Chapter 8

Measuring and Managing Life-Cycle Costs

After completing this chapter, you will be able to:

1. Describe the total-life-cycle costing approach for managing product costs.
2. Explain target costing.
3. Compute target costs.
4. Calculate the breakeven time for a new product development project.
5. Select nonfinancial measures for product development processes.
6. Identify environmental costing issues.

Chemco International

Marais Young has just been appointed controller of a specialty chemical company after serving several years as senior manager of the manufacturing division. Although her performance was excellent in that division, she continually struggled with the narrow scope of the company's management accounting system.

The system focused solely on assigning the costs of the manufacturing process to products and did not provide any insight into premanufacturing and postmanufacturing costs, such as the cost of developing products and disposing of toxic waste from the production process and the used chemicals that had been returned by customers. Competition in the chemicals industry had increased dramatically, and Marais knew she needed to understand the total costs over the entire life cycle of the company's products.

She has heard that some companies in the industry have adopted an approach imported from Japan called target costing, which helps engineers lower the costs of products during the design and development stage. In addition, the variety of products produced by the company have different hazards and toxicities associated with them. With the cost of environmental compliance rising rapidly, Marais wanted to trace safety, take-back, recycling, and disposal costs to individual products in the same way that activity-based costing now allows the tracing of manufacturing costs to individual products, and MSDA costs to individual customers. She believed that better costing systems would help the company's managers and product and process engineers make better decisions about how to design, produce, recycle, and dispose of products over their entire life cycle.

Managing Products over Their Life Cycle

In the past several chapters, we have focused on measuring and improving product, customer, and process performance. Companies, however, should not only improve the profitability from existing products but also create new products and services. Successful innovation drives customer acquisition and growth, margin enhancement, and customer loyalty. Without innovation, a company's advantage in the marketplace will eventually be imitated, forcing it to compete solely on price for commodity products and services.

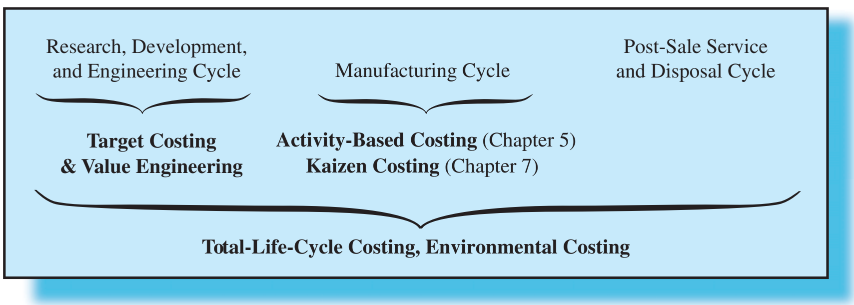
Companies, such as Apple, become the industry's leader and earn exceptional profits by bringing innovative products—well matched to targeted customers needs and expectations—to the market fast and efficiently. Product innovation is a prerequisite to even participate in some dynamic, technologically based industries, such as pharmaceuticals, specialty chemicals, semiconductors, telecommunications, and media.

Companies that continually bring new products to the market quickly must also be concerned about the environmental impact from their innovation, as customers discard their now obsolete products. Societal concerns about pollution have caused companies such as Xerox, HP, and Sony to measure the total life-cycle costs of their products, including the impact of raw material extraction, energy consumption during use, and, finally, salvage, recycling, and disposal. We refer to **total-life-cycle costing (TLCC)** as the approach companies now use to understand and manage all costs incurred in product design and development, through manufacturing, marketing, distribution, maintenance, service, and, finally, disposal (see Exhibit 8-1). Managing life-cycle costs is also known as managing costs "from the cradle to the grave."

The innovation process itself is expensive. One automotive component supplier discovered that it incurred 10% of its expenses during product design and development, whereas its entire production direct labor costs were 9% of expenses. Yet it monitored and controlled direct labor expense tightly, whereas its design and development group had hardly any management accounting system to monitor its rate of expenditure in R&D or to measure the performance of the new products that it released to the production department.

Beyond managing the costs of product development, engineers and managers must plan ahead for a product's production costs once its design and development have been

Exhibit 8-1
Cycle Comprising the Total-Life-Cycle Costing Approach



completed. After products reach the manufacturing stage, the opportunities for substantial cost reduction may be limited. Companies have learned that most of a product's costs are designed in during the research and development stages. And many companies are now planning for the postproduction costs of retrieving, recycling, and salvaging their products (referred to as product take-back) after their customers are finished using them.

Consider the situation faced by managers of the Burleson Company who have just learned about a new product concept that may revolutionize their business. Their initial research suggests to them that they can manufacture the product at a reasonably low cost, especially given the new technology that they have just acquired. They begin to consider how they can reorganize their operations to accommodate the production of the new product. Because they have only some preliminary ideas about the feasibility of product design, they approach their research, development, and engineering (RD&E) division for further investigation. The report from the RD&E group tells them that the product can be produced, but the cost of developing prototypes is 20 times more than the average prototype costs. RD&E confirms, however, that the actual cost to manufacture the product after the first year will be low as Burleson gains experience with the new technology. Thus, the initial life-cycle cost of the product may be high, but unit manufacturing costs should be relatively low. With this new information, managers of the division have to determine whether they should forge ahead with developing the new product in light of its high R&D costs, low manufacturing costs, and the opportunity costs of committing their scarce engineers for this project.

Each part of a company's value chain—new product development, production, distribution, marketing, sales, and postsales service and disposal—is typically managed by a different organizational function. Although costs may be collected and traced to each function, companies need a total-life-cycle perspective that integrates the trade-offs and performance over time and across functional units. From the company's perspective, total-life-cycle product costing integrates RD&E, manufacturing, and postsales service and disposal. Let us look at each.

Research, Development, and Engineering Stage

The **research, development, and engineering (RD&E) stage** consists of three substages:

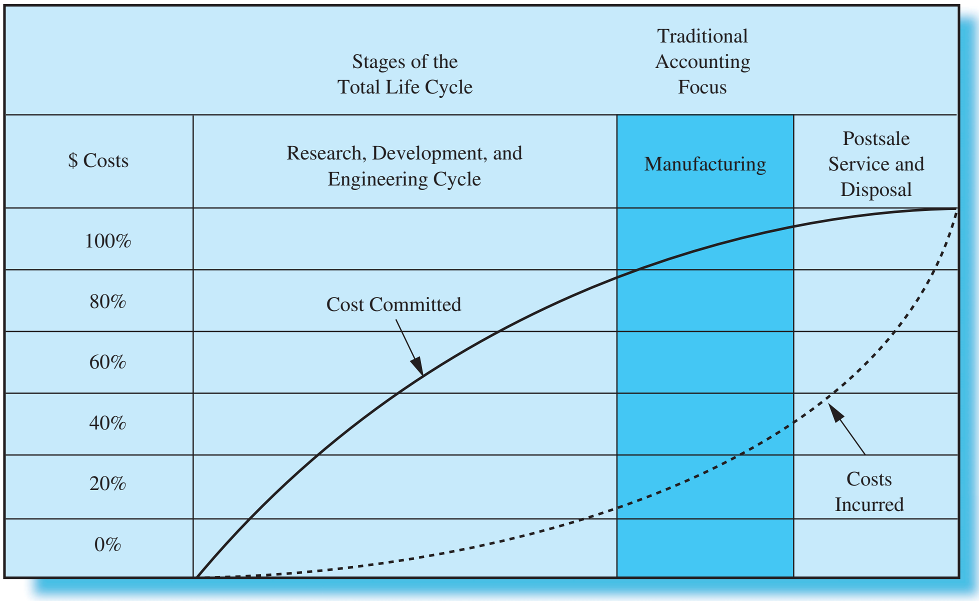
1. *Market research*, during which emerging customer needs are assessed and ideas are generated for new products.
2. *Product design*, during which scientists and engineers develop the technical specifications of products.
3. *Product development*, during which the company creates features critical to customer satisfaction and designs prototypes, production processes, and any special tooling required.

By some estimates, 80% to 85% of a product's total life-cycle costs are committed by decisions made in the RD&E stage of the product's life (see Exhibit 8-2). Decisions made during this cycle can have a huge impact on the costs incurred in later stages. Spending an additional dollar in better design can often save $8 to $10 in manufacturing and postmanufacturing activities, by reducing the costs of design changes, service costs, and take-back and recycling costs.

Manufacturing Stage

After the RD&E stage, the company enters the **manufacturing stage**, in which it spends money—on materials, labor, machinery, and indirect costs—to produce and distribute the product. This stage offers little opportunity for engineering decisions to reduce product costs through redesign decisions since most costs have already been

Exhibit 8-2
Total-Life-Cycle Costing: Relationship between Committed Costs and Incurred Costs



determined during the RD&E stage. In Exhibit 8-2, the lower curve illustrates how costs are incurred over both the RD&E and the manufacturing cycle. For moderate to long life-cycle products, the costs incurred during RD&E will be less than 10% of total-life-cycle costs. But the decisions made during the RD&E stage will determine 80% of the costs that will be incurred in subsequent stages. Traditional cost accounting and process improvement methods focus their attention on the manufacturing stage. This is the role for product and process costing, facilities layout, kaizen, benchmarking, and just-in-time manufacturing (discussed in Chapters 4 through 7). These methods help reduce product costs during the manufacturing stage. But they ignore the potential for effective cost management during the RD&E stage.

Postsale Service and Disposal Stage

In the third stage, companies incur costs for **postsale service and disposal**. Although the costs for service and disposal are committed in the RD&E stage, the actual service stage begins once the first unit of a product is in the hands of the customer. Thus, this stage overlaps somewhat with the manufacturing stage. It typically consists of three substages:

1. Rapid growth from the first time the product is shipped through the growth stage of its sales.
2. Transition from the peak of sales to the peak in the service cycle.
3. Maturity from the peak in the service cycle to the time of the last shipment made to a customer; disposal occurs at the end of a product's life and lasts until the customer retires the final unit of a product.

Disposal costs include those associated with eliminating any harmful effects associated with the end of a product's useful life. Products whose disposal could involve harmful effects to the environment, such as nuclear waste or other toxic chemicals, can incur very high salvage, recycling, and disposal costs.

A breakdown of costs for each of the functional life cycles will differ, depending on the industry and specific product produced. Exhibit 8-3 illustrates four types of products and the variation of costs over their total life cycles. For example, the manufacturing

Exhibit 8-3
Percentage of Life-Cycle Costs Incurred across Four Types of Products

Stage of Life Cycle	Type of Product			
Cycle	Combat Jets	Commercial Aircraft	Nuclear Missiles	Computer Software
RD&E	21%	20%	20%	75%[a]
Manufacturing	45%	40%	60%	[a]
Service and disposal	34%	40%	20%	25%
Average length of life cycle	30 years	25 years	2 to 25 years	5 years

[a]For computer software, both RD&E and manufacturing are often tied directly together.

costs of the commercial aircraft company are approximately 40% of total incurred costs. RD&E and postsale service and disposal incur 20% and 40%, respectively. An understanding of total-life-cycle costs encourages product engineers to select product designs that make them easier to service and easier and less costly to dispose of at the end of their useful life. Computer software development during the RD&E stage creates and debugs the software code. It can cost 100 times more to correct a software defect during its operating stage than to prevent or catch the bug in the design phase.

Target Costing

Japanese engineers in the 1960s developed an approach called **target costing** to help them consider manufacturing costs early in their design decisions. Target costing helps engineers design new products that meet customers' expectations and that can be manufactured at a desired cost. Target costing is an important management

Japanese camera companies use target costing to lower the manufacturing costs of a new generation of products during its research, development, and engineering stage.
Reuters Limited

Exhibit 8-4
A Comparison of the Process of Traditional U.S. and Japanese Cost Reduction Methods

Traditional U.S. Cost Reduction	Japanese Target Costing
Market research to determine customer requirements	Market research to determine consumer needs and price points
⇩	⇩
Product specification	Production specification and design
⇩	⇩
Design	Target selling price (S_{tc}) (and target product volume)
⇩	
Engineering	–
⇩	
Supplier pricing	
⇩	Target profit (P_{tc})
ESTIMATED COST (C_t) (if too high, return to design phase)	=
Desired profit margin (P_t)	TARGET COST (C_{tc})
=	⇩
	Value engineering / Supplier cost reduction
Expected selling price (S_t) – Estimated cost (C_t)	(Both value engineering and collaboration with suppliers are used to achieve the target costs for each component)
⇩	⇩
Manufacturing	**Manufacturing**
⇩	⇩
Periodic cost reduction	Continuous cost reduction

accounting method for cost reduction during the design stage of a product's life cycle and one that can explicitly help to manage total-life-cycle costs.

The traditional product development method followed in the United States and other Western companies is shown as the left-hand column in Exhibit 8-4. It starts with market research into customer requirements for the new product, and the price they are willing to pay for a product that performs according to those requirements. From this research, engineers determine the product's specifications to deliver the desired performance. They then perform detailed product design and engineering for the product to meet its specifications.

After the product has been completely designed, the development team requests prices from raw materials and component suppliers, and production cost estimates from manufacturing engineers. This leads to the first estimate of the product's cost (C_t), where t indicates a product cost estimate derived from this traditional, sequential design and development process. The team then estimates the product's profit margin (P_t) by subtracting the estimated cost from the expected selling price (S_t), which has also been determined during the initial market research. The new product's profit margin is the difference between the expected selling price and the estimated production cost[1] as expressed in the following equation:

$$P_t = S_t - C_t$$

[1] Robin Cooper developed the structure for comparing costs in this manner in "Nissan Motor Company, Ltd.: Target Costing System," HBS No. 9-194-040 (Boston: Harvard Business School Publishing, 1994).

Another widely used approach, the cost-plus method, adds the desired profit margin for the product P_{cp} to the expected product cost (C_{cp}) where *cp* indicates numbers derived from the cost-plus method. This calculation yields the selling price (S_{cp}). In equation form, this relationship is expressed as follows:

$$S_{cp} = C_{cp} + P_{cp}$$

In both the traditional and cost-plus methods, product designers do not attempt to achieve a particular cost target. The company either accepts the profit margin allowed as the difference between the market-determined selling price and the estimated product cost, or it attempts to set the price sufficiently high to earn the desired margin over the product's cost, without paying much attention to customers' willingness to pay. In both methods, product development engineers do not attempt to actively influence the product's cost. They design the product to meet its specifications and accept the costs as the consequence of their design and development decisions.

Target costing, in contrast, strives to actively reduce a product's cost during its RD&E stage rather than wait until the product has been released into production to start the cost reduction, or kaizen, process. As previously noted, cost reduction during the manufacturing stage is generally more costly and less effective than during the RD&E stage. In target costing (see right-hand column of Exhibit 8-4), both the sequence of steps and the way of thinking about determining product costs differ significantly from traditional costing. Although the initial steps—market research to determine customer requirements and product specification—appear similar to traditional costing, target costing introduces some important differences. First, market research under target costing is not a single event as it often is under the traditional approach. Rather, the approach is *customer driven*, with customer input obtained continually throughout the process. Second, the product engineers attempt to design costs out of the product before design and development ends and manufacturing begins. This approach is particularly effective since, as previously stated, 80% or more of a product's total-life-cycle costs get committed during the RD&E cycle (review Exhibit 8-2). Third, target costing uses the total-life-cycle concept by adopting the perspective of minimizing the cost of ownership of a product over its useful life. Thus, not only are costs such as the initial purchase price considered, but so are the costs of operating, servicing, maintaining, repairing, and disposing of the product.

In a third target costing innovation, the engineers set an allowable cost for the product that enables the targeted product profit margin to be achieved at a price that customers are willing to pay. With this approach, a target selling price and target product volume are chosen on the basis of the company's perceived value of the product to the customer. The target profit margin results from a long-run profit analysis that is often based on return on sales (net income ÷ sales). Return on sales is the most widely used measure because it can be linked most closely to profitability for each product. The **target cost** is defined as the difference between the target selling price and the target profit margin. (Note that *tc* indicates numbers derived under the target costing approach.) This relationship for the target costing approach is shown in the following equation:

$$C_{tc} = S_{tc} - P_{tc}$$

Once the target cost has been set for the entire product, the engineers next determine the target costs for each component in the product. The **value engineering process** examines the design of each component to determine whether it is possible to reduce costs while maintaining functionality and performance. In some cases, the engineers can change the product's or component's design, substitute new materials, or modify and improve the manufacturing process. For example, a product redesign may enable the same functionality to be achieved but with fewer parts or with more common rather than unique parts.

Recall from activity-based costing that it is less expensive to produce 10% more from an existing production run than to change over to switch to a low-production run for a specialty component. It is less expensive to order 10% more of a component from an existing supplier than to find a new vendor to order a low quantity of a specialty component. All of these decisions and trade-offs are best made during the RD&E stage when the product's design is still fluid rather than during the manufacturing stage when it is far more costly to do a major redesign of a product. Several iterations of value engineering usually are needed before the final target cost gets achieved.

Two other differences characterize the target costing process. First, throughout the entire process, **cross-functional product teams** made up of individuals representing the entire value chain—both inside and outside the organization—guide the process. For example, it is not uncommon for a team to consist of people from inside the organization (such as design engineering, manufacturing operations, management accounting, and marketing) and representatives from outside the organization (including suppliers, customers, distributors, and waste disposers).

A second difference is that suppliers play a critical role in making target costing work. Often the company asks its suppliers to participate in finding ways to reduce the cost of specific components or an entire subassembly or module. Companies offer incentive plans to suppliers who come up with the largest cost reduction ideas. As companies work more closely with their suppliers during the RD&E stage, they use a set of methods collectively known as **supply chain management**. Supply chain management develops cooperative, mutually beneficial, long-term relationships between buyers and suppliers. The benefits are many. For example, as trust develops between buyer and supplier, decisions about how to resolve cost reduction problems can be made with shared information about various aspects of each other's operations. In some organizations, the buyer may even expend resources to train the supplier's employees in some aspect of the business, or a supplier may assign one of its employees to work with the buyer to understand a new product. Such interactions are quite different from the short-term, arms-length relationships that are characteristic of a transactions-based buyer–seller relationship.

A Target Costing Example

How does target costing actually work in practice?[2] We illustrate the target costing process with an example drawn from actual experiences but using a hypothetical company, Kitchenhelp, Inc.

Among other products, Kitchenhelp manufactures coffeemakers. Market research has identified eight features of a coffeemaker that are important to customers:

1. Coffee tastes and smells like espresso.
2. The coffeemaker is easy to take apart and clean.
3. Capacity is at least six cups.
4. The coffeemaker has an attractive design (since it is continually visible as it sits on a kitchen counter).
5. The coffeemaker has a clock timer to start automatically at a designated time.
6. The grinder performs well with different kinds of coffee beans.
7. The coffeemaker keeps the coffee warm after making it.
8. The coffeemaker automatically shuts off after a designated time period.

[2] We thank Shahid Ansari, Jan Bell, Tom Klammer, and Carol Lawrence for allowing us to use this example from their book *Target Costing* (Boston: Houghton Mifflin Company, 2004).

These customer requirements become the basis for the engineering design of the coffeemaker. Engineers must ensure that the product encompasses all of the features that are important to customers. Assume that Kitchenhelp's current coffeemaker unit costs $50 to manufacture. Management has decided that the cost of the new unit has to be reduced to broaden its appeal to a much larger customer audience.[3] Product engineers perform cost analysis and value engineering to reduce the cost of each of the coffeemaker's components.

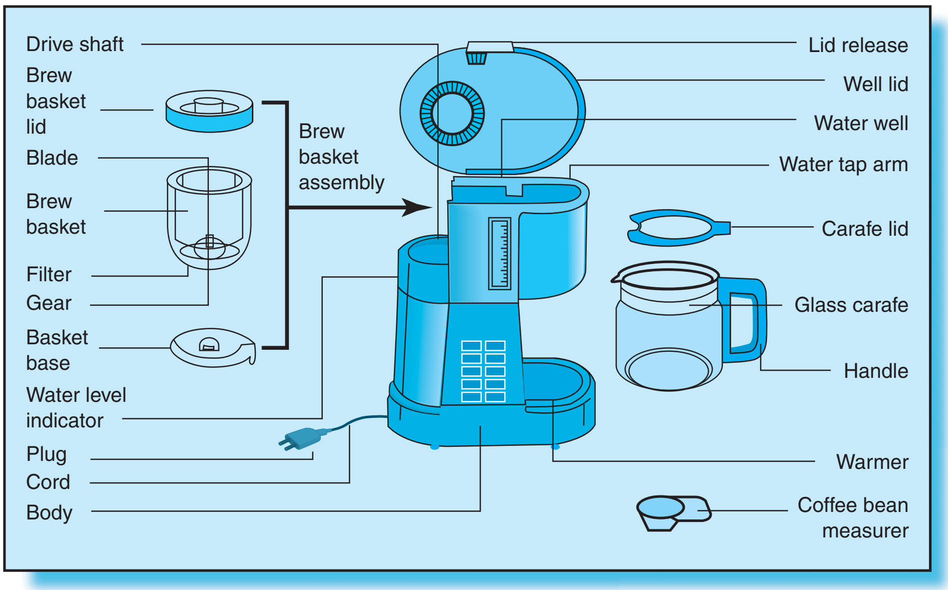
Cost Analysis

For Kitchenhelp, cost analysis involves determining what components of the coffeemaker (heating element, control panel, or grinder) to target for cost reduction and then assigning a cost target to each of these components. Cost analysis also focuses on the interaction between components and parts. Often a reduction in the cost of one component may be more than offset by a cost increase elsewhere. For example, decreasing the cost of the outer shell of the coffeemaker by making it smaller may increase the costs of shrinking the size of the control panel, electronic circuitry, and heating element. Cost analysis requires five subactivities:

1. **Develop a list of product components and functions.** Cost reduction efforts start by listing the various product components and identifying the functions that they perform and their current estimated cost. The initial product design and cost estimates provide this information. The list tells us what components and functions are needed to satisfy customer requirements and what it might cost to provide these functions. Exhibit 8-5 shows a diagram of the various components of the proposed coffeemaker.

2. **Perform a functional cost breakdown.** Each of the various parts and components of the coffeemaker performs a specific function. The next step is to identify that function and to estimate the cost. The functional cost breakdown is shown in

Exhibit 8-5
Major Components of Kitchenhelp's Proposed Coffeemaker



[3] To simplify the example, we assume that selling, general, and administrative costs stay the same, although in practice these costs can change as well.

Exhibit 8-6
Functional Cost Breakdown for Kitchenhelp's Coffeemaker

Component	Function	Cost Amount	Cost Percent
Brew basket	Grinds and filters coffee	$9	18%
Carafe	Holds and keeps coffee warm	2	4
Coffee warmer	Keeps coffee warm	3	6
Body shape and water well	Holds water and encasement	9	18
Heating element	Warms water and pushes it	4	8
Electronic display panel	Controls grinder/clock settings	23	46
Total		$50	100%

Exhibit 8-6. For example, the function of the brew basket is to grind and filter coffee. The current estimated cost is $9 for the basket, which represents 18% of the total manufacturing cost for this product. To keep the example simple, we have combined several functions and components for the coffeemaker. At a detail level, the brew basket or the electronic control panel will be broken into several subcomponents. The total for all components is $50.

3. **Determine the relative importance of customers' requirements.** Engineers often have a different view of a product's functionality than customers. Recall that Kitchenhelp had identified eight features important to its customers. The engineer's view of a product as a collection of functions must be reconciled with a customer's view of a product as a set of performance features. To connect a product's functions to the features that customers want, engineers first assess the relative importance that customers place on the various features. They conduct a formal survey of prospective customers asking them to rank the relative importance of the product's eight features. The results from this survey are shown in Exhibit 8-7. The importance ranking is based on a scale from 1 to 5, where a 5 means that the feature is very important and a score of 1 indicates that it is unimportant. From this exhibit, we learn that the taste and smell of coffee is the most important feature, and multiple grinder settings is the least important.

Exhibit 8-7
Customer Feature Ranking for Kitchenhelp's Coffeemaker

Customer Requirements	Customer Ranking: 1 Not Important				5 Very Important	Relative Ranking In Percent
Coffee tastes and smells like espresso					5	20%
Coffeemaker is easy to clean				4		16
Looks nice		2				8
Has 6+ cup capacity			3			12
Starts automatically at designated time				4		16
Works well with different coffee beans	1					4
Keeps the coffee warm			3			12
Automatically shuts off			3			12
Total						100%

The last column of Exhibit 8-7 converts the raw scores for the importance of features into a relative ranking of features. The total feature score is 25 (calculated as 5 + 4 + 2 + 3 + 4 + 1 + 3 + 3 = 25) and each feature's score gets expressed as a percentage of this total score of 25. For example, coffee taste has a ranking of 20% (a score of 5 out of 25) indicating that 20% of the total value a customer derives from this coffeemaker comes from the taste of the coffee.

4. **Relating features to functions.** Engineers can now convert the relative rankings of features into an importance ranking for each product function. Since components carry out the functions of a product and are the key design parameters, this step relates customer rankings to the components that best meet that particular requirement. The engineers use a tool called a **quality function deployment (QFD) matrix** for displaying the information about these three variables—features, functions (components), and competitive evaluation—in a matrix format.

The QFD matrix (see Exhibit 8-8 for Kitchenhelp's coffeemaker) highlights the relationships among competitive offerings, customer requirements, and design parameters. The QFD matrix summarizes the information about product functions from Exhibit 8-6 with customer rankings from Exhibit 8-7. It adds two other pieces of information that have been collected during market research: the correlation between a component or design parameter and customer requirements and information about how customers evaluate competitor offerings on these same features.

The matrix shows that the requirement that the coffee taste like espresso has a high correlation with the design of the brew basket and the heating element. Similarly, how many cups the coffeemaker can hold is correlated to the water well and carafe size. It also shows that taste, the most important feature to a customer, is currently rated at 3 for Kitchenhelp and 2 for its competitor. This tells Kitchenhelp that while it is ahead of the competition, it still is far from the customer's ideal taste experience. On appearance, the competition obviously has a better looking product, with a rating of 5. However, the customer ranking for this feature is 2, which suggests that Kitchenhelp should not spend much of its resources to improve the coffeemaker's appearance.

Exhibit 8-8
A QFD Matrix for Kitchenhelp's Coffeemaker

Components or Functions → / Customer Requirements ↓	Brew Basket	Carafe	Coffee Warmer	Body/Water Well	Heating Element	Display Panel	Comparison Competitor vs. Our Product					Customer Feature Ranking
							1	2	3	4	5	
Tastes/smells like espresso	▲				▲			■	❑			5
Easy to clean	●	●		▲				❑	■			4
Looks nice				▲		▲			❑		■	2
Has 6+ cup capacity		▲		▲				■	❑			3
Starts automatically on time						▲			❑		■	4
Works with different beans	❍					▲		■	❑			1
Keeps the coffee warm		●	▲					■		❑		3
Automatic shutoff						▲				❑	■	3

Correlation of design parameters and customer requirements:
▲ = Strong correlation
● = Moderate correlation
❍ = Weak correlation

Comparative competitor rankings:
■ = Competitor ranking
❑ = Our ranking

Exhibit 8-9

Kitchenhelp Coffeemaker: Percentage Contribution of Each Component to Customer Requirements

Components → / Customer Requirements ↓	Brew Basket	Carafe	Coffee Warmer	Body/ Water Well	Heating Element	Display Panel	Relative Feature Ranking
Tastes/smells like espresso	50% × 20 = 10					50% × 20 = 10	20%
Easy to clean	30% × 16 = 4.8	10% × 16 = 1.6		60% × 16 = 9.6			16
Looks nice				60% × 8 = 4.8		40% × 8 = 3.2	8
Has 6+ cup capacity		50% × 12 = 6		50% × 12 = 6			12
Starts automatically on time						100% × 16 = 16	16
Has multiple grinder settings	5% × 4 = 0.2					95% × 4 = 3.8	4
Keeps the coffee warm		20% × 12 = 2.4	80% × 12 = 9.6				12
Automatic shutoff						100% × 12 = 12	12
Converted component ranking	15.0	10.0	9.6	20.4	10.0	35.0	100%

5. **Develop relative functional rankings.** The QFD matrix enabled the engineers to convert feature rankings into functional or component rankings, shown as a general association in Exhibit 8-8. This is valuable but the engineers still need one additional piece of information: the percentage that each component contributes to a customer feature, as shown in Exhibit 8-9. You can see in this exhibit that the feature "Tastes/smells like espresso" depends on the design of the brew basket and heating element (an association also shown in Exhibit 8-8). Engineers feel that the brew basket and heating element component contribute equally to the "taste" feature, and they assign each a 50% contribution to taste. The relative value ranking of the "taste" feature is 20%. Therefore, since both components contribute equally, they assign each of the two components a value ranking of 10%. The last row of Exhibit 8-9 shows *each component's approximate value to a customer* by adding up all the value contributions from a component to all customer-desired features. You can see that the brew basket component has an overall value of 15% to a customer, and that the carafe has a value of 10%. Note that the last row and last column add up to 100%. They are simply different views of customer values. The last column represents the value of each feature, and the last row represents the value of each component that delivers the desired features.

Conduct Value Engineering

Once the five-step cost analysis has been completed, engineers start the value engineering (VE) activity. During VE, engineers analyze the functions of the various components and attempt to improve the components' and product's design to lower overall cost without reductions in required performance, reliability, maintainability, quality, safety, recyclability, and usability. For example, the purpose or function of a heating element is to heat water to a desired temperature. Value engineering asks how the function of raising room temperature water to 110 degrees within three minutes can be accomplished at a lower cost. It analyzes both product and manufacturing process design and reduces costs by generating ideas for simplifying both.

Exhibit 8-10
Value Index for Kitchenhelp's Coffeemaker

Component or Function	Component Cost (% of total) (Ex. 8-6)	Relative Importance (Ex. 8-9) (in %)	Value Index (Col 3 ÷ 2)	Action Implied
Brew basket	18	15.0	0.83	Reduce cost
Carafe	4	10.0	2.50	Enhance
Coffee warmer	6	9.6	1.60	Enhance
Body shape and water well	18	20.4	1.13	O.K.
Heating element	8	10.0	1.25	Enhance
Electronic display panel	46	35.0	0.76	Reduce cost
	100%	100%		

Value engineering is a key activity within target costing and consists of the following two subactivities:

1. **Identify components for cost reduction.** Choosing which components to select requires computing a **value index**. This is the ratio of the value (degree of importance) to the customer and the percentage of total cost devoted to each component. For the coffeemaker, the value information appears in the last row of Exhibit 8-9, and the relative cost information is in the last column of Exhibit 8-6. Both of these quantities are expressed as percentages. Exhibit 8-10 shows the value index calculation and its implications for cost reduction. Components with a value index of less than 1 are candidates for value engineering. Components with a high value index are candidates for enhancement since we are spending too little for a feature that is important to the customer. These components present an opportunity to enhance the product. Cost and relative importance are plotted in Exhibit 8-11.

The optimal value zone in Exhibit 8-11 indicates the value band in which no action is necessary. The optimal value zone is based on the experience and opinions of target costing team members. The zone is usually wider at the bottom of the value index chart, where low importance and low cost occur, and narrower at the top, where features are important and cost variations are larger. The area of the graph above the optimal value zone indicates components that are candidates for cost reduction. Items below the zone are candidates for enhancement.

Exhibit 8-11
Value Index Chart for Kitchenhelp's Coffeemaker

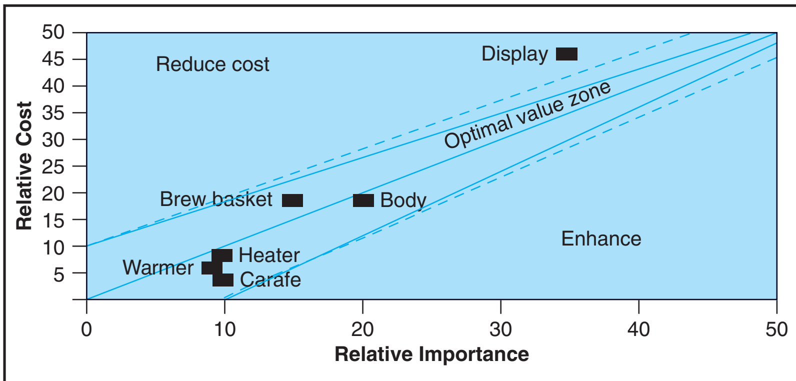


Exhibit 8-12
Kitchenhelp Coffeemaker: Electronic Display Panel Value Engineering Ideas to Reduce Cost

Panel Subcomponent	Cost Reduction Idea
Power supply	**Reduce** wattage—more than needed in current design.
Flexible circuit	**Eliminate** flexible circuit. Use wiring harness.
Printed wire board	**Standardize** board specifications. Use mass-produced unit.
Clock timer	**Combine** with printed wire board.
Central processor chip	**Substitute** standard 8088 chip instead of custom design.
Heater connector	**Rearrange** layout of board to heater connection.

2. **Generate cost reduction and function enhancement ideas.** Engineers engage in creative thinking and brainstorming to identify what can be reduced, eliminated, combined, substituted, rearranged, or enhanced to provide the same or higher level of functionality from a component at less cost. Exhibit 8-12 lists several of the cost reduction ideas that Kitchenhelp's engineers have proposed to reduce the cost of the electronic display panel, the prime target for cost reduction identified by the value index. Perhaps reducing the number of parts, simplifying the assembly, and not overengineering the product beyond what a customer needs will lower cost. Finally, testing and implementing ideas is the last subactivity within value engineering. Promising ideas are evaluated to ensure that they are technically feasible and acceptable to customers.

Concerns about Target Costing

Although target costing has some obvious advantages, some studies of target costing indicate potential problems in implementation, especially if a focus on meeting the target cost diverts attention away from the other elements of overall company goals.[4] Consider the following examples:

1. **Lack of understanding of the target costing concept.** For many in the West, target costing is not a mainstream concept. Without a clear understanding of the benefits, many senior executives reject the idea.

2. **Poor implementation of the teamwork concept.** Teamwork and trust issues can lead to significant problems in implementing target costing. In some cases, companies put excessive pressure on subcontractors and suppliers to conform to schedules and reduce costs. This can lead to alienation or failure of the subcontractor. Sometimes design engineers become upset when other parts of the organization are not cost conscious; they argue that they exert much effort to squeeze pennies out of the cost of a product while other parts of the organization (administration, marketing, and distribution) are wasting dollars. Thus, many organizations must enhance cross-functional teamwork, trust, and cooperation to succeed at target costing.

3. **Employee burnout.** Employees, especially design engineers in Japanese companies, work under continual pressure to meet target costing goals and eventually experience burnout from the pressure and become far less effective in their jobs.

4. **Overly long development time.** Although the target cost might be met, development time may increase because of repeated value engineering cycles to reduce

[4] See M. Sakurai, "Past and Future of Japanese Management Accounting," *Journal of Cost Management* (Fall 1995): 1–14; and Y. Kato, G. Boer, and C. W. Chow, "Target Costing: An Integrated Management Process," *Journal of Cost Management* (Spring 1995): 39–51.

IN PRACTICE

Target Costing and the Mercedes-Benz M-Class

In the early 1990s, Mercedes-Benz wanted to develop a new line of SUVs, the Mercedes-Benz M-Class. Production began in 1997 at the Tuscaloosa plant in Alabama. Mercedes decided to use target costing to help them define costs before they were committed. Mercedes relied on a number of customer, design, product, and marketing clinics before manufacturing the product and determined that safety, comfort, economy, and styling were the four key characteristics that customers were concerned about. Engineers determined that the key components for the automobile were the chassis, transmission, air conditioner, electrical system, and other systems.

Using an approach very similar to the one used for design and development of the Kitchenhelp coffeemaker, Mercedes determined the relationships among customer requirements and engineering components. What follows is an illustration of how the final value index for the Mercedes-Benz M-Class might look. The value index shows that both the chassis and the air conditioner could be enhanced, while the transmission, electrical system, and other systems' costs could be reduced.

Component or Function	Component Cost (% of Total)	Relative Importance (%)	Value Index	Action Implied
Chassis	20	33	1.65	Enhance
Transmission	25	20	0.80	Reduce cost
Air conditioner	5	7	1.40	Enhance
Electrical systems	7	6	0.86	Reduce cost
Other systems	43	35	0.81	Reduce cost

Source: Professor Thomas L. Albright, "Use of Target Costing in Developing the Mercedes-Benz M Class," class presentation, University of Alabama.

costs, ultimately leading to the product coming late to market. For some types of products, being six months late may be far more costly than having small cost overruns.

Companies may find it possible to manage many of these factors, but organizations interested in using the target costing process should be aware of them before immediately attempting to adopt this cost reduction method. The behavioral issues associated with motivating employees to meet ambitious targets are particularly important to consider. We will discuss these issues more fully in Chapter 9. Despite these concerns, target costing does provide engineers and managers with a great tool at the time of greatest leverage, the RD&E stage, to reduce total-life-cycle product costs.

A survey conducted by Kobe University of Japanese companies showed that of those responding, 100% of transportation equipment manufacturers, 75% of precision equipment manufacturers, 88% of electrical manufacturers, and 83% of machinery manufacturers stated that they used target costing.[5] These companies had been experiencing diminishing returns from their kaizen costing and just-in-time production systems and were looking for new opportunities to reduce manufacturing and service costs by focusing on cost reduction activities that could be accomplished during the RD&E stage.[6]

In the United States, target costing has gained momentum as a management method; however, it is not only a method of cost control but also a comprehensive

[5] See Kato et al., "Target Costing."

[6] See R. Cooper and R. Slagmulder, *Target Costing and Value Engineering* (Portland, OR: Productivity Press, 1997).

approach to profit planning and cost management. Companies such as Boeing, Texas Instruments, Eastman Kodak, and DaimlerChrysler have successfully adopted target costing in their businesses.[7]

Breakeven Time: A Comprehensive Metric for New Product Development

New product development requires work to be performed by many of an organization's departments: marketing, engineering, finance, operations, sales, and service. In many companies, the work in these various departments is not coordinated well; each department does its own job by receiving inputs from one or more departments, performing its work, and, when finished, handing its work output to another department. Such fragmented, compartmentalized activities lead to poor hand-offs between departments, delays, high costs, and frequent errors.

Product development delays are particularly problematic since delaying the launch of a product into the market by six months can cost a company up to 35% of the product's lifetime profits, a far more consequential loss than exceeding the project's R&D budget by 10%. Target costing, as we described, does an excellent job of reducing total-life-cycle costs. But like all cost-based measures, it does not reflect all of the economic factors associated with creating value for customers and shareholders. Companies that are attempting to manage an intangible asset such as their new product pipeline are particularly in need of nonfinancial measures, the motivation for the Balanced Scorecard that we discussed in Chapter 2.

Several decades ago, Hewlett-Packard engineers developed a comprehensive metric for the product development process, called the **breakeven time (BET)**, to motivate and measure the benefits from cross-functional integration during the product development cycle.[8] BET measures the length of time from the project's beginning until the product has been introduced and generated enough profit to pay back the investment originally made in its development (see Exhibit 8-13). BET brings together in a single measure three critical elements in an effective and efficient product development process. First, for the company to break even on its RD&E process, its investment in the product development process must be recovered. So BET requires tracking the entire cost of the design and development process.[9] It provides incentives to make the product development process faster and less costly. Second, BET stresses profitability. It encourages marketing managers, manufacturing personnel, and design engineers to work together to develop a product that meets real customer needs, including offering the product through an effective sales channel at an attractive price, and at a manufacturing cost that enables the company to earn profits that can repay the product development investment cost. Third, BET is denominated in time: it encourages the launch of new products faster than the competition so that higher sales can be earned sooner to repay the product development investment.

Beyond the technical aspects of the BET measure, which we will illustrate shortly, success in improving the comprehensive measure encourages collaboration and

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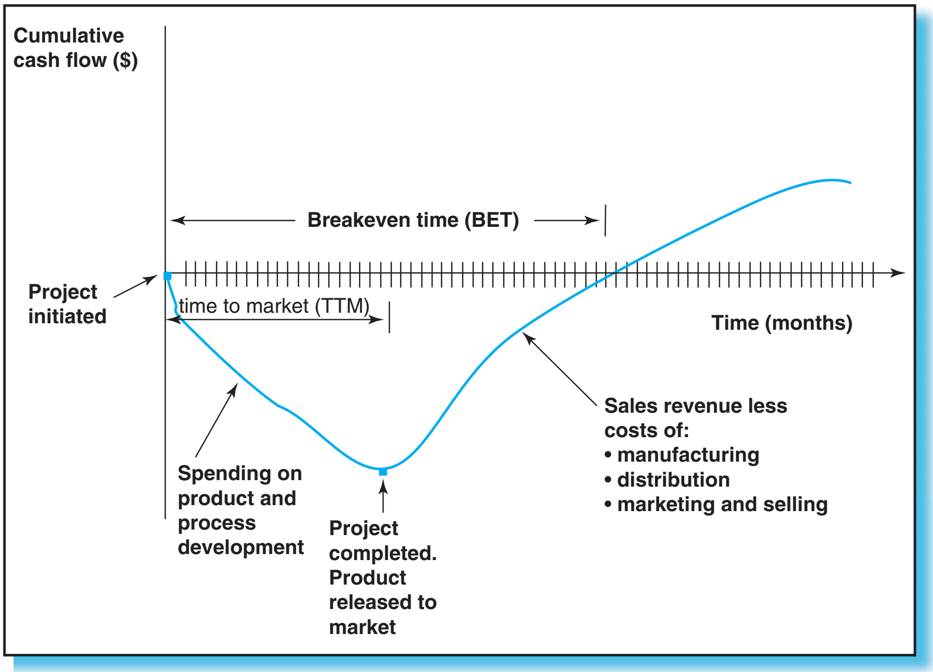
[7] See J. Dutton and M. Ferguson, "Target Costing at Texas Instruments," *Journal of Cost Management* (Fall 1996): 33–38.

[8] Charles H. House and Raymond L. Price, "The Return Map: Tracking Product Teams," *Harvard Business Review* (January–February 1991): 92–100; also Marvin L. Patterson, "Designing Metrics," Chapter 3 in *Accelerating Innovation: Improving the Process of Product Development* (New York: Van Nostrand Reinhold, 1993).

[9] For financial reporting purposes, research and development expenses are expensed each reporting period (fiscal year quarter) so many companies never accumulate in one account the total spending on a project over the multiple periods required for the RD&E stage.

Exhibit 8-13
Illustration of Breakeven Time



integration across organizational functions. It allows people from different disciplines to come together at the start of every product development project to estimate the time and money they require to perform their tasks, and the impact of their efforts on the success of the entire project. The metric facilitates discussion and decision making during the project among people from the multiple functions as more information about the project, customers, and competitors becomes available.

The breakeven time graph (see Exhibit 8-13) plots cumulative profits on the *y* or vertical axis, and elapsed time on the *x* or horizontal axis. Initially, the company spends on market research and on developing the technical specifications for the new product, such as its features, target cost and price, feasibility of the proposed manufacturing technology and processes, and preliminary project plan. These initial costs, at the start of the project, cause the project's profit curve to head in the negative direction since the project is unprofitable at this point. If the project is approved for further development, additional costs get incurred for product development, value engineering, building prototypes, testing, and doing the engineering changes to develop a feasible product along with its associated manufacturing processes. The RD&E stage ends when the company makes a commitment to produce, sell, and deliver the product.

As production gears up during the manufacturing stage, sales get realized and, as assumed in Exhibit 8-13, if the sales revenues exceed the production, marketing, sales, and distribution costs of the product, the cumulative profitability curve finally heads upward. Eventually, the company hopes that the profits earned over the initial years of the product's launch will repay its front-end marketing research and all RD&E costs. BET measures how long it takes for these initial costs to be recovered. Of course, the goal is not just to break even but to earn a substantial profit from the new product launch. To keep the analysis simple, the HP engineers found that a focus on the time required just to break even on the project stimulated a productive and collaborative dialogue among employees in the marketing, engineering, manufacturing, finance, sales, logistics, and service departments.[10]

We illustrate these points with a simple numerical example. Consider the data shown in panel A of Exhibit 8-14 for Greyson Technology's launch of a new digital communications device. The project's cross-functional project team prepared the data shown in panel A after extensive discussion of the new product's specification's, estimated RD&E time, and the likely selling price, manufacturing cost, rate of sales, and incremental marketing, distribution, sales, and service costs. The team anticipated that market research and subsequent product development would take seven quarters

Exhibit 8-14

Greyson Technology New Product Introduction

Panel A

	Y1, Q1	Y1, Q2	Y1, Q3	Y1, Q4	Y2, Q1	Y2, Q2	Y2, Q3	Y2, Q4	Y3, Q1	Y3, Q2	Y3, Q3	Y3, Q4
Market research*	(100)	(50)										
Product development*		(80)	(200)	(200)	(200)	(200)	(60)					
Selling price							20	20	20	19	19	18
Cost per unit							12	11	10	10	10	10
Margin/unit							8	9	10	9	9	8
Sales quantity*							25	40	50	50	50	50
Contribution*							200	360	500	450	450	400
MSDA expenses*							80	100	120	120	120	120
Product profit*							120	260	380	330	330	280
Quarterly profit/loss*	(100)	(130)	(200)	(200)	(200)	(200)	60	260	380	330	330	280
Cumulative profit/loss*	(100)	(230)	(430)	(630)	(830)	(1,030)	(970)	(710)	(330)	–	330	610

Panel B

	Y1, Q1	Y1, Q2	Y1, Q3	Y1, Q4	Y2, Q1	Y2, Q2	Y2, Q3	Y2, Q4	Y3, Q1	Y3, Q2	Y3, Q3	Y3, Q4
Market research*	(100)	(50)										
Product development*		(100)	(250)	(250)	(250)	(250)						
Selling price						22	22	22	22	20	20	20
Cost per unit						12	11	10	10	10	10	10
Margin/unit						10	11	12	12	10	10	10
Sales quantity*						30	40	50	50	50	50	50
Contribution*						300	440	600	600	500	500	500
MSDA expenses*						80	100	120	120	120	120	120
Product profit*						220	340	480	480	380	380	380
Quarterly profit/loss*	(100)	(150)	(250)	(250)	(250)	(30)	340	480	480	380	380	380
Cumulative profit/loss*	(100)	(250)	(500)	(750)	(1,000)	(1,030)	(690)	(210)	270	650	1,030	1,410

*In thousands

[10] As introduced at HP and illustrated here, the BET metric does not account for the time-value of money. This is a significant omission for most development projects where the BET is measured in several years. It is a simple extension to use net present value techniques (not discussed in this textbook) to calculate a discounted breakeven time metric, which will always be longer than the undiscounted version described in this chapter.

(20 months) to launch the new product, and a total of $1,090,000 of spending over this time period. Once launched, the team expected that the product would have a selling price of $20 per unit, cost per unit of $12, and first quarter sales of 25,000 units. It also estimated the MSDA expenses associated with this new product ($80,000 in the initial quarter, increasing up to $120,000 in future quarters). The team anticipated some modest production cost reductions due to learning effects and application of kaizen costing during the first few months of production. It also forecasted that as the market for the device matured and lower cost competitors entered, the selling price and margins would begin to erode.

Combining all of these data—product development time and cost, selling prices, production costs, sales quantities over time, and MSDA expenses—the example shows a BET of 30 months; the product recovers its $1,090,000 development costs at the end of the second quarter in year 3. Although the actual calculation of BET is simple, its calculation requires the active participation of key employees from multiple departments to provide information on new product features and functionality, development time and cost, expected selling price and volumes, and expected manufacturing and MSDA costs over the product's useful lifetime.

The BET metric allows the product development team to conduct sensitivity analyses on key parameters in the product's development process. Many companies, when financial difficulties arise, respond by slowing down the spending on new product development. But this action will delay the time when the product comes to the market; at this later date, the product will likely be be a follower, not a product leader; as such, it will command a lower selling price and generate lower sales volumes. Quarterly financial reporting shows the benefits from reduced spending on RD&E but not the loss in future revenues and profits from bringing the product to market a year or two later. By having a metric such as BET readily available, perhaps Greyson's managers will see that reducing the spending on RD&E now causes a much larger loss in future cash flows.

Consider the alternative scenario shown in panel B of Exhibit 8-14 in which the development team contemplates accelerating product development by spending more during the RD&E stage. For example, they plan to raise spending by $50,000 per quarter to $250,000 between year 1, quarter 3, and year 2, quarter 2. Because of the higher and more intensive spending, Greyson launches the product three months earlier. This brings the product to market faster, opening up a longer lead time before competitors can offer rival products with similar functionality. As a consequence, the initial selling price is 10% higher and opening period sales are also somewhat higher. Even with the higher total spending on RD&E in the panel B scenario, Greyson breaks even on the project in the middle of year 3, quarter 1, five months earlier than in the original scenario. Of course, the sustainable profits, beyond the breakeven time, are also substantially higher in the panel B scenario because of the advantages from being the first-to-market with the new technology.

Among the other scenarios to consider might be a product with less innovative functionality, which would require a shorter and less expensive development time, but also lower market share, and lower selling price and a longer BET. Conversely, the development team can also debate, at the start of the project, the consequences from a longer and more expensive product development process caused by attempting to meet highly demanding specifications from the marketing study.

The BET metric is not a decision-making tool. It does, however, offer a means by which a multifunctional product development team can conduct productive discussions and make trade-offs between the time, cost, and functionality of new product proposals along with the product's anticipated sales volume and prices, and production and other organizational costs.

Innovation Measures on the Balanced Scorecard

The BET metric is a good example of the use of a nonfinancial measure to supplement financial measures, such as target cost, for managing a company's total-life-cycle costs. Before turning to additional **nonfinancial measures of innovation**, we first mention other financial measures that companies use to motivate and evaluate the success of their innovation and product development processes. Companies, such as 3M, that have a strategy to continually introduce new products measure their success by the percentage of sales from products launched within, say, the past 24 months. Another financial metric of new product success would be the gross margin of newly introduced products. Companies that rely only on an innovation metric such as percentage of revenues from new products might find that their engineers begin to introduce new products that are merely line extensions of existing products. For example, the laser-jet printer when first introduced was a major new product platform. But versions 2.0, 3.0, and 4.0 of this product, while representing incremental new design features, were basically built off of the original product platform innovation. The new versions replace, some would say cannibalize, existing versions so sales from the new products will increase. But over time, the company's products will become stale, copied by competitive offerings, and prices and margins will decline.

A truly innovative new product, such as Amazon.com's Kindle e-book reader and Apple's iPad, generates far higher margins than existing products. So an attractive financial metric for evaluating the success of new product introductions would be *gross margins from new products*. Version 1.0 of a revolutionary product will enjoy high margins, whereas the release, 10 years later, of version 9.0 of this product will earn the same or lower margins than the version it replaced.

Financial measures alone, however, cannot drive a company's success in new product development. Companies, especially those following a strategy of innovation and product leadership, need nonfinancial measures to motivate and evaluate their innovation activities. Let's look at several objectives and measures that can appear in the process perspective of a company's Balanced Scorecard to evaluate the effectiveness and efficiency of its innovation process.

Market Research and Generation of New Product Ideas

Some typical objectives and measures for the market research and idea generation stage include the following:

Objectives for Generating New Ideas	Measures
Anticipate future customer needs.	• Time spent with targeted customers learning about their future opportunities and needs • Number of new projects launched based on customer input
Discover and develop new, more effective, or safer products/services.	• Number of new projects or concepts presented for development • Number of new value-added services identified

Design, Development, and Launch of New Products

Once ideas for new products and services have been accepted, we can think of various objectives and measures to guide the RD&E stage:

Objectives for Managing the RD&E Process	Measures
Develop innovative new products offering superior performance.	• Potential value of products in project pipeline • Customer feedback and revenue projections based on prototypes of products in pipeline • Number of patents; number of patent citations[11]
Reduce product development cycle time.	• Number of projects delivered on time • Average time spent by projects at the development, test, and launch stages of the development process • Total RD&E time: from idea to market
Manage development cycle cost.	• Actual vs. budgeted spending on projects at each development stage
Launch the new product into production	• Manufacturing cost of new products: actual vs. target cost • Number of failures or returns of new products from customers • Warranty and field service costs • Consumer satisfaction or complaints about new products launched

The new product development process is one of the most important that organizations perform if they are to avoid extreme price competition on nondifferentiated products and services. Yet many companies' management accounting systems focus only on operations and production costs and do not apply the same rigor and discipline to their innovation processes. As a consequence, their innovation processes take longer, incur higher costs, and deliver products that are more expensive to produce than they need to be. In this chapter, we have introduced new management accounting tools, such as target costing and nonfinancial metrics, to improve both the effectiveness and the efficiency of innovation processes.

IN PRACTICE

Life-Cycle Revenues: The Case of Motion Pictures

In this chapter, we have discussed life-cycle costing. The other side of this issue is life-cycle revenues. The motion picture industry provides a good example where we can examine life-cycle revenues.

In 2008, consumers worldwide spent more than $50 billion watching U.S. movies in a variety of formats. Until the early 1970s, consumers in the United States had only a few ways in which they could enjoy a movie: They could see it during its theatrical release, attend a film festival or revival, or view it long after theatrical release on one of the three major television networks (ABC, NBC, or CBS). During this era, the main sources of revenues for the studios came from theatrical release, international sales, and network television.

Today the viewing options for consumers and, hence, the revenue streams for the studios have increased significantly as content delivery systems continue to evolve. Because studios rely on a variety of revenue streams, new technologies allow the industry to remain viable in turbulent times. Nevertheless, the theatrical release of a movie is still the single most important indicator of success and offers a critical means by which to evaluate industry trends.

(*continued*)

[11] Number of patents and patent citations has been identified in B. Lev, *Intangibles: Management, Measurement, and Reporting* (Washington, DC: Brookings Institution Press, 2001): 57–61, as a key indicator of research output.

To maximize their television license revenue, studios divide the licensing of their movies into discrete time periods, known as "windows of exhibition," as listed in the following table:

Windows of Exhibition for Movies

Sources	Window
Domestic box office (theaters)	Initial theatrical release 3 weeks to 8 months
Home video (VHS/DVD)	Exclusive window of only 6 weeks before release to pay-per-view
Pay-per-view	Exclusive window from 2 to 6 weeks before release to premium channels
Premium pay channels (pay TV)	Exclusive window for up to 18 months before release to network and cable TV
Network (free) and cable TV	Up to 12 to 18 months before release to syndication
Syndication	60 months on either network television or cable network

Note: Omitted from the distribution channels and windows are foreign sales, hotel and airline viewings, college campus showings, the video game sector, consumer products merchandising, and theme parks. Foreign sales usually begin after the initial theatrical release in the United States. Each territory has different windows for different channels. Video games based on blockbuster movies sometimes earn equivalent revenues as theatrical releases.

Domestic Box Office. In 2008, overall box office performance reached an all-time high of $9.8 billion and, although this number may be seen as good news, the percentage of the population that actually goes to a movie theater to watch a movie has been in decline. Second, box office revenues have reached this record level due primarily to the large increases in ticket prices. Third, in 2008, movie piracy, especially illegal downloads from the Internet, has reduced studios' revenues by more than $6.1 billion.

Faced with a decline in patrons at the box office, increased competition from other entertainment options, and piracy of its content, the major studios are constantly assessing new revenue streams. Currently, the major sources of revenue (outside of theater releases) come from home video; network, satellite, and cable television; international distribution; the Internet; and mobile devices.

Home Video. The development of home video tapes in VHS format in the mid-1970s as a highly profitable post-theatrical release option fundamentally altered the economic structure of the film industry and its market practices. In 1997, the first digital versatile disc (DVD) players were sold in the United States. DVDs quickly became the industry standard and today VHS tapes are no longer produced for new films. In 2008, DVD sales accounted for $16.2 billion, and DVD rentals generated revenues of $7.5 billion; however, DVD sales are on the decline. Based on a 9% drop in 2008, projections are that DVD sales will decline 8% in 2009. The decline is attributed to the high price of DVDs, the downturn in the economy, and the popularity of DVD rental sites.

Industry analysts suggest that DVDs will be replaced by Blu-ray discs (although market penetration of Blu-ray has been much slower than anticipated) once the price of Blu-ray players and Blue-ray discs drops significantly. Some suggest that all physical discs will be phased out and that consumers will then obtain their films by direct streaming from Internet sources like Netflix and iTunes or via satellite.

As the table above shows, after the initial theatrical run (which lasts from 2 weeks to 6 months), the next window is for home video, which lasts up to 6 weeks with guaranteed exclusivity. According to Larry Gerbrandt, senior analyst at Paul Kagan & Associates, a little known secret in the home video rental market is that the video rental companies make their largest profits from late fees.

Pay-per-View (PPV). The next window is pay-per-view (PPV), which allows subscribers to cable and satellite television to order movies directly through a joint venture that licenses the films from all of the major studios. Initially this window was timed to open about seven months after the theatrical release to avoid delaying or competing with the video release. But when studios began releasing DVDs in the late 1990s and their popularity soared, the window had to be moved up when cable and satellite suppliers complained that they received their movies too late to compete with DVDs. Despite claims that PPV would provide another strong cash stream, the six studios' revenues from it have remained relatively modest.

Premium Pay Channels. The next window, which opens one year after the movie is released in theaters, is premium pay channels. The three major pay TV channels are HBO, Showtime, and Starz. This window remains open for up to 18 months. The licensing fee to show a major studio movie over a one-year period is based on domestic box office performance and can be as high as $20 to $25 million for a blockbuster, although the average is more like $7 million per film.

Network or Cable TV. The fifth window is network or free television. This interval lasts between 12 and 18 months. The networks and cable stations compete to determine who will obtain the rights to broadcast each film. Typically, fees range from $3 to $15 million for a movie depending on the box office success of the title and number of runs.

When television was born in the 1940s, the Hollywood studios initially viewed it more as a threat than an opportunity. In time, however, the studios discovered that it was quite profitable to license movies to television. The six major studios earned revenues of about $17.7 billion in 2005 by licensing their movies and TV series to television networks and stations

Syndicated TV. The final window is syndicated television stations. Syndicated television means that local stations can bid for the right to show the movie and can air it for up to five years. In the largest TV markets, studios may charge up to $5 million for syndicated television rights to a strong film.

International Distribution. The international box office has accounted for slightly under half of the major studios' total income from theatrical markets since the 1960s. Internationally, the market for U.S. films continues to grow. It has been estimated that in 2008, foreign consumers spent nearly $18 billion watching U.S. movies (the worldwide box office is $28 billion, including nearly $10 billion of domestic box office revenue). The largest foreign consumers of films are those in the United Kingdom, Japan, Germany, France, Spain, and Australia/New Zealand. Of course, not all of the $18 billion in revenues went to U.S. studios—the exhibitors kept approximately 50% of box office receipts.

Television licensing is equally profitable overseas. Studios typically sell their movies to foreign television networks in blocks of 6 to 10 films. The license fee for the package is then allocated across the movies at the studio's discretion. In 2003, overseas TV licensing was valued at approximately $1.76 billion, half from conventional broadcast stations and networks and the other half from pay TV.

The overseas non-theatrical market grew in the late 1980s as a result of the growth of cable and video. The home video market became a larger source of overseas revenue for Hollywood studios than the overseas theatrical market in the 1990s. It has been predicted that the overseas revenue from U.S. movies is expected to increase to $41.6 billion by 2011.

Internet and Mobile Technology. As has been the case historically, new technology will pave the way for perhaps the most significant revenue streams yet to come. The rate at which the new technology (e.g., smart phones) penetrates the market is the limiting factor for new product (e.g., downloadable movies) proliferation. Hollywood has taken note of how file sharing almost destroyed the music industry and it is now preparing to deal with a similar threat. Like their experience with television and home video, the film industry is trying to determine a new revenue-generating model to exploit the Internet as a new revenue source.

The greatest concern is protecting copyright. Studios fear that once a film is released online in digital format, that they will lose all control over its subsequent use and distribution. In one effort to maintain control over online content, the studios are working with the computer industry to build copy-protection technology into its hard drives. For instance, Microsoft has developed a digital rights management system that tries to stop DVD-restricted content from playing while unsigned software is running in order to prevent the unsigned software from accessing the content. DVD rental companies and studios have come up with a new business model although it will take some time for digital downloading and video-on-demand (VOD) to become significant revenue streams. Netflix and Blockbuster, through an alliance with TiVo, the digital video recording service, are creating a digital entertainment service that reportedly will allow customers to order a movie online, which will then be loaded onto their TiVo sets, providing DVD-quality movies on demand. Walt Disney recently joined News

(*continued*)

Group and Universal Studios to finance and supply content to Hulu.com. Walt Disney will not only supply archived TV programs but also titles from Disney's movie library. Hulu operates on a revenue-sharing basis with its content partners.

Already, consumers can download films directly to their iPods, iPhones, and other mobile devices. It was estimated that the number of those so-called smart phones would reach 2.6 billion worldwide by 2011. It is no stretch to see, then, that movie downloads potentially offer a significant revenue source for the movie studios, assuming they can put in place the right business models. Predictions are hard to make, but it has been estimated that revenues from Internet movie downloads in the United States and Western Europe may potentially reach $1.3 billion in the next couple of years.

Getty Images Inc.—Stone Allstock

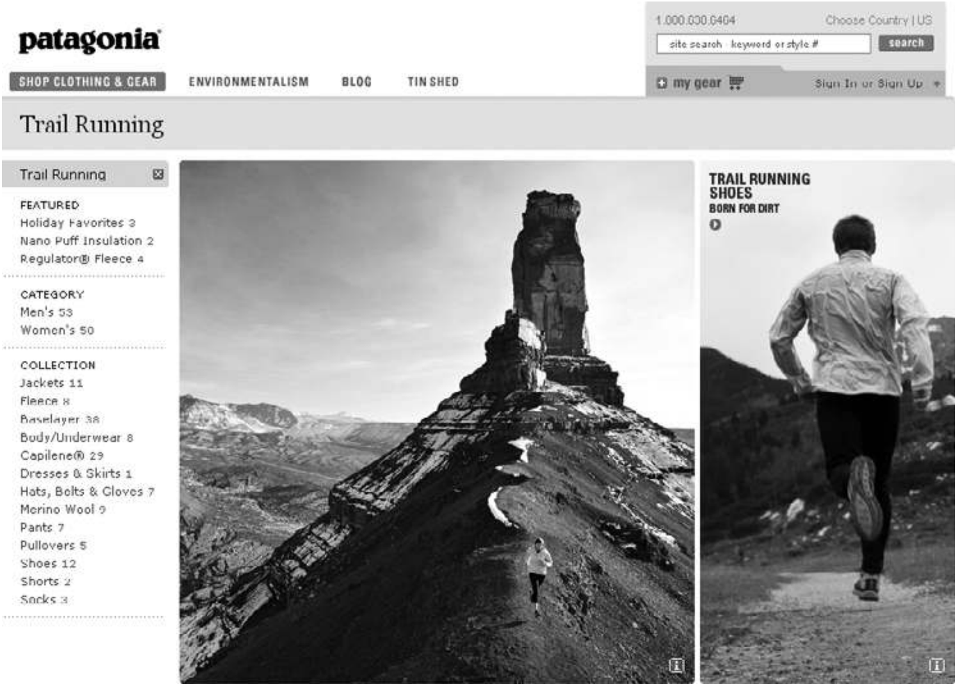
Source: Adapted from S. Mark Young, James J. Gong, and Wim A. Van der Stede, "The Business of Making Money with Movies," *Strategic Finance* (February 2010): 35–40.

Environmental Costing

We have now, for total-life-cycle costing (TLCC), developed management accounting tools to help manage the front-end product development cycle, and the long middle production and operations stage. But all good things eventually have to end and companies must also deal with cost issues at the end of a product's life. In today's business environment, environmental remediation, compliance, and management have become critical aspects of enlightened business practice. **Environmental costing** involves selecting suppliers whose philosophy and practice in dealing with the environment match those of buyers, disposing of waste products during the production process, and incorporating postsale service and disposal issues into management accounting systems.

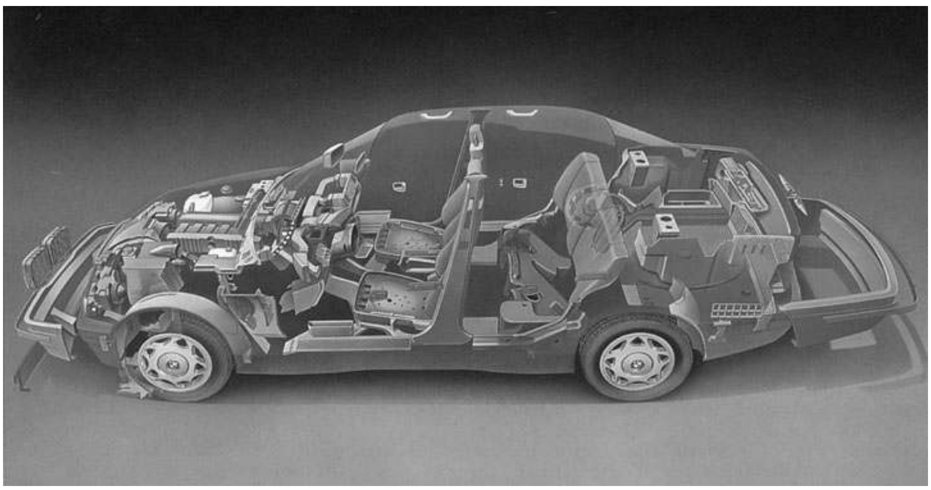
Controlling Environmental Costs

Activity-based costing, as introduced in Chapter 5, can be easily applied to the measurement, management, and reduction of environmental costs. First, identify the processes that cause environmental costs to be incurred. Second, assign the organizational costs associated with these processes. Third, assign those costs to the individual products, distribution channels, and customers that cause the environmental issues or



On Patagonia's website, you can track the impact of specific products on the environment, an issue of concern to many of its customers.

that benefit from processes associated with the prevention or **remediation** of environmental impact. You can't manage when you don't measure so by measuring and making managers and employees aware of the environmental costs associated with their design, production, distribution, and consumption activities, they have more ability to control and reduce them.



BMW uses parts made of recycled plastics and parts that can be recycled. So-called green manufacturing and potential legislation for companies to take back used components illustrate decision making based on the total-life-cycle costing concept.

Companies can reuse, refurbish, or dispose of a product's components safely and reduce total-life-cycle product costs.

BMW of North America, LLC

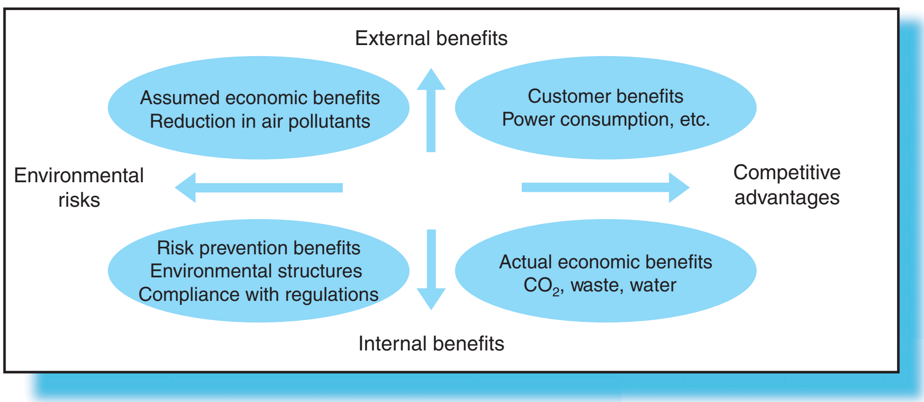
When applying ABC for environmental costing, first remove all environmentally related costs from general overhead cost pools. Then trace these costs, using the ABC methodology, directly to products and services. For example, costs such as pollution control equipment and the use of raw materials and energy can be directly traced to products. Also, some hidden and less tangible costs and benefits, such as the capital costs for emissions monitoring equipment, expenses for monitoring and testing, and product liability costs, can also be traced to the products that benefit from such spending. Removing environmental costs from overhead costs and accurately allocating them to specific products results in far fewer distortions in product costing and more attention directed to reducing the environmentally related costs of individual products.

Activity-based costing also applies at the end of a product's life cycle. This is particularly important in Europe where environmental legislation is increasingly forcing companies to be responsible for the "take-back" and disposal of products at their end of life, and to remediate land used for production facilities. Companies wishing to minimize product take-back, recycling, and site cleanup costs need to recognize and consider environmental costs during product and process design stages where they have the greatest influence. A comprehensive ABC model will help identify all of the activities and the total resource costs related to preventing and remediating expected environmental damage. Current environmental costs must be correctly attributed to both existing products and past products. A failure to recognize in today's production costs the costs of future disposal, recycling, and remediation will underestimate the total costs of producing today's products.

Environmental costs fall into two categories: explicit and implicit. *Explicit costs* include the direct costs of modifying technology and processes, costs of cleanup and disposal, costs of permits to operate a facility, fines levied by government agencies, and litigation fees. *Implicit costs* are often more closely tied to the infrastructure required to monitor environmental issues. These costs are usually administration and legal counsel, employee education and awareness, and the loss of goodwill if environmental disasters occur.

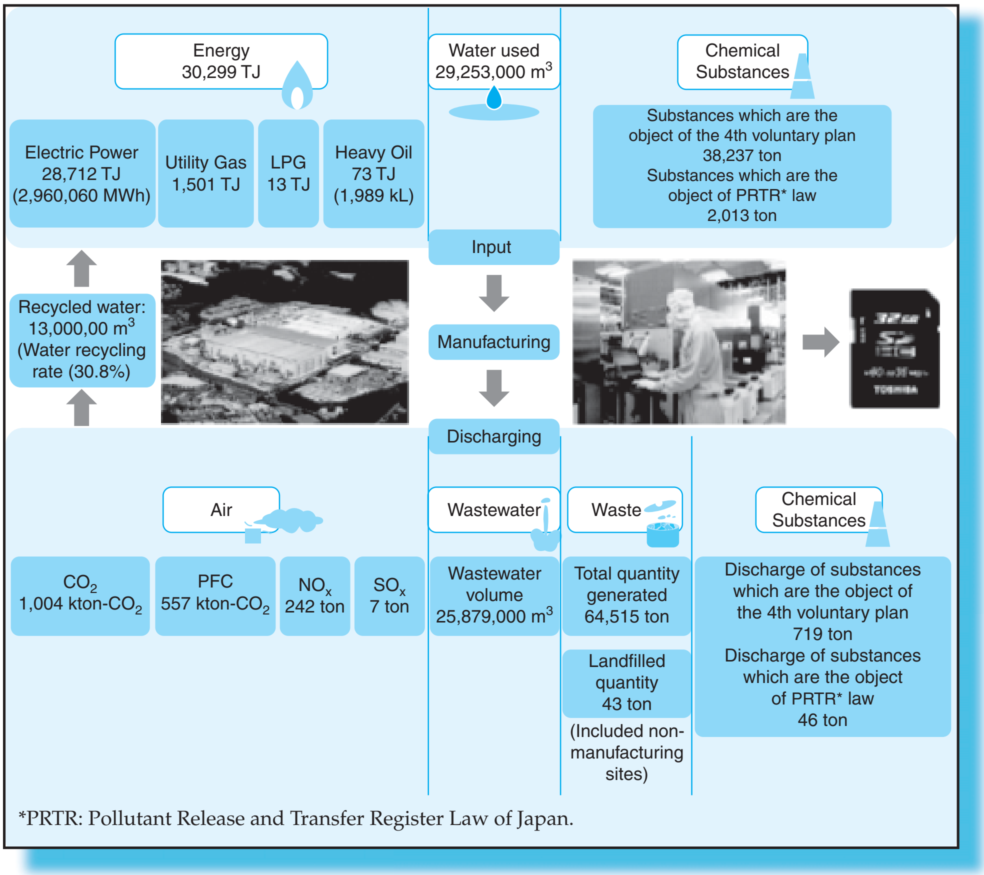
Toshiba introduced environmental accounting to provide information about the company's environmental management initiatives. Exhibit 8-15 illustrates Toshiba's model for weighing both environmental costs and benefits using a framework that assesses internal and external benefits, environmental risks, and competitive advantages. Toshiba reduced its total environmental costs by 10.5% in FY2009 compared with FY2008.[12] Exhibit 8-16 shows the estimated environmental impact from

Exhibit 8-15
Environmental Accounting as an Environmental Management Tool



[12] This information was adapted from Toshiba's website, http://www.toshiba.co.jp/env/en/management/account.htm

Exhibit 8-16
Toshiba Semiconductor's Environmental Summary

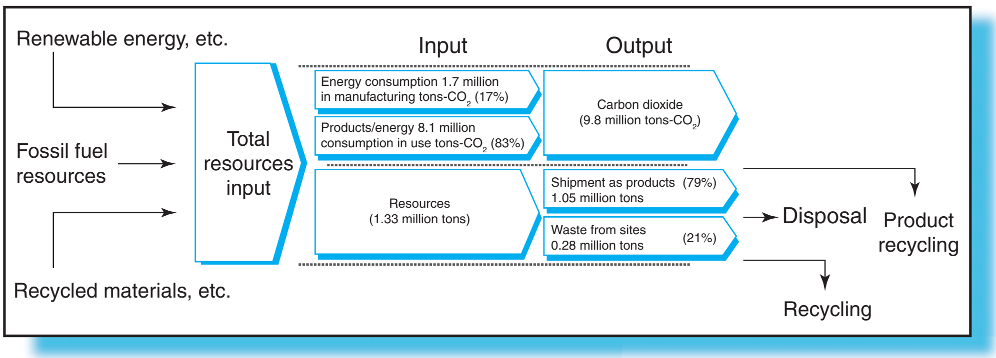


*PRTR: Pollutant Release and Transfer Register Law of Japan.

Toshiba's semiconductor division. Exhibit 8-17 shows a similar summary of energy and resource consumption produced by the Sony Group.

Xerox in its 2009 report "Nurturing a Greener World through Sustainable Innovations and Development," provides extensive documentation and measurement on

Exhibit 8-17
Sony Group's Total Environmental Impact



IN PRACTICE

The Cisco Take-Back and Recycle Program

Cisco has introduced a take-back and recycling program to decrease the costs associated with tracking, storing, and managing excess or obsolete Cisco networking and IT assets. This program enables customers and partners to ship Cisco products back to Cisco, where they will be recycled in an environmentally safe manner using processes that comply with all current and future regulations.

A manager at Dimension Data, a leading IT services provider and value reseller of Cisco products, commented "Many companies, when they issue tenders are asking for environmental policies regarding recycling old products. By working diligently with Cisco, to re-use or recycle end-of-useful-life products, we can . . . comply with the [takeback] directive. We have an environmental and social responsibility to maximize the use of such programs."

Cisco, in turn, works with a recycler to ensure that the highest standards are met and conducts audits of its facilities as well as downstream smelters and processors. In this way, Cisco ensures that only 0.5% of what is sent to the recycler ends up in landfill sites, a percentage that is a below any legislative target.

Source: Cisco website, retrieved August 21, 2010, from http://www.cisco.com/web/about/ac227/ac228/ac231/docs/DimensionDataCS.pdf

its efforts to reduce total-life-cycle consumption of energy, solid waste disposal, and harmful emissions. Much of the success arises from decisions made in the RD&E stage. For example:

> Xerox engineers used light emitting diode (LED) technology in newly designed printheads that last the life of the machine to reduce sleep mode power consumption to less than two watts. The results? The Xerox Work Centre 7435 uses 30% less total energy compared with a previous comparable model.

These are good examples of the emerging importance of how management accounting systems help make companies and their stakeholders more aware of a company's total environmental impact and the actions that engineers and managers can take, early in a product's life cycle to reduce a company's environmental footprint.

IN PRACTICE

Scientific Progress and the Reduction of Environmental Costs: The Case of Chromium in Groundwater

The toxic effects of chemical chromium-6 (hexavalent chromium) found in groundwater at hazardous waste sites were brought to the public attention by Julia Roberts in her portrayal of environmental crusader Erin Brockovich. Chromium is an odorless, hard gray metal that is able to take a very high polish. The metal is extremely resistant to corrosion and is used in steel production and as a protective in automotive accessories, such as car bumpers. Chromium is not found in nature but is the result of interactions with other compounds. Chromium becomes hexavalent chromium when it interacts with water.

Geologists at the University of Illinois at Urbana–Champaign have now developed a new method for determining the rate at which the suspected carcinogen naturally breaks down into a less toxic form. The results will help engineers assess when a major cleanup is necessary and hence provide decision makers with more accurate information by which to assess chromium's total-life-cycle costs.

Source: Adapted from Julie Foster, "Knowing When to Get the Chrome Out," *BusinessWeek* (March 25, 2002): 43.

Summary

We present the total-life-cycle costing concept as a method that accumulates product costs over a product's entire life cycle, from design and development, through production, and culminating with salvage and disposal. We have introduced new management accounting tools that help managers measure and manage a product's total-life-cycle cost, including target costing, RD&E performance metrics, such as breakeven time, and environmental costing. Target costing and environmental costing must begin in the RD&E stage so that engineers and managers can control and reduce costs throughout the life cycle while still delivering desired customer performance and features.

Key Terms

breakeven time (BET), 316
cross-functional product teams, 308
environmental costing, 324
manufacturing stage, 303
nonfinancial measures of innovation, 320
postsale service and disposal stage, 304
quality function deployment (QFD) matrix, 311
remediation, 325
research, development, and engineering (RD&E) stage, 303
supply chain management, 308
target cost, 307
target costing, 305
total-life-cycle costing (TLCC), 302
value engineering process, 307
value index, 313

Assignment Materials

Questions

8-1 What is the total-life-cycle costing approach? Why is it important? **(LO 1)**

8-2 What are the three major stages of the total-life-cycle costing approach in a manufacturing situation? **(LO 1)**

8-3 What is the difference between committed costs and incurred costs? **(LO 1)**

8-4 What are the three substages of the RD&E stage of total-life-cycle costing? **(LO 1)**

8-5 What three substages typically occur in the postsale service and disposal stage of total-life-cycle costing? **(LO 1)**

8-6 What is target costing? **(LO 2)**

8-7 What are the two essential financial elements needed to arrive at a target cost? **(LO 2, 3)**

8-8 What is a quality function deployment matrix, and how does it relate to value index computations for target costing? **(LO 2, 3)**

8-9 What is value engineering? **(LO 2, 3)**

8-10 In which stage of the total life cycle of a product is target costing most applicable? **(LO 2)**

8-11 What roles do cross-functional teams and supply chain management play in target costing? **(LO 2)**

8-12 What does the breakeven time (BET) metric for the product development process measure? **(LO 4)**

8-13 What three critical elements does the BET metric bring together? **(LO 4)**

8-14 What desirable behavioral consequences are likely as people focus on improving the BET metric? **(LO 4)**

8-15 Explain why using *percentage of revenues from new products* as a performance metric may fail to stimulate the creation of highly innovative products. **(LO 5)**

8-16 What are some nonfinancial measures that a company might use in order to motivate achieving the objective of anticipating future customer needs? **(LO 5)**

8-17 What are some nonfinancial measures that a company might use in order to motivate achieving the objective of reducing product development cycle time across an array of products? **(LO 5)**

8-18 What activities are included in environmental costing? **(LO 6)**

8-19 What are some examples of explicit and implicit environmental costs? **(LO 6)**

Exercises

LO 1 **8-20** ***Total-life-cycle costing*** Explain how the total-life-cycle costing approach differs from traditional product costing.

LO 1 **8-21** ***Benefits of total-life-cycle costing*** Explain the benefits of using a total-life-cycle costing approach to product costing.

LO 1 **8-22** ***Problems with traditional accounting focus*** What is the traditional accounting focus in managing costs over the total life cycle of a product? What is the problem with this focus?

LO 1 **8-23** ***Costs committed versus costs incurred*** Review Exhibit 8-2, showing the relationship between committed costs and incurred costs over the total life cycle of a product. Explain what the diagram means and what the implications are for managing costs.

LO 1 **8-24** ***Postsale service and disposal stage*** When does the disposal phase of the postsale service and disposal stage of a product begin and end?

LO 2 **8-25** ***Target costing*** Explain how target costing differs from traditional cost reduction methods.

LO 2 **8-26** ***Value engineering*** What is the relationship between value engineering and target costing?

LO 2 **8-27** ***Target costing profitability measure*** What is the profitability measure most widely used to develop the target profit margin under target costing?

LO 2 **8-28** ***Implementing target costing*** From a behavioral point of view, what potential problems can occur when implementing a target costing system?

LO 2 **8-29** ***Benchmarking a target costing system*** As a manager asked to benchmark another organization's target costing system, on what factors would you gather information? Why?

LO 3 **8-30** ***Target costing equation*** Express the target costing relationship in equation form. How does this equation differ from the two other types of traditional equations relating to cost reduction? Why is this significant?

LO 3 **8-31** ***Target costing calculations*** Refer to the Kitchenhelp Coffeemaker example in the chapter. Suppose that Exhibits 8-6 and 8-7 remain the same but that engineers developed different numerical correlations, shown below, for the QFD matrix in Exhibit 8-8.

	Components or Functions					
Customer Requirements	Brew Basket	Carafe	Coffee Warmer	Body/Water Well	Heating Element	Display Panel
Tastes/smells like expresso	0.7				0.3	
Easy to clean	0.5	0.1		0.4		
Looks nice		0.1		0.5		0.4
Has 6+ cup capacity		0.5		0.5		
Starts automatically on time						1
Has multiple grinder settings	0.1					0.9
Keeps the coffee warm		0.2	0.8			
Automatic shutoff						1

Required

(a) Prepare an exhibit similar to Exhibit 8-9 showing percentage contributions of each component to customer requirements.

(b) Prepare a value index exhibit similar to Exhibit 8-10. Which components are candidates for cost reduction?

LO 4 **8-32** ***Breakeven time for new product development*** Refer to Exhibit 8-14 regarding Greyson Technology's launch of a new digital communications device. Suppose that Greyson reduced the quarterly spending on product development in panel A, which delayed launching the new product for two quarters, at which time the selling price and sales volume would be lower. Specifically, assume the following:

	Y1, Q1	Y1, Q2	Y1, Q3	Y1, Q4	Y2, Q1	Y2, Q2	Y2, Q3	Y2, Q4	Y3, Q1
Market research (000)	$ (100)	$ (50)							
Product development (000)		$ (80)	$ (150)	$ (150)	$ (150)	$ (150)	$ (150)	$ (150)	$ (60)

	Y3, Q1	Y3, Q2	Y3, Q3	Y3, Q4	Y4, Q1	Y4, Q2	Y4, Q3	Y4, Q4
Selling price	$ 19	$ 18	$ 18	$ 17	$ 17	$ 16	$ 15	$ 15
Sales quantity (000)	25	35	45	50	50	50	40	30

Required

Assuming that the cost per unit remains $10 and the MSDA expenses remain $120,000 per quarter, determine the difference between the breakeven time metrics under the initial assumptions in panel A and the new assumptions.

LO 4 **8-33** ***Breakeven time for new product development*** Refer to Exhibit 8-14 regarding Greyson Technology's launch of a new digital communications device. Suppose that Greyson reduced the quarterly spending on product development in panel A, which delayed launching the new product for two quarters, at which time the selling price and sales volume would be lower. Specifically, assume the following:

	Y1, Q1	Y1, Q2	Y1, Q3	Y1, Q4	Y2, Q1	Y2, Q2	Y2, Q3	Y2, Q4	Y3, Q1
Market research (000)	$ (100)	$ (50)							
Product development (000)		$ (80)	$ (150)	$ (150)	$ (150)	$ (150)	$ (150)	$ (150)	$ (60)

	Y3, Q1	Y3, Q2	Y3, Q3	Y3, Q4	Y4, Q1	Y4, Q2	Y4, Q3	Y4, Q4
Selling price	$ 18	$ 17	$ 17	$ 16	$ 15	$ 15	$ 15	$ 15
Sales quantity (000)	20	30	40	45	45	35	30	20

After Y4, Q4, the competitive price is expected to remain at $15 and the maximum sales will be 20,000 units.

Required

Assuming that the cost per unit remains $10 and the MSDA expenses remain $120,000 per quarter, determine the breakeven time metric under the new assumptions.

LO 6 **8-34** ***Activity-based costing for environmental costs*** How can a firm use activity-based costing to help control and reduce environmental costs?

Problems

LO 3 **8-35** ***Target costing calculations*** A major car manufacturer developed the following information as part of its target costing efforts:

Customer Importance Rating by Category

Category	Importance
Safety	140
Comfort and convenience	120
Economy	40
Styling	60
Performance	140
Total	500

Target Cost by Function Group

Function Group	Target Cost
Chassis	$1,400
Transmission	280
Air conditioner	100
Electrical system	700
Other function groups	4,520
Total	$7,000

Quality Function Deployment (Correlation) Matrix

	Function Group				
Categories	Chassis	Transmission	Air Conditioner	Electrical System	Other Function Groups
Safety	0.3	0.1		0.1	0.5
Comfort and convenience	0.3		0.1	0.1	0.5
Economy	0.2	0.2	0.1	0.1	0.4
Styling	0.1				0.9
Performance	0.3	0.2		0.1	0.4

Required

(a) Prepare an exhibit similar to Exhibit 8-9 showing percentage contributions of each function group to categories of customer requirements.
(b) Prepare a value index exhibit similar to Exhibit 8-10.
(c) Which function groups are candidates for cost reduction?

LO 1 **8-36** ***Total-life-cycle costing*** Consider the following situation: Your manager comes to you and says, "I don't understand why everyone is talking about the total-life-cycle costing approach to product costing. As far as I am concerned, this new approach is a waste of time and energy. I think we should just stick to what we know, and that is the traditional approach to product costing."

Required

Write a memorandum critiquing your manager's view. In the memo, discuss the benefits of adopting the total-life-cycle costing approach.

LO 1 **8-37** ***Total-life-cycle costing versus traditional methods*** Gregoire Grant is a traditional manufacturing manager who is concerned only with managing costs over the manufacturing cycle of the product. He argues that since traditional accounting methods are focused on this cycle, he should not bother with the RD&E cycle because it is separate from his area of manufacturing.

Required

Write an essay discussing Gregoire's views. What types of structural and functional changes in organizations may be necessary to help Gregoire overcome his traditional view?

LO 3 **8-38** ***Target costing: unit cost*** Calcutron Company is contemplating introducing a new type of calculator to complement its existing line of scientific calculators. The target price of the calculator is $75; annual sales volume of the new calculator is expected to be 500,000 units. Calcutron has a 15% return-on-sales target.

Required

Compute the unit target cost per calculator.

LO 3 **8-39** ***Target costing: return on sales*** Stacy Yoo, president of Caremore, Inc., an appliance manufacturer in Seattle, Washington, has been trying to decide whether one of her product-line managers, Bill Mann, has been achieving the companywide return-on-sales target of 45%. Stacy has just received data from the new target costing system regarding Bill's operation. Bill's sales volume was 300,000 appliances with an average selling price of $500 and expenses totaling $90 million.

Required

Determine whether Bill's return-on-sales ratio has met the companywide target. Has Bill done a good or a poor job? Explain.

LO 2 **8-40** ***Target costing: implementation issues*** Pierre LeBlanc, manager of Centaur Corporation, is thinking about implementing a target costing system in his organization. Several managers have taken him aside and have expressed concerns about implementing target costing in their organization.

Required

As an expert in target costing, you have been called in to discuss these concerns and offer advice on overcoming them. Write a memorandum discussing common concerns that managers have about target costing. In the memo, state how you would remedy these concerns.

LO 2, 3 **8-41** ***Traditional cost reduction versus target costing*** Traditional cost reduction in the United States differs significantly from the Japanese method of target costing.

Required

Discuss the similarities and differences in the process by which cost reduction under both systems occurs. Be specific in your answer.

LO 2 **8-42** ***Benchmarking for target costing*** As a manager interested in implementing target costing, you are contemplating three approaches. The first is to bring in an outside consultant; the second is to develop your own system inside your organization with little to no outside assistance; and the third is to engage in a benchmarking project with several other firms.

Required

Critique each of these approaches, discussing their pros and cons. On what basis will you select your approach to implementing target costing? Explain.

LO 2, 3 **8-43** ***Target costing versus traditional cost reduction methods*** According to this chapter, the target costing and traditional cost reduction methods approach the relationships among cost, selling price, and profit margin quite differently.

Required

Write an essay that illustrates how the target costing and traditional cost reduction methods differ, using the appropriate symbols and equations. In addition to the equations, describe how the processes differ in deriving costs.

LO 2 **8-44** ***Target costing and service organization*** Imagine that you are the manager of a large bank. Having heard about a management accounting method called *target costing*, you are wondering whether it can be applied to the banking industry. In particular, you are trying to determine how to benchmark other organizations to gain more information.

Required

Can target costing be applied to the banking industry? To what products or services can target costing be applied?

Cases

LO 6 **8-45** ***Environmental costs, activity-based costing*** Bevans Co. makes two products, Product X and Product Y. Bevans has produced Product X for many years without generating any hazardous wastes. Recently, Bevans developed Product Y, which is superior to Product X in many respects. However, production of Product Y generates hazardous wastes. Because of the hazardous wastes, Bevans now must deal with hazardous waste disposal, governmental environmental reports and inspections, and safe handling procedures.

Bevans Co. uses an indirect cost rate based on machine hours to assign manufacturing support costs to its two products. Because of concerns about the accuracy of the product costing system, Joel Dempsey, the controller, undertook an activity-based costing analysis of the manufacturing support costs, including an analysis of the support costs related to Product Y's generation of hazardous wastes. The resulting cost information, as well as machine hours and number of units, is summarized in the following table:

	Product X	Product Y
Direct costs (material plus labor)	$9,000,000	$4,000,000
Environmental support costs	—	$14,000,000
Nonenvironmental support costs	$22,000,000	$29,000,000
Total machine hours	10,000,000	6,000,000
Number of units	100,000,000	40,000,000

Required

(a) Compute product costs per unit for Products X and Y using the current indirect cost rate based on machine hours for manufacturing support costs.
(b) Compute product costs per unit for Products X and Y using the activity-based costing figures provided in the table.

(c) Explain the reasons for the differences in cost for each product using the two cost systems.
(d) Bevans has been selling Products X and Y at a price equal to 1.5 times the product cost computed using the machine-hour–based cost driver rate for manufacturing support costs. Compute these prices and provide recommendations to Bevans' management concerning profit improvement through pricing changes and cost reduction through manufacturing improvements.

LO 6 **8-46** ***Explicit and implicit environmental costs*** Refer to Case 7-57, which describes Kwik Clean's environmental costs.

Required

(a) Of the costs listed by Pat Polley, identify which are explicit and which are implicit environmental costs.
(b) Should Polley identify any other environmental costs?
(c) Prepare a memo to Polley explaining how an activity-based costing approach can help her control and reduce Kwik Clean's environmental costs.

LO 2 **8-47** ***Target costing*** Mercedes-Benz All Activity Vehicle (AAV)[13]

Introduction

During the recession beginning in the early 1990s, Mercedes-Benz (MB) struggled with product development, cost efficiency, material purchasing, and problems in adapting to changing markets. In 1993, these problems caused the worst sales slump in decades, and the luxury car maker lost money for the first time in its history. Since then, MB has streamlined the core business, reduced parts and system complexity, and established simultaneous engineering programs with suppliers.

In their search for additional market share, new segments, and new niches, MB started developing a range of new products. New product introductions included the C-Class in 1993, the E-Class in 1995, the new sportster SLK in 1996, and the A-Class and M-Class All Activity Vehicle (AAV) in 1997. Perhaps the largest and most radical of MB's new projects was the AAV. In April 1993, MB announced it would build its first passenger vehicle–manufacturing facility in the United States. The decision emphasized the company's globalization strategy and desire to move closer to its customers and markets.

Mercedes-Benz United States International used function groups with representatives from every area of the company (marketing, development, engineering, purchasing, production, and controlling) to design the vehicle and production systems. A modular construction process was used to produce the AAV. First-tier suppliers provided systems rather than individual parts or components for production of approximately 65,000 vehicles annually.

The AAV Project Phases

The AAV moved from concept to production in a relatively short period of time. The first phase, the concept phase, was initiated in 1992. The concept phase resulted in a feasibility study that was approved by the board. Following board approval, the project realization phase began in 1993, with production commencing in 1997. Key elements of the various phases are described next.

[13] Institute of Management Accountants, *Cases from Management Accounting Practice, Volume 15*. Adapted with permission. The case author, Tom Albright, wishes to express his gratitude to Ola Kallenins, Johnathan DeHart, Jason Hoff, Henrik Jonsson, Iosef Pfau, and Günther Thuss of Mercedes-Benz for their generous contributions to the development of this case.

Concept Phase, 1992–1993

Team members compared the existing production line with various market segments to discover opportunities for new vehicle introductions. The analysis revealed opportunities in the rapidly expanding sports utility vehicle market that was dominated by Jeep, Ford, and GM. Market research was conducted to estimate potential worldwide sales opportunities for a high-end AAV with the characteristics of a Mercedes-Benz. A rough cost estimate was developed that included materials, labor, overhead, and one-time development and project costs. Projected cash flows were analyzed over a 10-year period using net present value (NPV) analysis to acquire project approval from the board of directors. The sensitivity of the NPV was analyzed by calculating "what-if" scenarios involving risks and opportunities. For example, risk factors included monetary exchange rate fluctuations, different sales levels due to consumer substitution of the AAV for another MB product, and product and manufacturing costs that differed from projections.

On the basis of the economic feasibility study of the concept phase, the board approved the project and initiated a search for potential manufacturing locations. Sites located in Germany, other European countries, and the United States were evaluated. Consistent with the company's globalization strategy, the decisive factor that brought the plant to the United States was the desire to be close to the major market for sports utility vehicles.

Project Realization Phase, 1993–1996

Regular customer clinics were held to view the prototype and to explain the new vehicle concept. These clinics produced important information about how the proposed vehicle would be received by potential customers and the press. Customers were asked to rank the importance of various characteristics, including safety, comfort, economy, and styling. Engineers organized in function groups designed systems to deliver these essential characteristics. However, MB would not lower its internal standards for components, even if initial customer expectations might be lower than the MB standard. For example, many automotive experts believed that the superior handling of MB products resulted from manufacturing the best automobile chassis in the world. Thus, each class within the MB line met strict standards for handling, even though these standards might exceed customer expectations for some classes. MB did not use target costing to produce the lowest price vehicle in an automotive class. The company's strategic objective was to deliver products that were slightly more expensive than competitive models. However, the additional cost would have to translate into greater perceived value on the part of the customer.

Throughout the project realization phase, the vehicle (and vehicle target cost) remained alive because of changing dynamics. For example, the market moved toward the luxury end of the spectrum while the AAV was under development. In addition, crash test results were incorporated into the evolving AAV design. For these reasons, MB found it beneficial to place the design and testing team members in close physical proximity to other functions within the project to promote fast communication and decision making. Sometimes new technical features, such as side air bags, were developed by MB. The decision to include the new feature on all MB lines was made at the corporate level because experience had shown that customers' reactions to a vehicle class can affect the entire brand.

Production Phase, 1997

The project was monitored by annual updates of the NPV analysis. In addition, a three-year plan (including income statements) was prepared annually and reported to the headquarters in Germany. Monthly departmental meetings were held to discuss actual cost performance compared with standards developed during the cost estimation process. Thus, the accounting system served as a control mechanism to ensure that actual production costs would conform to target (or standard) costs.

Target Costing and the AAV

The process of achieving target cost for the AAV began with an estimate of the existing cost for each function group. Next, components of each function group were identified with their associated costs.

Cost reduction targets were set by comparing the estimated existing cost with the target cost for each function group. These function groups included the following: doors, sidewall and roof, electrical system, bumpers, power train, seats, heating system, cockpit, and front end. Next, cost reduction targets were established for each component. As part of the competitive benchmark process, MB bought and tore down competitors' vehicles to help understand their costs and manufacturing processes.

The AAV manufacturing process relied on high-value-added systems suppliers. For example, the entire cockpit was purchased as a unit from a systems supplier. Thus, systems suppliers were part of the development process from the beginning of the project. MB expected suppliers to meet established cost targets. To enhance function group effectiveness, suppliers were brought into the discussion at an early stage in the process. Decisions had to be made quickly in the early stages of development.

The target costing process was led by cost planners who were engineers, not accountants. Because the cost planners were engineers with manufacturing and design experience, they could make reasonable estimates of costs that suppliers would incur in providing various systems. Also, MB owned much of the tooling, such as dies to form sheet metal, used by suppliers to produce components. Tooling costs are a substantial part of the one-time costs in the project phase.

Index Development to Support Target Costing Activities

During the concept development phase, MB team members used various indexes to help them determine critical performance, design, and cost relationships for the AAV.[14] To construct the indexes, various forms of information were gathered from customers, suppliers, and their own design team. Although the actual number of categories used by MB was much greater, Table 1 illustrates the calculations used to quantify customer responses to the AAV concept. For example, values shown in the "Importance" column resulted from asking a sample of potential customers whether they consider each category extremely important when considering the purchase of a new MB product. Respondents could respond affirmatively to all categories that applied.

To gain a better understanding of the various sources of costs, *function groups* were identified together with target cost estimates. (MB also organizes teams called function groups whose role is to develop specifications and cost projections.) As shown in Table 2, the relative target cost percentage of each function group was computed.

TABLE 1 Relative Importance Ranking by Category

Category	Importance	Relative Percentage
Safety	32	41%
Comfort	25	32
Economy	15	18
Styling	7	9
Total	79	100%

TABLE 2 Target Cost and Percentage by Function Group

Function Group	Target Cost	Percentage of Total
Chassis	$x,xxx	20%
Transmission	x,xxx	25
Air conditioner	xxx	5
Electrical system	xxx	7
Other function groups	x,xxx	43
Total	$x,xxx	100%

[14] All numbers have been altered for proprietary reasons; however, the tables illustrate the actual process used in the development of the AAV.

TABLE 3 Function Group Contribution to Customer Requirements

Function Group	Category: Safety	Comfort	Economy	Styling
Chassis	50%	30%	10%	10%
Transmission	20	20	30	
Air conditioner		20		5
Electrical system	5		20	
Other function groups	25	30	40	85
Total	100%	100%	100%	100%

Table 3 summarizes how each function group contributes to the consumer requirements identified in Table 1. For example, safety was identified by potential customers as an important characteristic of the AAV; some function groups contributed more to the safety category than others. MB engineers determined that chassis quality was an important element of safety (50% of the total function group contribution).

Table 4 combines the category weighting percentages from Table 1 with the function group contribution from Table 3. The result is an importance index that measures the relative importance of each function group across all categories. For example, potential customers weighted the categories of safety, comfort, economy, and styling as 0.41, 0.32, 0.18, and 0.09, respectively. The rows in Table 4 represent the contribution of each function group to the various categories. The importance index for the chassis is calculated by multiplying each row value by its corresponding category value and summing the results: $(0.50 \times 0.41) + (0.30 \times 0.32) + (0.10 \times 0.18) + (0.10 \times 0.09) = 0.33$.

As shown in Table 5, the target cost index is calculated by dividing the importance index by the target cost percentage by function group. Managers at MB used indexes such as these during the concept design phase to understand the relationship of the importance of a function group to the target cost of a function group. Indexes less than 1 may indicate a cost in excess of the perceived value of the function group. Thus, opportunities for cost reduction consistent with customer demands, may be identified and managed during the early stages of product development. Choices

TABLE 4 Importance Index of Various Function Groups

Function Group	Category: Safety 0.41	Comfort 0.32	Economy 0.18	Styling 0.09	Importance Index
Chassis	0.50	0.30	0.10	0.10	0.33
Transmission	0.20	0.20	0.30		0.20
Air conditioner		0.20		0.05	0.07
Electrical system	0.05		0.20		0.06
Other function groups	0.25	0.30	0.40	0.85	0.35
Total	1.00	1.00	1.00	1.00	

TABLE 5 Target Cost Index

Function Group	(A) Importance Index	(B) % of Target Cost	(C) Target Cost Index = A/B
Chassis	0.33	0.20	1.65
Transmission	0.20	0.25	0.80
Air conditioner	0.07	0.05	1.40
Electrical system	0.06	0.07	0.86
Other function groups	0.35	0.43	0.81
Total		1.00	

made during the project realization phase were largely irreversible during the production phase because approximately 80% of the production cost of the AAV was for materials and systems provided by external suppliers.

The AAV project used a streamlined management structure to facilitate efficient and rapid development. The streamlined MB organization produced an entirely new vehicle from concept to production in four years. Using the target costing process as a key management element, MB manufactured the first production AAV in 1997.

Required

(a) What is the competitive environment faced by MB as it considers launching the AAV?
(b) How has MB reacted to the changing world for luxury automobiles?
(c) Using Cooper's cost, quality, and functionality chart,[15] discuss the factors on which MB would have to compete with other automobile producers, such as Jeep, Ford, and GM.
(d) How does the AAV project link with MB's strategy in terms of market coverage?
(e) Explain the process of developing an importance index for a function group or component. How can such an index guide managers in making cost reduction decisions?
(f) How does MB approach cost reduction to achieve target costs?
(g) How do suppliers factor into the target costing process? Why are they so critically important to the success of the MB AAV?
(h) What role does the accounting department play in the target costing process?

[15] Robin Cooper, *When Lean Enterprises Collide* (Boston: Harvard Business School Press, 1995).