint (the process for which total hours required for the given demand exceeds available hours—Process 4)

	Hours Required: HPI-2	HPI-3	Total Hours	Hours Available	Slack Hours
Process 1: Assemble earpiece (5,500 hrs = 3,000 × 110/60, etc.)	5,500	3,900	9,400	9,600	200
Process 2: Test and program chip	0	900	900	960	60
Process 3: Install other electronics	2,000	1,200	3,200	3,600	400
Process 4: Perform final assembly and test	1,500	1,800	3,300	2,400	(900)
Process 5: Pack and ship	1,250	750	2,000	2,160	160

Step 2, Part 1: Identify Most Profitable Product = HPI-2

	HPI-2	HPI-3
Price	$600.00	$1,200.00
Materials cost	300.00	750.00
Throughput margin	$300.00	$ 450.00
Constraint time (for Process 4)	30	60
Throughput margin per minute	$ 10.00	$ 7.50

Step 2, Part 2: Determine the Most Profitable Product Mix

	HPI-2	HPI-3	Hours per Unit	Constraint Time (Process 4)
Total monthly demand	3,000 units	1,800 units		
Constraint process time available				2,400 hours
Time required to meet demand for most profitable product	3,000 units		× 0.50 =	1,500 hours
Constraint process time remaining to meet remaining demand and quantity that can be produced in the remaining time available		900 units	× 1.00 =	900 hours
Unmet demand	-0-	900 units		

available per month for all employees (assuming a 40-hour work week in which 30 hours are available for work and 10 hours are used for breaks, training, etc.). HPI processes are very specialized, and employees are able to work only within their assigned process. Moreover, because of the specialized skills required, HPI has difficulty maintaining adequate staffing in all processes except process 5, pack and ship.

Step 1 in Exhibit 13.8 shows the total time required in each process given the current level of demand. Each of the five processes except process 4 has slack time. Therefore, the constraint occurs with process 4, perform final assembly and test. Because of inadequate time (900 hours too few) available in this process, HPI will not be able to meet the total demand for HPI-2 and HPI-3 and will delay some orders or perhaps not fill them at all. HPI must now determine which orders to fill and which not to fill. This takes us to the second step of TOC.

Step 2: Determine the Most Profitable Product Mix Given the Constraint

The most profitable product mix is the combination of products that maximizes total profits for both products. Should we produce all 3,000 units of HPI-2 and whatever we can of HPI-3, or should we produce all 1,800 units of HPI-3 and whatever we can of HPI-2? Or some other mix? The step 2 analysis in Exhibit 13.8 provides the answer.[6]

Throughput margin
is a TOC measure of product profitability; it equals price less materials cost, including all purchased components and materials handling costs.

To determine the most profitable product mix, we first determine the most profitable product, given the constraint. TOC measures product profitability using the **throughput margin,** which is the product price less materials cost (which includes the costs of all materials used, purchased components, and materials-handling costs). All other manufacturing costs are excluded in determining profitability because they are assumed to be fixed and will not change regardless of which product mix is chosen.[7] Step 2, part 1, in Exhibit 13.8 shows that throughput margins for the HPI-2 and HPI-3 are $300 and $450 per unit, respectively. Although HPI-3 has the higher margin, the profitability analysis is not complete without considering the time each product requires from the constrained process 4, final assembly and test. Since HPI-3 involves twice as much constraint time as HPI-2 (60 versus 30 minutes), HPI can produce twice as many HPI-2 models for each HPI-3 produced. In effect, the relevant measure of profitability is throughput margin *per minute of time in final assembly and test,* that is, a throughput per minute of $10 for HPI-2 and $7.50 for HPI-3. This means each minute of final assembly and test used to produce HPI-2 earns $10 while each minute used to produce HPI-3 earns only $7.50. HPI-2 is the most profitable product when final assembly and test is the constraint.

The best product mix is determined in step 2, part 2, of Exhibit 13.8. Since it is the most profitable product, HPI produces all 3,000 units or demand for HPI-2 and then determines the remaining capacity in final assembly. Finally, HPI determines the number of units of HPI-3 it can produce with the remaining capacity on the constraint. Despite the demand for 1,800 units of HPI-3, only 900 can be produced with the available capacity. Thus, the optimal product mix is 3,000 units of HPI-2 and 900 units of HPI-3.

The assumption in our illustration of the TOC approach is that minimal or no inventory of HPI-3 is maintained, so that it is not possible to fill the unmet demand for HPI-3 out of inventory. This assumption is in keeping with the TOC approach, which emphasizes the reduction of cost and speed of product flow by removing constraints and reducing inventory levels.

Step 3: Maximize the Flow through the Constraint

In this step, the management accountant looks for ways to speed the flow through the constraint by simplifying the process, improving the product design, reducing setup time, and reducing other delays due to unscheduled and non-value-added activities such as inspections or machine breakdowns, among others.

Takt time
is the speed at which units must be manufactured to meet customer demand.

A commonly used method for identifying constraints and smoothing production flow is the use of **Takt time.** *Takt* is a German word meaning the conductor's baton, or rhythm. It is the ratio of the total time available to the expected customer demand. For example, suppose a

[6] Note that the analysis in step 2, part 1, and step 2, part 2, of Exhibit 13.8 is identical to that explained in Chapter 11 under the heading of "Multiple Products and Limited Resources," for one production constraint. The determination of the optimal product mix is arrived at in the same manner. Step 2, part 2, can be solved using the Solver tool in Excel, as illustrated in Chapter 11.

[7] Note that TOC analysis assumes that factory labor is not a direct and variable cost but is a fixed cost. This assumption applies when labor is a small or an unchanging part of total cost.

REAL-WORLD FOCUS — Focus on Cycle Time at Starbucks

SPEEDING DELIVERY OF YOUR DRINK

Starbucks has decided to speed up drink delivery by reengineering the process of drink preparation. An 11-person team will be using lessons from the Toyota production system to reduce preparation time and improve a customer's experience. It also means that each Starbucks location could serve more drinks with the same number of workers or reduce the number of workers required to serve the same number of drinks.

Sources: Julie Jargon, "Latest Starbucks Buzzword: 'Lean' Japanese Technique," *The Wall Street Journal*, August 4, 2009, p. A1.

manufacturing plant operates for eight hours per day, and that after allowing for break time, 400 minutes of manufacturing time are available per day. Also, since the average customer demand per day is 800 units, the Takt time is 30 seconds per unit:

$$\text{Takt time} = \frac{\text{Available manufacturing time}}{\text{Customer demand}}$$

$$\text{Takt time} = \frac{400 \text{ minutes}}{800 \text{ units}} = {}^1\!/_2 \text{ minute (or 30 seconds) per unit}$$

This means that each unit must be manufactured in an average of 30 seconds to meet customer demand. To illustrate how Takt time can be used to identify constraints, consider a product that has demand of 18,000 units per week, with total operating time available per week at 75 hours. The Takt time is:

$$\frac{\text{Available time}}{\text{Demand}} = \frac{75 \text{ hr.} \times 60 \text{ min.} \times 60 \text{ seconds}}{18{,}000 \text{ units}}$$

$$= \frac{270{,}000 \text{ seconds}}{18{,}000 \text{ units}}$$

$$= 15 \text{ seconds per unit}$$

The plant must produce a unit each 15 seconds to keep up with demand. Assuming the manufacturing process has three operations in sequence, each requiring 15 seconds of processing time, a product will be completed every 15 seconds. Now, assume that the first operation requires 10 seconds, the second operation requires 20 seconds, and the third requires 15 seconds. The processing line is now unbalanced; the first operation moves quickly and work in process will build up at the relatively slower second operation. Furthermore, the total demand of 18,000 units cannot be met because the second process requires more than the 15 seconds of Takt time. The second operation is a constraint. In fact, the plant will only be able to meet a demand of 13,500 units (13,500 = 270,000 seconds ÷ 20 seconds per unit) because of the slow second operation. Only when the three operations are balanced at or near the Takt time of 15 seconds will the demand be met. The goal of implementing Takt time is to balance the processing of the operations, so that the processing time of each operation is preferably a little below the overall Takt time. An operation that has a very low processing time relative to Takt time has too much capacity, making it more efficient to reduce capacity (and thus increase processing time) on that operation, as long as processing time remains below Takt time.

Step 4: Add Capacity to the Constraint

As a longer term measure to relieve the constraint and improve cycle time, management should consider adding capacity to the constraints by adding new or improved machines and/or additional labor.

Step 5: Redesign the Manufacturing Process for Flexibility and Fast Cycle Time

The most complete strategic response to the constraint is to redesign the manufacturing process, including the introduction of new manufacturing technology, the deletion of some hard-to-manufacture products, and the redesign of some products for greater ease of manufacturing. Simply removing one or more minor features on a given product might speed up the production process significantly. The use of value engineering as described earlier might help at this point.

The Five Steps of Strategic Decision Making for Speed and Efficiency in the Fashion Industry

Burberry Group PLC is a London-based fashion retailer with several hundred retail stores worldwide providing its famous trench coats and a variety of fashion clothing for women and men. Burberry CEO Angela Ahrendts, upon taking the position in July 2006, noticed that the company was making "way too much stuff." There were too many product lines—for example, 20 different versions of men's and women's polo shirts. The complexity of the large number of products resulted in delay throughout the value chain—design, manufacturing, and distribution.[8]

The Five Steps of Strategic Decision Making for Burberry, the Fashion Retailer

1. **Determine the strategic issues surrounding the problem.** Burberry, as a fashion retailer, competes on the basis of design and fashion innovation, a differentiation strategy.

2. **Identify the alternative actions.** The company can continue to focus on product development, design, and innovation, with the expectation that the delays will not affect customer satisfaction or profitability. Alternatively, the company could review its product lines and look for efficiency throughout the value chain and expect to maintain the unique designs that have satisfied its customers in the past.

3. **Obtain information and conduct analyses of the alternatives.** Ahrendts directed the CFO to prepare a report showing what amount each product contributed to overall sales. The findings were that 20% of the products produced 80% of total sales. The enterprise system, SAP, was later introduced to help determine product profitability.

4. **Based on strategy and analysis, choose and implement the desired alternative.** Based on the CFO's information and her understanding that the firm's strategy required comprehensive, coherent product development, Ahrendts decided to reduce the number of Burberry's products by one-third and to switch from two large collections of fashion per year to five smaller collections. At the same time, she coordinated product development from London, so that all Burberry lines provided ". . . one brand and one message." The changes allowed the company to design and produce its fashions much more quickly, to adjust much more rapidly to changes in customer expectations, and to reduce costs through more efficient processes.

5. **Provide an ongoing evaluation of the effectiveness of implementation in step 4.** The changes made the company more competitive, more profitable, and better able to meet customer expectations. However, since design and innovation are the hallmarks of the fashion industry and for Burberry, the company must maintain a priority on these facets of the business as well.

Theory of Constraints Reports

When a firm focuses on improving cycle time, eliminating constraints, and improving speed of delivery, the performance evaluation measures also focus on these critical success factors. A common approach is to report throughput margin as well as selected operating data in a *theory of constraints (TOC) report.* TOC reports are useful for identifying the most profitable product and for monitoring success in achieving the critical success factors. An example of this report used by a manufacturer of automotive glass is shown in Exhibit 13.9. Note in the exhibit that window styles H and B are the most profitable because they have far higher

[8] The information is from Burberry's 2007 annual report and from Cecilie Rohwedder, "Burberry CEO Retrenches: Fewer Items, Faster Delivery," *The Wall Street Journal,* May 24, 2007, p. B1. Other high fashion designers including Valentino, Gucci, and Zara are also changing design and manufacturing processes for greater speed and flexibility; see Christina Passariello, "Logistics Are in Vogue with Designers," *The Wall Street Journal,* June 27, 2008, p. B1; Kerry Capell, "Zara Thrives by Breaking All the Rules," *BusinessWeek,* October 20, 2008, p. 66; and Christina Binkley, "Tracking the Trousers Cycle," *The Wall Street Journal,* August 16, 2007, p. D1.

EXHIBIT 13.9
The TOC Report for an Auto Glass Manufacturer

Source: R. J. Campbell, "Pricing Strategy in the Automotive Glass Industry," *Management Accounting*, July 1989, pp. 26–34.

	March 2016			
	Style C	**Style A**	**Style H**	**Style B**
Window size	0.77	.073	7.05	4.95
Sales volume	High	Moderate	High	Moderate
Units in unfilled orders	1,113	234	882	23
Average lead time (days)	16	23	8	11
Market price	$2.82	$6.68	$38.12	$24.46
Direct production costs				
Materials	0.68	0.64	5.75	4.02
Scrap allowance	0.06	0.05	0.42	0.34
Materials handling	0.12	0.12	1.88	1.61
Subtotal	.86	.81	8.05	5.97
Throughput margin	$1.96	$5.87	$30.07	$18.49
Furnace hours per unit	.0062	.0061	.0082	.0078
Throughput margin per hour	$ 316	$ 962	$3,667	$2,371

throughput margins based on the binding constraint, hours of furnace time. The throughput margin per hour is $3,667 for style H and $2,371 for style B; in contrast, the throughput margin per hour for styles C and A is less than $1,000.

Activity-Based Costing and the Theory of Constraints

Firms using such cost management methods as target costing and the theory of constraints may also employ activity-based costing (ABC). Like TOC, ABC is used to assess the profitability of products. The difference is that TOC takes a short-term approach to profitability analysis by emphasizing only materials-related costs, while ABC costing develops a long-term analysis by including all product costs.

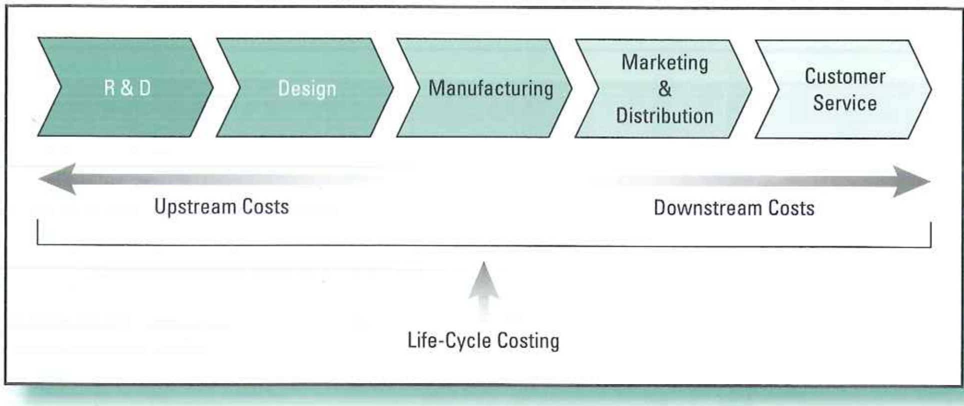
ABC, unlike TOC, does not explicitly include the resource constraints and capacities of production activities. Thus, ABC cannot be used to determine the best short-term product mix. ABC and TOC are thus *complementary* methods; ABC provides a comprehensive analysis of cost drivers and accurate unit costs as a basis for strategic decisions about long-term pricing and product mix. In contrast, TOC provides a useful method for improving the short-term profitability of the manufacturing plant through short-term product mix adjustments and through attention to production constraints. The differences between ABC and TOC are outlined in Exhibit 13.10.[9]

EXHIBIT 13.10
Comparison of the TOC and ABC Costing Methods

	TOC	ABC
Main objective	**Short-term focus;** throughput margin analysis based on materials and materials-related costs	**Long-term focus;** analysis of all product costs, including materials, labor, and overhead
Resource constraints and capacities	Included explicitly; a principal focus of TOC	Not included explicitly except as shown in time-driven ABC (see Chapter 5)
Cost drivers	No direct utilization of cost drivers	Develop an understanding of cost drivers at the unit, batch, product, and facility levels
Major use	Optimization of production flow and short-term product mix	Strategic pricing and profit planning

[9] For a comparison of TOC and ABC, see Robin Cooper and Regine Slagmulder, "Integrating Activity-Based Costing and the Theory of Constraints," *Management Accounting*, February 1999, p. 2; Robert Kee and Charles Schmidt, "A Comparative Analysis of Utilizing Activity-Based Costing and the Theory of Constraints for Making Product-Mix Decisions," *International Journal of Production Economics* 63 (2000), pp. 1–17; and Bih-Ru Lea, "Management Accounting in ERP Integrated MRP and TOC Environments," *Industrial Management + Data Systems* 107, no. 8 (October 2007), pp. 1188–1211.

EXHIBIT 13.11
Life-Cycle Costing in the Cost Life Cycle



Life-Cycle Costing

LO 13-3
Describe how life-cycle costing facilitates strategic management.

Typically, product or service costs are measured and reported for relatively short periods, such as a month or a year. Life-cycle costing provides a long-term perspective because it considers the entire cost life cycle of the product or service (see Exhibit 13.11). It therefore provides a more complete perspective of product or service costs and profitability. For example, a product that is designed quickly and carelessly, with little investment in design costs, could have significantly higher marketing and service costs later in the life cycle. Managers are interested in the total cost, over the entire life cycle, not manufacturing costs only.

While cost management methods have tended to focus only on manufacturing costs, upstream and downstream costs can account for a significant portion of total life-cycle costs, especially in certain industries:

Industries with High Upstream Costs

Computer software
Specialized industrial and medical equipment
Pharmaceuticals

Industries with High Downstream Costs

Fashion apparel
Perfumes, cosmetics, and toiletries

The Importance of Design

As managers consider upstream and downstream costs, decision making at the design stage is critical. Target costing, as explained earlier in this chapter, shows that although the costs incurred at the design stage may account for only a very small percentage of the total costs over the entire product life cycle, design-stage decisions commit a firm to a given production, marketing, and service plan. Therefore, they lock in most of the remaining life-cycle costs.

This concept is illustrated in Exhibit 13.12, which shows the difference in terms of time between when costs are committed versus when those costs are actually incurred.

While Exhibit 13.12 shows the difference in timing between committing and incurring costs, Exhibit 13.13 provides an example of the effects of poor design and quality on life-cycle costs.

The critical success factors at the design stage include the following:

Reduced time to market. In a competitive environment where the speed of product development and the speed of delivery are critical, efforts to reduce time to market have high priority.

Reduced expected service costs. By careful, simple design and the use of modular, interchangeable components, the expected service costs can be greatly reduced.

EXHIBIT 13.12 **Committed versus Incurred Costs**

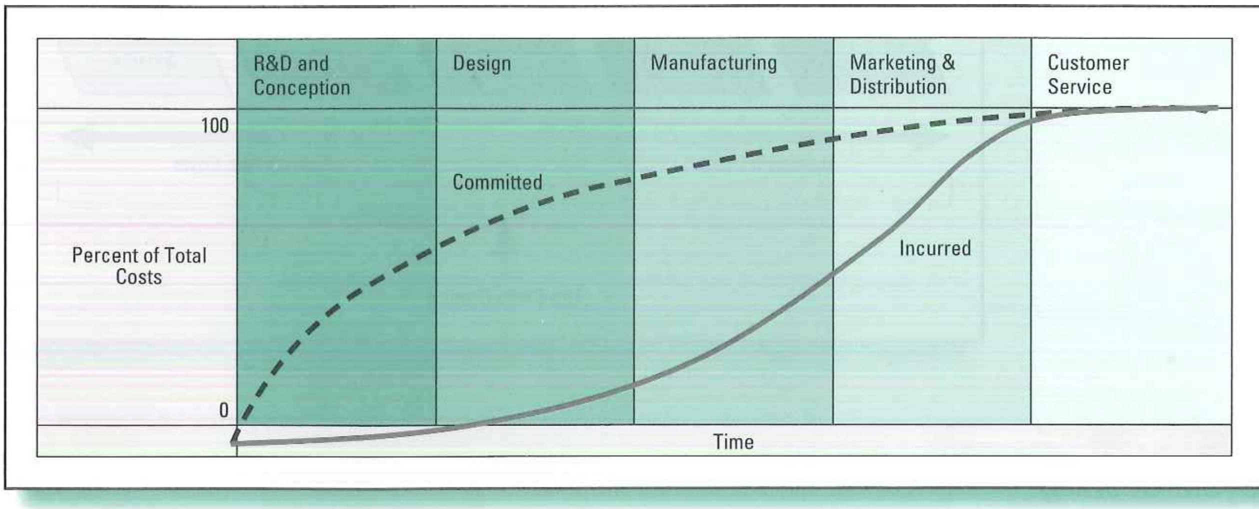
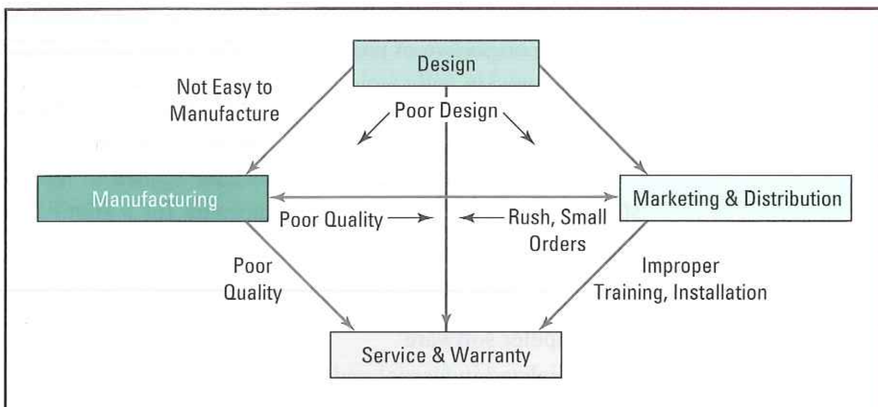


EXHIBIT 13.13
Value Chain Showing Upstream and Downstream Linkages for a Manufacturer



Reduced product environmental impact. Product design should focus on sustainability; that is, efforts should be made to reduce or lower the product's carbon footprint (use of greenhouse gasses) in manufacturing and in later use, to incorporate recycled materials, and so on.[10]

Improved ease of manufacture. To reduce production costs and speed production, the design must be easy to manufacture.

Process planning and design. The plan for the manufacturing process should be flexible, allowing for fast setups and product changeovers, using flexible manufacturing concepts, computer-integrated manufacturing, computer-assisted design, and concurrent engineering.

Strategic Pricing Using the Product Life Cycle

LO 13-4

Outline the objectives and techniques of strategic pricing.

Management accountants are involved in three pricing situations: The first is the special order decision (explained in Chapter 11) in which a nonrecurring sales opportunity arises. The second context is target costing (explained earlier in this chapter), in which a firm faces a market price and determines how to achieve the level of costs necessary to make a profit. The

[10] John Miller, "Maersk Orders 10 Huge Ships from Daewoo," *The Wall Street Journal,* February 22, 2011, p. B3. See also, Marc J. Epstein, *Making Sustainability Work: Best Practices in Managing and Measuring Corporate Social, Environmental, and Economic Impacts* (San Francisco: Berrett-Koehler, 2008).

REAL-WORLD FOCUS — Innovation Triangle at Electrolux

In an effort to compete against top appliance manufacturer Whirlpool, Electrolux is revamping the way it develops and updates its lineup. In an effort to get new products to market as much as 30% faster, the company is moving away from a production development process run mainly by accountants and engineers. Electrolux's new process makes use of an "innovation triangle" that includes design, research and development, and marketing. There are also customer focus groups involved and any proposal that receives less than a 70% approval rating is not ready for production. As one example of the process, researchers watched people use a vacuum to find the pain points. It was discovered that many dust particles start to fly around when the vacuum is emptied. One idea was to compact the dust into a disk to eliminate the dust particles. Then a decision had to be made regarding how to compress the particles. One option was a manual piston and the other was a motorized compactor. The manual piston won out because the motorized version was more expensive and would require batteries. However, before a final decision was made, additional customer focus groups were involved, with the 70% approval rule applied at every step.

Sources: Carol Matlack, "Electrolux's Holy Trinity," *Bloomberg Businessweek*, November 4, 2013, pp. 55–56.

third type of pricing decision—not involving special orders or market-determined prices—is the focus in this section. These are the long-term, strategic pricing decisions facing many managers. They are complex decisions involving strategic issues and the careful use of cost information. To assist in these pricing decisions, the management accountant prepares cost information from the perspective of the cost life cycle and the sales life cycle, and through the use of analytical pricing methods.

Pricing Using the Cost Life Cycle

Pricing based on cost is a common approach for manufacturing and service firms. Those that compete on cost leadership use cost information to improve operating efficiency to reduce costs and price. Prices are set by the most efficient producers: the ones that are best able to reduce costs. In contrast, firms that compete on differentiation have more discretion in setting prices. The differentiated firm's goal might be to increase profits by setting an initial high price for those willing to pay, followed by lower prices for the cost-conscious customers (called *skimming*). Alternatively, the firm's goal might be to increase market share by lowering the price (called *penetration*). A third approach would be to build longer-term customer relationships by utilizing "value pricing" in which pricing is based on meeting specific customer needs. A firm's pricing policy is also influenced by patterns in the industry. For example, firms with seasonal demand (clothing, appliances, furniture, among others) usually offer discounts and promotions during the slow periods of the year. Other industries are sensitive to interest rates, stock market returns, other factors in the economy (automobiles and construction, among others), and new products or pricing policies of competitors. To deal with the complexity of the pricing decision, firms like GE Lighting, DHL, and Hewlett-Packard use web-based software systems to determine prices more quickly and accurately for different customers. The systems speed up the process of quoting prices and assist in determining the timing and location of discount programs. Thus, a number of seasonal, cyclical, economic, and other strategic factors influence the pricing policies of the firm, and cost information is only the starting point of the pricing decision. The cost information for pricing is commonly based on one of the four methods: (1) full manufacturing cost plus markup, (2) life-cycle cost plus markup, (3) full cost and desired gross margin percent, and (4) full cost plus desired return on assets.

Full Manufacturing Cost Plus Markup

In this method, a firm uses the total of variable and fixed manufacturing costs and applies a markup percentage to cover other operating costs plus profit. The markup percentage could be determined by industry practice, judgment, or a desired level of profit. Suppose that a firm has a markup rate of 40% and, using ABC costing, determines the full manufacturing cost is \$150. The resulting price would be \$210, calculated as \$150 + (150 × 40%).

Life-Cycle Cost Plus Markup

The life-cycle approach to pricing uses the full life-cycle cost instead of manufacturing cost only. Suppose that in addition to manufacturing costs of \$150 per unit, the example firm has selling and administrative costs of \$25 per unit, for a total life-cycle cost of \$175. The firm uses a markup rate of 25% based on life-cycle costs. The calculated price is now \$218.75:

$$\text{Total life-cycle costs} \times \text{Markup} = \text{Price}$$

$$\$175 \times 125\% = \$218.75$$

The life-cycle approach has the advantage that all costs are included, so that the markup percentage can be directly tied to a desired level of profit.

Full Cost and Desired Gross Margin Percent

In this variation, the price is determined based upon achieving a desired gross margin percentage. To continue with the previous example, suppose that the desired gross margin is 30% of sales. Then, the price would be \$214.29:

$$\text{Price} = \frac{\text{Full manufacturing cost}}{(1 - \text{Desired gross margin percentage})}$$

$$= \frac{\$150}{(1 - .3)} = \$214.29$$

This price would produce a gross margin of \$214.29 − \$150 = \$64.29, which is 30% of sales. Alternatively, a variation of this method could be used to achieve a desired percentage return on life-cycle costs. For example, if the desired percentage return on life-cycle costs is 15%, then the price would be \$205.88:

$$\text{Price} = \frac{\text{Full life-cycle cost}}{(1 - \text{Desired life-cycle margin percentage})}$$

$$= \frac{\$175}{(1 - .15)} = \$205.88$$

Full Cost Plus Desired Return on Assets

Another pricing approach is to set the price to achieve a desired return on assets. Starting with the same information, now assume that the firm has \$3.5 million assets committed to the production of the product and desires a 10% before-tax return on assets. Sales are expected to be 10,000 units. Using a life-cycle cost approach (a full manufacturing-cost approach could be used in a similar manner), the markup percentage would be 20%.

$$\text{Markup rate} = \frac{\text{Desired before-tax profit}}{\text{Life-cycle cost of expected sales}}$$

$$= \frac{\$3{,}500{,}000 \times 10\%}{10{,}000 \times \$175} = 20\%$$

And the price would then be \$210:

$$\text{Price} = \text{Life-cycle cost} \times 120\% = \$175 \times 120\% = \$210$$

Each of these illustrations assumes that all sales are for the price determined. The desired price could be adjusted to reflect expected discounts or losses due to spoilage or theft.

Strategic Pricing for Phases of the Sales Life Cycle

Strategic pricing depends on the position of the product or service in the sales life cycle. As the sales life cycle becomes shorter (only months in some industries such as consumer electronics), the analysis of the sales life cycle becomes increasingly important. In contrast to the cost

REAL-WORLD FOCUS Setting Prices for Profitability

Setting prices can be tricky for any organization. While some companies compete on price, others compete on the basis of performance and adjust the price accordingly. The key is to identify value opportunities. One manufacturer of rubber stoppers was able to charge a premium for a product that was very similar to, but not exactly the same as, a low-priced stopper. The company was able to charge a premium because of the tighter tolerances and greater quality control needed by the customer because of the high-value application of the stopper.

Sometimes the value of differentiation is found by accident. **Headset.com** erroneously posted its products at cost rather than retail and found only a marginal increase in sales before the error was caught and corrected. It found that customer service, not price, was driving sales. Following that event, the company raised prices 8% and found virtually no change in sales volume, so revenue went up by about 8%.

Sources: Frank Cespedes, Elliot Ross, and Benson Shapiro, "Raise Your Prices," *The Wall Street Journal,* May 24, 2010, p. R8; Eilene Zimmerman, "Real-Life Lessons in the Delicate Art of Setting Prices," *The Wall Street Journal,* April 21, 2011, p. B4.

life cycle just described, the sales life cycle refers to the phase of the product or service's sales in the market, from introduction of the product or service to decline and withdrawal from the market. (Exhibit 13.2 illustrates the phases of the sales life cycle.)

Phase 1: Introduction. The first phase involves little competition, and sales rise slowly as customers become aware of the new product or service. Costs are relatively high because of high R&D expenditures and capital costs for setting up production facilities and marketing efforts. Prices are relatively high because of product differentiation and the high costs at this phase. Product variety is limited.

Phase 2: Growth. Sales begin to increase rapidly as does product variety. The product continues to enjoy the benefits of differentiation. Competition increases, and prices begin to fall.

Phase 3: Maturity. Sales continue to increase but at a decreasing rate. The number of competitors and product variety both decline. Prices fall further, and differentiation is no longer important. Competition is based on cost given competitive quality and functionality.

Phase 4: Decline. Sales and prices decline, as do the number of competitors. Control of costs and an effective distribution network are key to continued survival.

In the first phase, the focus of management is on design, differentiation, and marketing. The focus shifts to new product development and pricing strategy as competition develops in the second phase. In the third and fourth phases, management's attention turns to cost control, quality, and service as the market continues to become more competitive. Thus, the firm's strategy for the product or service changes over the sales life cycle from differentiation in the early phases to cost leadership in the final phases.

Similarly, the strategic pricing approach changes over the product or service life cycle. In the first phase, pricing is set relatively high to recover development costs and to take advantage of product differentiation and the new demand for the product. In the second phase, pricing is likely to stay relatively high as the firm attempts to build profitability in the growing market. In the latter phases, pricing becomes more competitive, and target costing and life-cycle costing methods are used as the firm becomes more of a price taker than a price setter and makes efforts to reduce upstream and downstream costs.

Strategic Pricing: Analytical and Peak Pricing Methods

Increasingly, retailers, manufacturers, and even service providers use a strategic approach to pricing in which they determine prices by what the customer is willing to bear, often using analytical methods based upon extensive data analysis of customer buying behavior. Consider, for example, the variability in the prices charged to fly between two destinations, the higher price for electricity in the middle of the day, the difference in the cost of a hotel room on a weekend versus a weekday, or the cost of peak versus off-peak minutes for a cell phone plan. Another example is the use of a "fighter brand," a low-priced version of the well-known product. The fighter brand is especially common in a recessionary environment, as consumers of high-end products look for less expensive substitutes.[11]

Summary

The strategic cost management concepts introduced in the preceding chapters are extended here. First, we discuss four cost management methods used to analyze the product or service's life cycle: target costing, the theory of constraints, life-cycle costing, and strategic pricing. Target costing is a tool for analyzing the cost structure to help management identify the proper design features and manufacturing methods to allow the firm to meet a competitive price.

Target costing has five steps:

1. Determine market price.
2. Determine desired profit.
3. Calculate target cost.
4. Use value engineering to identify ways to reduce costs.
5. Use kaizen costing and operational control to further reduce costs.

The theory of constraints (TOC) is a tool that assists managers in identifying bottlenecks (constraints) and scheduling production to maximize throughput and profits. TOC analysis has five steps:

1. Identify the constraint.
2. Determine the most efficient product mix given the constraint.
3. Maximize the flow through the constraint.
4. Add capacity to the constraint.
5. Redesign the manufacturing process for flexibility and fast throughput.

Life-cycle costing assists managers in minimizing total cost over the product or service's entire life cycle. Life-cycle costing brings a focus to the upstream (before production) activities (research and development, engineering) and downstream (after production) activities (marketing, distribution, service), as well as the manufacturing and operations that cost systems focus on. Especially important is a careful consideration of the effects of design choices on downstream costs.

Strategic pricing helps management determine the price of the product or service based on its life-cycle costs or its position in the different phases of its sales life cycle.

Appendix

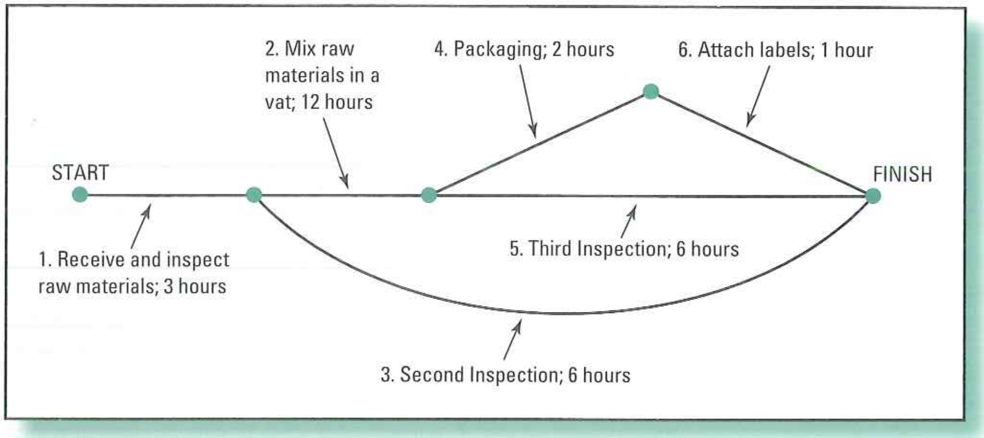
Using the Flow Diagram to Identify Constraints

This chapter illustrated the use of the flow diagram to identify the constraint when there are two or more products being produced through a common set of processes, with no specific completion time. The flow diagram can also be useful when there is a single product or project and a specific completion time. This appendix illustrates the latter case, where the flow diagram is used to identify the processes that must be finished on time for the product or project to be completed on time.

To illustrate, suppose that a small pharmaceutical firm, Skincare Products, Inc. (SPI), manufactures an insect repellent with sunscreen. The batch production process requires mixing the active and inert ingredients in a large vat. Because of Food and Drug Administration

[11] Thomas H. Davenport and Jeanne G. Harris, *Competing on Analytics* (Boston: Harvard Business School Press, 2007); Josh Hyatt, "And in This Corner, the Fighter Brand," **CFO.com**, December 1, 2008; Rebecca Smith, "Electricity: The New Math," *The Wall Street Journal*, July 19, 2010, p. A6; Scott McCartney, "You Paid What for That Flight?" *The Wall Street Journal*, August 26, 2010, p. D1.

EXHIBIT 13A.1
Flow Diagram for Skincare Products, Inc.



requirements, SPI provides three inspections: (1) the raw materials it receives, (2) the mix of raw materials during the mixing process, and (3) the final product. The first and second inspections check the materials for correct chemical content and potency; the third inspection focuses on correct weight or item count. The manufacturing process has six processes, which are illustrated in Exhibit 13A.1, a flow diagram of the work done.

The exhibit shows the sequence of processes and the amount of time required for each and is used to identify the constraints. Computer techniques do this for large networks, but the constraints for a smaller network, such as the one illustrated in Exhibit 13A.1, can be identified by visual inspection. As defined earlier, a *constraint* is any process that delays the entire manufacturing process. The amount of the delay is often called *slack time.* Processes that can be delayed without delaying the finish time for the entire process are called *nonconstraints* or simply *slack* processes since the processes have some slack time in which to be completed. The constraints for SPI are shown in the following table:

Process	Required Time (hours)
1 – Receive and inspect raw materials	3
2 – Mix raw materials in vat	12
5 – Perform third inspection	6

The total time for the entire manufacturing process cannot be less than the total time of these three processes added together (3 + 12 + 6 = 21 hours) since these processes must follow in sequence and cannot overlap. The remaining processes—3, 4, and 6—are not constraints and can be delayed one or more hours without delaying the entire production process. The amount of the delay can be determined as follows. Process 3 requires 6 hours and must be finished while processes 2 and 5 are being completed, but because processes 2 and 5 require 18 hours (12 + 6) and process 3 requires only 6 hours, process 3 has 12 hours (18 − 6) of slack time. Similarly, since processes 4 and 6 together require only 3 hours (2 hours plus 1 hour, respectively) and must be completed during process 5 (which requires 6 hours), a total of 3 hours of slack exists for processes 4 and 6 combined. Often the constraint processes (1, 2, and 5 in this case) are called *critical processes* since they cannot be delayed without delaying the entire batch of product. Also, the sequence of critical processes is often called the *critical path.*

Key Terms

concurrent engineering, *505*
constraints, *510*
cost life cycle, *501*
cost tables, *505*
cycle time, *509*
design analysis, *504*
flow diagram, *511*
functional analysis, *504*
group technology, *505*
manufacturing cycle efficiency (MCE), *509*
quality function deployment (QFD), *507*
sales life cycle, *501*
Takt time, *513*
throughput margin, *513*
value engineering, *503*

Comments on Cost Management in Action

Why Go Abroad?

In competitive industries such as apparel, consumer electronics, and computers, manufacturers continuously look for ways to reduce cost and increase value throughout the value chain. These industries have chosen to locate extensive manufacturing operations and/or partners in Latin America and China to reduce cost and to benefit from innovative manufacturing methods and facilities. Wage costs are lower and, using target costing and value engineering, manufacturing processes are built around modular manufacturing methods that reduce the number of parts in the product, speeding the manufacturing process and reducing costs.

Consumer Electronics and Computer Products Why is outsourcing manufacturing to foreign plants an advantage to Apple and Hewlett-Packard? The contract manufacturers' manufacturing experience and technology give them a cost advantage. Foxconn and the other contract manufacturers also can focus on the manufacturing process rather than the entire product value chain. Moreover, they gain economies of scale by manufacturing similar products for different clients. The use of contract manufacturing is an important part of the strategy to achieve target costs while maintaining product leadership in design and customer service. These arrangements are not, however, without risks in terms of both supply and reputation.

Apparel Companies Liz Claiborne and Ralph Lauren are saving lots of time and money by outsourcing many phases of the product development, from design to manufacturing, to plants in China. Having the product development and manufacturing in one place has helped the firms introduce new products more quickly and has also allowed them to deliver their product more quickly around the world.

Sources: Gabriel Kahn, "Making Labels for Less," *The Wall Street Journal,* August 13, 2004, p. B1; Justin Scheck, "Dell Plans to Sell Factories in Effort to Cut Costs," *The Wall Street Journal,* September 5, 2008, p. 1; Jason Dean and Ting-I Tsai, "Suicides Spark Inquiries; Apple, H-P to Examine Asian Supplier After String of Deaths at Factory," *The Wall Street Journal (Online),* May 26, 2010; Aries Poon, Loretta Chao, and Yukari Iwatani Kane, "Factory Blast Roils Tech Supply Chain; China's Hon Hai Closes Product Polishing Workshops," *The Wall Street Journal (Online),* May 24, 2011.

Self-Study Problems

(For solution, please turn to the end of the chapter.)

Best Brand Lighting Inc.

Best Brand Lighting Inc. (BBL) manufactures lighting fixtures. The two major markets for BBL products are major retailers, including Home Depot, Walmart, and Kmart, and specialty lighting stores. The former sell primarily to homeowners, and the latter primarily to electrical contractors.

Although its standard sizes and models typically are sold to the large retailers, BBL sells its products with more specialized features and sizes only to the specialty stores. Thus, the design and manufacturing costs of the products going to the specialty stores are slightly higher. The products in both markets have similar sales life cycles of about two years.

Because of the difference in consumers, BBL has a larger marketing cost for the products sold to the large retailers—advertising in major media to attract homeowners. In contrast, the marketing for the specialty shops consists mainly of catalogs and advertisements in trade publications resulting in a lower overall marketing cost. The sales policies also differ somewhat for the two markets. Sales to specialty stores are priced higher but include significant discounts and attractive return policies. In contrast, sales to the major retailers have restrictive return policies and offer little, if any, discount.

BBL management is interested in an in-depth analysis of the profitability of its two markets. As a first step, it has asked for the average costs and other data for all BBL products:

	Major Retailers	Specialty Stores
Design costs	$ 0.80	$ 1.10
Manufacturing costs	5.20	5.90
Marketing costs	0.95	0.10
Returns	0.05	0.95
Discounts	0.10	0.95
Average price	10.55	12.50
Total market ($000) in BBL's sales region	188,000	32,000
Current unit sales ($000)	9,200	8,000

Required Using the methods discussed in this chapter, analyze BBL's two market segments. What questions would you want to ask management and which fact-finding studies would be appropriate to support this analysis?

Please visit the Connect Library to access a narrated, animated tutorial for solving this problem.