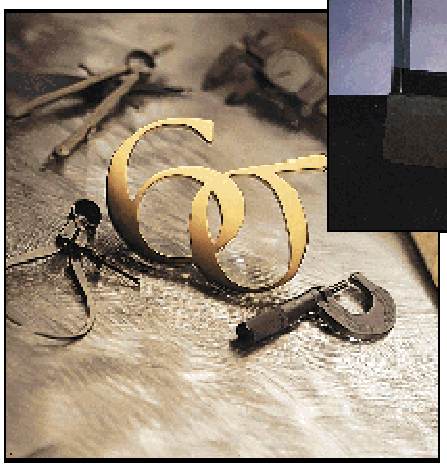
Chapter 3 Total Quality Management

Total Customer Satisfaction at Motorola

Motorola began in the late 1920s as a small manufacturer of car radios (hence the name *Motor*ola). It has grown to a corporation with more than 132,000 employees at 50 factories around the world, manufacturing such products as semiconductors, integrated circuits, paging systems, cellular telephones, computers, and satellite communications systems.

Motorola was an engineering-oriented company that focused on product development to create new markets. In the mid-1970s it changed its focus from products to customers with an objective of total customer satisfaction. Motorola is now recognized as having one of the best quality management programs in the world. In 1988 it was among the first group of winners of the prestigious Malcolm Baldrige National Quality Award. Chief executives of the National Business Roundtable recently ranked Motorola as the top quality management program practitioner.

Motorola has two quality-improvement goals to achieve total customer satisfaction. One goal is to reduce defects--where a defect is any failure to meet customer requirements in any of its products or services. Its current goal of "six sigma" quality means no more than 3.4 defects per million products or services. Its goal by the year 2000 is 2 defects per *billion* products or services, with an ultimate goal of zero defects. Its other goal is to reduce cycle time--the time from the point a customer places an order until it is delivered--by 50 percent each year.



Motorola's Six Sigma symbol represents its commitment to producing quality products and customer satisfaction. Technically, six sigma performance is a level of statistical variation in product quality that translates to only a little over 3 defects for every million parts produced, or virtually no defects. The six sigma performance program is part of the Motorola Corporate Quality Council (MCQC) which was established to coordinate and manage Motorola's corporate-wide quality program. Motorola's goal from this program has been to instill a commitment to absolute quality performance and total customer satisfaction throughout all areas of the company from purchasing to engineering and design to manufacturing to sales. Its MCQC program and its goal of six sigma performance enabled Motorola, Inc. to be among the first U.S. companies to receive the coveted Malcolm Baldrige National Quality Award from the U.S. Department of Commerce in 1988. Total quality management (TQM) with zero defects has been adopted by numerous companies that hope to survive in today's highly competitive global business environment.

Motorola continuously looks for ways to improve quality throughout its organization at all levels. For example, each employee has at least 40 hours of training that includes basic statistical quality control concepts; its goal is 160 hours of training per employee by the year 2000. Every task in every process in the company is measured by the employees who perform these tasks to identify defects and errors and to reduce cycle time. Every department at Motorola has a "participative management" team of eight to twelve employees who set local quality goals to achieve corporate goals. Small teams from its corporate quality council visit each of the company's divisions each year to conduct a quality audit, and teams from each sector in Motorola participate in company-wide quality competitions. Motorola teaches its suppliers its own quality management techniques and has its suppliers rate its production process and offer suggestions for quality improvement. Sales representatives at Motorola have the authority to replace defective products up to six years after their purchase.

Motorola's quality management program has been a success according to any measure. From 1988 to 1994 Motorola's employee productivity increased 100 percent (an annual rate of over 12 percent). From 1993 to 1994 its sales increased 31 percent and its stock rose 49 percent. By the mid-1990s it was selling more cellular phones in Japan than Japanese manufacturers. In 1994 alone the company estimated that it had saved several billion dollars because of its focus on quality improvement. The quality management program at Motorola is a standard or "benchmark" for companies around the world to try to emulate.[1]

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[1] K. Bemowski, "Motorola's Fountain of Youth," *Quality Progress* 28, no. 10 (October 1995): 29-31; and E. Pena, "Motorola's Secret to Quality Control," *Quality Progress* 23, no. 10 (October 1990): 43-45

We emphasize quality throughout this text in the context of all operational processes. In today's international business environment, quality cannot be underestimated or overlooked by any firm, regardless of its size or assets. Business leaders and CEOs cite quality as the most important factor in the long-term profitability and success of their firms.

In our everyday life we are exposed to quality in a variety of forms, from product advertising with slogans like "Putting Quality on the Road" (General Motors) and "Quality Is Job 1" (Ford) to everyday phrases such as "quality of life" and "quality time."

Why has quality become so important to businesses and consumers around the world? Following World War II, when the consumption of goods and services expanded dramatically in the United States, quality was not a big concern to consumers or producers. Consumers purchasing U.S. goods and services assumed they were getting the best products available; that they were of good quality was accepted without question. "Made in Japan" stamped on inferior Japanese products was a term of derision. This began to change during the 1970s due mainly to foreign competition, especially from Japan, in markets for manufactured goods and electronic products. Consumers began to have more choices and more information to help them make these choices. This resulted in higher expectations for products and services. Consumers found that they could demand--and expect to receive--high-quality products that were reliable and priced affordably and competitively. In this new environment of increased competition from foreign companies, quality not only allows for product discrimination, it also has become a marketing weapon.

Quality was not the sole reason for the initial Japanese success in the U.S. market. High-quality products from foreign firms such as Rolls Royce and Mercedes Benz automobiles and Hasselblad cameras had been available in the United States for years but had not altered consumers' preferences or perceptions. However, these products were expensive; Japanese products were not. The Japanese were uniquely able to establish the concept of *value*--the combination of price plus quality--and change their product-design philosophy such that the cost of achieving better quality was not prohibitive.

How were Japanese firms able, in such a short time, to change their image from producers of inferior quality products to producers of high-quality products? There are many reasons; some were the result of chance and opportunity. A gasoline shortage in the mid-1970s awakened consumers to the high gas mileage of their cars at about the same time the Honda Accord was being introduced in the United States, making Americans aware of high performance standards in Japanese cars. The growing media attention to consumer issues, particularly quality (exemplified by publications such as *Consumer Reports*), consumer advocates such as Ralph Nader, and various consumer affairs' reports on radio and television provided information not previously available about the quality of products. However, the most important factor in changing consumer perspectives was that foreign competitors, especially the Japanese, were able to produce goods equal or superior in quality to U.S. goods at a very competitive price; through word of mouth, effective marketing, and circumstances, the U.S. consumer became quality and value conscious.

The Japanese achieved enhanced product quality by adapting many of the principles of quality management originally developed in the United States, combined with their own management philosophies. As a competitive reaction, American firms have focused attention on quality as possibly the most important factor in their long-term profitability and survival.

In this chapter we discuss some of the more popular aspects of quality management as they apply to business organizations.

The Meaning of Quality

Asked "What is quality?" one of our students replied "getting what you pay for." Another student added that to her, quality was "getting *more* than you paid for!" The *Oxford American Dictionary* defines quality as "a degree or level of excellence." The "official" definition of quality by the American National Standards Institute (ANSI) and the American Society for Quality Control (ASQC) is "the totality of features and characteristics of a product or service that bears on its ability to satisfy given needs." Obviously quality can be defined in many ways, depending on who is defining it and to what product or service it is related. In this section we attempt to gain a perspective on what quality means to consumers and different people within a business organization.

Quality from the Consumer's Perspective

A business organization produces goods and services to meet its customers' needs. Quality is rapidly becoming a major factor in a customer's choice of products and service. Customers now perceive that certain companies produce better-quality products than others, and they buy

accordingly. That means a firm must consider how the consumer defines quality. The consumer can be a manufacturer purchasing raw materials or parts, a store owner or retailer purchasing products to sell, or someone who purchases retail products or services. W. Edwards Deming, author and consultant on quality, says that "The consumer is the most important part of the production line. Quality should be aimed at the needs of the consumer, present and future." From this perspective, product and service quality is determined by what the consumer wants and is willing to pay for. Since consumers have different product needs, they will have different quality expectations. This results in a commonly used definition of quality as a service's or product's *fitness for its intended use,* or **fitness for use;** how well does it do what the consumer or user thinks it is supposed to do and wants it to do?

Products and services are designed with intentional differences in quality to meet the different wants and needs of individual consumers. A Mercedes and a Ford truck are equally "fit for use," in the sense that they both provide automobile transportation for the consumer, and each may meet the quality standards of its individual purchaser. However, the two products have obviously been designed differently for different types of consumers. This is commonly referred to as the **quality of design**--the degree to which quality characteristics are designed into the product. Although designed for the same use, the Mercedes and Ford differ in their performance, features, size, and various other quality characteristics.

The *dimensions of quality* primarily for manufactured products a consumer looks for in a product include the following:[2]

1. *Performance:* The basic operating characteristics of a product; for example, how well a car handles or its gas mileage.
2. *Features:* The "extra" items added to the basic features, such as a stereo CD or a leather interior in a car.
3. *Reliability:* The probability that a product will operate properly within an expected time frame; that is, a TV will work without repair for about seven years.
4. *Conformance:* The degree to which a product meets preestablished standards.
5. *Durability:* How long the product lasts; its life span before replacement. A pair of L. L. Bean boots, with care, might be expected to last a lifetime.
6. *Serviceability:* The ease of getting repairs, the speed of repairs, and the courtesy and competence of the repair person.
7. *Aesthetics:* How a product looks, feels, sounds, smells, or tastes.
8. *Safety:* Assurance that the customer will not suffer injury or harm from a product; an especially important consideration for automobiles.
9. *Other perceptions:* Subjective perceptions based on brand name, advertising, and the like.

These quality characteristics are weighed by the customer relative to the cost of the product. In general, consumers will pay for the level of quality they can afford. If they feel they are getting what they paid for, then they tend to be satisfied with the quality of the product.

A Mercedes 560 SL and a Ford F-150 pickup truck are equally "fit for use," but with different design dimensions for different customer markets that result in significantly different purchase prices. The Mercedes costs about twice as much as the Ford pickup; however, the Ford purchaser uses a different set of quality characteristics for evaluation than the Mercedes purchaser and has a different set of quality expectations. Both vehicles can be of high quality depending on how they meet these customer expectations for quality. For example, a customer would expect the Mercedes to handle more smoothly on the highway and in traffic than a Ford pickup truck; if it didn't the customer would think its quality was poor. However, because the Ford doesn't handle as well as the Mercedes in these conditions does not mean that it's of poor quality; the Ford owners' expectations for handling are different.

The dimensions of quality for a service differ somewhat from those of a manufactured product. Service quality is more directly related to time, and the interaction between employees and the customer. Evans and Lindsay[3] identify the following dimensions of service quality.

1. *Time and timeliness:* How long a customer must wait for service, and if it is completed on time. For example, is an overnight package delivered overnight?
2. *Completeness:* Is everything the customer asked for provided? For example, is a mail order from a catalog company complete when delivered?
3. *Courtesy:* How customers are treated by employees. For example, are catalog phone operators at Lands' End nice and are their voices pleasant?
4. *Consistency:* Is the same level of service provided to each customer each time? Is your newspaper delivered on time every morning?
5. *Accessibility and convenience:* How easy it is to obtain the service. For example, when you call Lands' End or L. L. Bean does the service representative answer quickly?
6. *Accuracy:* Is the service performed right every time? Is your bank or credit card statement correct every month?
7. *Responsiveness:* How well the company reacts to unusual situations, which can happen frequently in a service company. For example, how well a telephone operator at L.L. Bean is able to respond to a customer's questions about a catalog item not fully described in the catalog.

L.L. Bean's first product was the Maine Hunting Shoe, developed in 1912 by company founder, Leon Leonwood Bean, a Maine outdoorsman. Tired of wet, sore feet from the heavy leather boots of his day, L.L. Bean invented a new boot that combined lightweight leather tops with waterproof rubber bottoms. He initially sold 100 pairs to fellow sportsmen through the mail, but 90 pairs were sent back when the stitching gave way. However, true to his word L.L. Bean returned their money and started over with an improved boot. In years to come L.L. Bean operated his business according to the following belief: "Sell good merchandise at a reasonable profit, treat your customers like human beings, and they will always come back for more." L.L. Bean also guarantees their products to "give 100% satisfaction in every way." If they don't L.L. Bean will replace the item or refund the purchase price "at any time." In 1994 they replaced more than 27,000 pairs of worn-out rubber bottoms on its hunting shoe, and it remains one of L.L. Bean's most popular products. Since its inception L.L. Bean has remained committed to its founder's dedication to product quality and customer service that has given it a global reputation for quality.

All the product and service characteristics mentioned previously must be considered in the design process to meet the consumer's expectations for quality. This requires that a company accurately assess what the consumer wants and needs. Consumer research to determine what kind of products are desired and the level of quality expected is a big part of a company's quality management program. Once consumer needs and wants have been determined by marketing, they are incorporated into the design of the product, and it is up to operations to ensure that the design is properly implemented, resulting in products and services consumers want and having quality they expect.

Quality from the Producer's Perspective

Now we need to look at quality the way a producer or service provider sees it. We already know that product development is a function of the quality characteristics (i.e., the product's fitness for use) the consumer wants, needs, and can afford. Product or service design results in design specifications that should achieve the desired quality. However, once the product design has been determined, the producer perceives quality to be how effectively the production process is able to conform to the specifications required by the design referred to as the **quality of conformance.** What this means is quality during production focuses on making sure that the product meets the specifications required by the design.

Examples of the quality of conformance: If new tires do not conform to specifications, they wobble. If a hotel room is not clean when a guest checks in, the hotel is not functioning according to the specifications of its design; it is a faulty service. From this producer's perspective, good-quality products conform to specifications--they are well made; poor-quality products are not made well--they do not conform to specifications.

Achieving quality of conformance depends on a number of factors, including the design of the production process (distinct from product design), the performance level of machinery equipment and technology, the materials used, the training and supervision of employees, and the degree to which statistical quality control techniques are used. When equipment fails or is maladjusted, when employees make mistakes, when material and parts are defective, and when supervision is lax, design specifications are generally not met. Key personnel in achieving conformance to specifications include the engineering staff, supervisors and managers, as well as employees.

An important consideration from the consumer's perspective of product quality is product or service price. From the producer's perspective an important consideration is achieving quality of conformance at an acceptable cost. Product cost is also an important design specification. If products or services cannot be produced at a cost that results in a competitive price, then the final product will not have acceptable value--the price is more than the consumer is willing to pay given the product's quality characteristics. Thus, the quality characteristics included in the product design must be balanced against production costs.

We approached quality from two perspectives, the consumer's and the producer's. These two perspectives are dependent on each other as shown in Figure 3.1. Although product design is customer-motivated, it cannot be achieved without the coordination and participation of the production process. When a product is designed without considering how it will be produced, it may be impossible for the production process to meet design specifications or so costly to do so that the product or service must be priced prohibitively high.

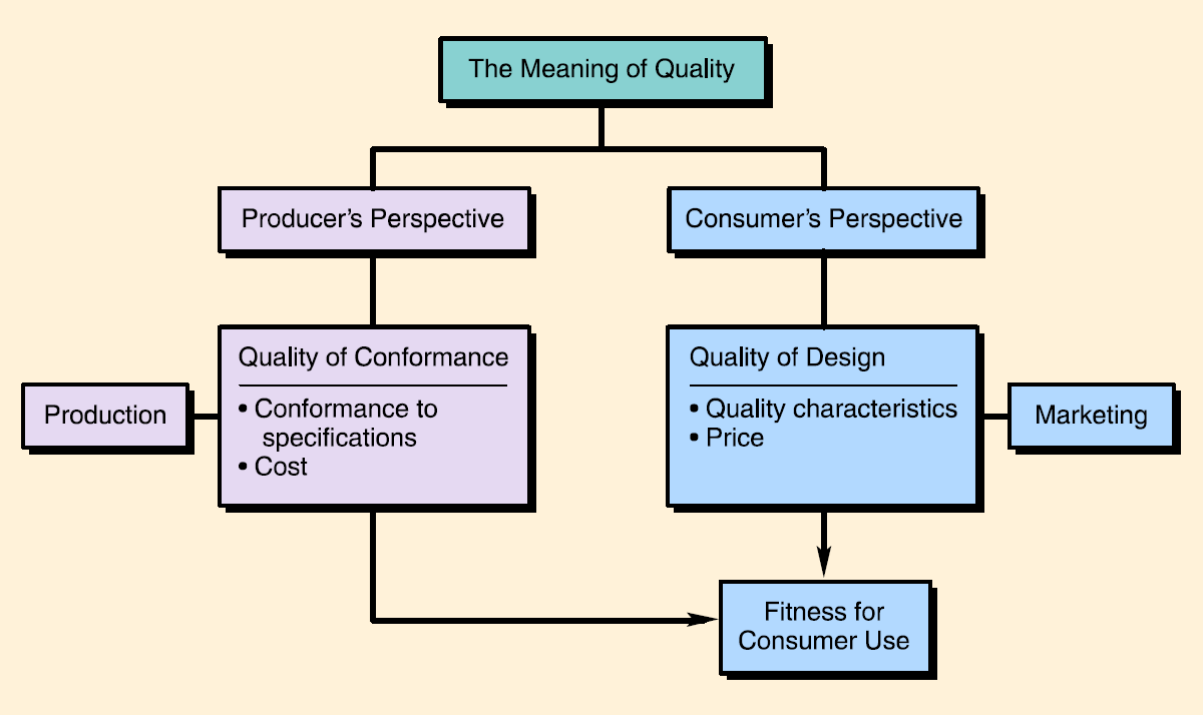

FIGURE 3.1 The Meaning of Quality

Figure 3.1 depicts the meaning of quality from the producer's and consumer's perspectives. The final determination of quality is fitness for use, which is the consumer's view of quality. It is the consumer who makes the final judgment regarding quality, and so it is the consumer's view that must dominate.

Giving high quality customer service: A focal point at Lands' End

A friendly phone staff is a key to customer services at Lands' End. The number one priority for a sales representative at Lands' End is that he or she be friendly--and love to talk. Lands' End customer sales representatives are explicitly instructed that they are there not to sell, but to provide service. Director of Customer Service, Joan Conlin, explains that "our customer sales representatives are there to help customers accomplish what they called for--to meet a customer's need; they are not there to market other products . . . their job is to listen and respond to customer needs; it's service, not sales."

Vice President of Human Resources Kelly Ritchie notes that Lands' End employees are given an "incredible amount of responsibility. Right down to our front-line sales reps, everybody has the authority to make whatever decision is necessary to please the customer . . . In every employee at every level, we try to instill the idea that they must do whatever is needed to meet a customer's need."

New hires at Lands' End are given 80 hours of training on all the company's basic products and core items, even fabrics, so they will have a basic understanding of what Lands' End sells. They are given training in proper politeness and how they are expected to operate when assisting customers. New employees are also given training on the computer system and a model phone system that replicates the actual system. As a result of this training most new customer service representatives feel very comfortable when they start taking real orders. Nevertheless, a trainer sits behind them for a few days to answer questions. Even when the formal training ends, an assist button can summon a supervisor able to answer questions. Operators can also call on specialty shoppers when a customer needs special assistance, and if an after-order problem arises they can call customer service.

Service representatives are assessed on a continuing basis. Supervisors listen to at least four calls for each service representative each month, fill out monitoring forms for these calls, and provide feed-back to the representative. Monitoring is done at random and the representative does not know when it is occurring.

The speed with which a call is answered is one indicator of customer service quality. The Lands' End goal is to answer 90 percent of calls within 20 seconds of its being placed. The average answering speed is 5 seconds--maybe two rings--and most callers don't even hear a ring. An automatic call-distribution system in each of their phone centers allows Lands' End to monitor each center and shift more calls to any of the centers when the need arises. Call duration (talk-time) is also monitored. The company especially watches the high end to make sure there is not a system problem or that operators aren't becoming too chatty--something that customers do not like either.

Lands' End takes customer comments very seriously. Positive and negative customer phone comments to sales representatives are logged and, on a monthly

basis, looked at by every department in the company. In 1995, for example, 10,000 comments were logged.

Pause and Reflect

***3-1.** There are many quality-related sites on the Internet. Begin your search by accessing ASQC's homepage. How was ASQC formed? What is its purpose? How large is the organization? What specialized divisions does ASQC sponsor? What special topics in quality is ASQC currently exploring? Is there an ASQC chapter near you? A student chapter? How does ASQC define quality? Read the most frequently asked questions. What additional questions do you have about quality?

3-2. How does the consumer's perspective of quality differ from the producer's?

3-3. Briefly describe the *dimensions of quality,* for which a consumer looks in a product, and apply them to a specific product.

3-4. How does *quality of design* differ from *quality of conformance?*

3-5. How do the marketing and sales areas affect product quality in a total quality management system? Purchasing?

3-6. What are the different quality characteristics you (as a consumer) would expect to find in the following three products: a VCR, a pizza, running shoes?

3-7. Describe how a quality assurance program might affect the different organizational functions for a fast-food business (such as McDonald's or Burger King).

3-8. Identify a company or organization from which you have received high-quality products and describe the characteristics which make it high quality.

3-9. Identify a company or organization from which you have received poor-quality products or services, describe the nature of the defects, and suggest ways in which you might improve quality.

These exercises require a direct link to a specific Web site. Click **Internet Exercises for the list of internet links for these exercises.*

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[2]Adapted from D. A. Garvin, "What Does Quality Really Mean?" *Sloan Management Review* 26, no. 1 (1984): 25-43.

[3]J. R. Evans and W. M. Lindsay, *The Management and Control of Quality,* 3d ed. (St. Paul, Minn.: West, 1996).

Total Quality Management

To make sure that products and services have the quality they have been designed for, a commitment to quality throughout the organization is required. This approach to the management of quality throughout the entire organization has evolved into what is referred to as total quality management or TQM.

The Evolution of Total Quality Management

A handful of prominent individuals have had a dramatic impact on the rise of quality awareness in the United States, Japan, and other countries. These individuals include Walter Shewhart, W. Edwards Deming, Joseph Juran, and Philip Crosby.

Walter Shewhart was an employee of Bell Telephone Laboratories during the 1920s where he developed the technical tools that formed the beginning of statistical quality control. These tools became the foundation of the modern quality management movement in Japan and later in the United States. Shewhart helped start a quality revolution at AT&T and later became known as the father of statistical quality control.

Shewhart and his colleagues introduced the term **quality assurance** for their program to improve quality at Bell Telephone Laboratories using statistical quality control methods. For almost five decades these technical methods formed the foundation of quality assurance. However, it was one of Shewhart's disciples, W. Edwards Deming, who changed the focus of quality assurance from the technical aspects to more of a managerial philosophy. Today quality assurance refers to a commitment to quality throughout the organization.

W. Edwards Deming

W. Edwards Deming met Walter Shewhart in 1927 while working at the Department of Agriculture in Washington. Deming often visited Shewhart at his home in New Jersey on weekends to discuss statistics. In 1940 Deming moved to the Census Bureau, where he introduced the use of statistical process control to monitor the mammoth operation of key punching data from census questionnaires onto millions of punch cards. During World War II Deming worked on military-related problems, and beginning in 1942 he developed a national program of eight- and ten-day courses to teach statistical quality control techniques to executives and engineers of companies that were suppliers to the military during the war. More than 10,000 engineers were trained in Shewhart's statistical process control techniques. Many of them formed study groups that eventually developed into the American Society for Quality Control. By the end of World War II, Deming had an international reputation, and by the late 1940s he was consulting in Japan.

In 1950 Deming began teaching statistical quality control to Japanese companies. As a consultant to Japanese industries and as a teacher, he was able to convince them of the benefits of statistical quality control. He is a major figure in the Japanese quality movement, and in Japan he is frequently referred to as the father of quality control.

Deming's approach to quality management advocates continuous improvement of the production process to achieve conformance to specifications and reduce variability. He identifies two primary sources of process improvement: eliminating common causes of

quality problems, such as poor product design and insufficient employee training, and eliminating special causes, such as specific equipment or an operator. Deming emphasizes the use of statistical quality control techniques to reduce variability in the production process. He dismisses the extensive use of final product inspection as coming too late to reduce product defects. Primary responsibility for quality improvement is employees' and management's--not the quality manager's or a technician's. He promotes extensive employee involvement in the quality improvement program, and he recommends training for workers in quality control techniques and methods.

Deming's overall philosophy for achieving improvement is embodied in his fourteen points, summarized as follows:

1. Create a constancy of purpose toward product improvement to achieve long-term organizational goals.
2. Adopt a philosophy of preventing poor-quality products instead of acceptable levels of poor quality as necessary to compete internationally.
3. Eliminate the need for inspection to achieve quality by relying instead on statistical quality control to improve product and process design.
4. Select a few suppliers or vendors based on quality commitment rather than competitive prices.
5. Constantly improve the production process by focusing on the two primary sources of quality problems, the system and workers, thus increasing productivity and reducing costs.
6. Institute worker training that focuses on the prevention of quality problems and the use of statistical quality control techniques.
7. Instill leadership among supervisors to help workers perform better.
8. Encourage employee involvement by eliminating the fear of reprisal for asking questions or identifying quality problems.
9. Eliminate barriers between departments, and promote cooperation and a team approach for working together.
10. Eliminate slogans and numerical targets that urge workers to achieve higher performance levels without first showing them how to do it.
11. Eliminate numerical quotas that employees attempt to meet at any cost without regard for quality.
12. Enhance worker pride, artisanry and self-esteem by improving supervision and the production process so that workers can perform to their capabilities.
13. Institute vigorous education and training programs in methods of quality improvement throughout the organization, from top management down, so that continuous improvement can occur.
14. Develop a commitment from top management to implement the previous thirteen points.

Deming is also credited for development of the *Deming Wheel,* or *plan-do-check-act (PDCA) cycle,* although it was originally formulated by Walter Shewhart and renamed by the Japanese. The Deming Wheel is a four-stage process for continuous quality improvement that complements Deming's fourteen points. This process is shown in Figure 3.2 and the stages of the process are described as follows:

1. *Plan.* In this first stage of the Deming Wheel, a process or situation is studied, identifying problems and planning how to solve them. This is where customer

expectations are determined and goals to measure quality improvement are established.

2. *Do.* In this stage, the plan is implemented on a test basis, improvement is measured, and the results documented.
3. *Study.* This stage was originally called the "check" stage, which is why the cycle is called plan-do-check-act. Deming changed this to "study" in 1990 to reflect a more thorough analysis of the plan than a simple check. In this stage, the plan is assessed to see if it is achieving the goals established in stage 1, and to see if any new problems have developed.
4. *Act.* In the final stage, the plan is implemented and the quality improvement is made part of the normal operation. The process then returns to stage 1 to start the cycle over again to identify new quality problems and develop plans to solve them--the *continuous improvement* of a committed quality management program.

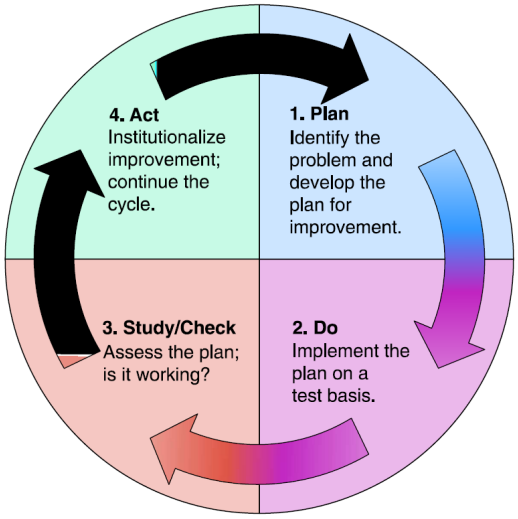

FIGURE 3.2 The Deming Wheel (PDCA Cycle)

Joseph M. Juran, Philip Crosby, and Armand V. Feigenbaum

Joseph Juran, an author and consultant on quality, followed W. E. Deming to Japan in 1954, where he taught courses on the management of quality. Previously he had worked in the quality program at Western Electric. Like Deming, he has been a major contributor to the Japanese movement in quality improvement.

Juran focused on *strategic quality planning*--determining the product quality level and designing the production process to achieve the quality characteristics of the product. Strategic planning for quality is conducted within an annual quality program. Management sets goals and priorities, assesses the results of previous plans, and coordinates quality objectives with other company goals. He also emphasizes *quality improvement* by focusing on chronic quality problems and securing a "break-through" solution. Juran believes that at any time there should be hundreds (or perhaps even thousands) of quality improvement projects going on everywhere in the company where improvement is possible.

Another leader in quality management is Philip Crosby, whose 1979 book *Quality Is Free* emphasized that the costs of poor quality (including lost labor and equipment time due to

scrap, downtime, and lost sales) far outweigh the cost of preventing poor quality, something not generally recognized in the United States at that time.

In the 1980s Armand V. Feigenbaum introduced **total quality control** to reflect a total commitment of effort from management and employees throughout an organization to improve on quality. Total quality control needs strong leadership from top management to improve quality and make it a continual process. The Japanese adopted this concept, referring to it as *company-wide quality control.* They believe that all employees at all levels of the organization, led by top management, are responsible for *continuous quality improvement.*

TQM and Continuous Process Improvement

TQM embodies the same basic principles as quality assurance, total quality control, and company-wide quality control. TQM emphasizes top management's role in leading a total quality effort on which all employees at all levels must focus. All employees are responsible for continuous quality improvement, and quality is the focal point of all organizational functions. TQM also emphasizes that quality is a strategic issue. The organization must decide what the customer wants in terms of quality and then use strategic planning encompassing all functional areas to achieve goals for quality. From this perspective, quality is the most important company issue.

In recent years the term *continuous process improvement* is being used among many companies to identify a quality improvement or TQM effort. Continuous process improvement is essentially a matter of nomenclature; it embodies the same basic philosophy and principles as TQM, although it does reflect a recent trend of focusing management attention on business processes rather than functions. In other words, all the tasks and activities in the business are part of a process or a group of interacting processes that are done over and over; a business is not just a group of separate functions. For example, filling a customer order is a process repeated continuously in a company, and it cuts across a number of different functions including sales, purchasing, accounting, manufacturing, packaging, and so on. In continuous process improvement the first step is to identify the critical processes in a company and then analyze these processes in order to understand how all the tasks and functions are interrelated (i.e., what is the process?). The objective is to determine ways to improve these processes while increasing the quality of the work being performed, and in turn, the product or service. When one critical process is improved, another process is addressed in a continual manner. This process for continuous improvement essentially follows the steps in the Deming Wheel (Figure 3.2).

Principles of Total Quality Management

Although companies use different terms to refer to their approach to quality, they mean essentially the same thing and embody many of the same concepts: strategic goals, total commitment, continuous improvement, comprehensive focus, employee responsibility, job training, and so forth. Total quality management represents a set of management principles that focus on quality improvement as the driving force in all functional areas and at all levels in a company. These principles are:

1. The *customer* defines quality, and the customer's needs are the top priority.
2. Top management must provide the *leadership* for quality.
3. Quality is a *strategic* issue.

4. Quality is the responsibility of all *employees* at all levels of the organization.
5. All functions of the company must focus on *continuous quality improvement* to achieve strategic goals.
6. Quality problems are solved through *cooperation* among employees and management.
7. Problem solving and continuous quality improvement use *statistical quality control* methods.
8. *Training and education* of all employees are the basis for continuous quality improvement.

TQM Throughout the Organization

Let's take a quick look at the impact of quality management on the various functions that make up the production process. *Marketing, sales,* and *research* have direct contact with the consumer. Marketing is typically responsible for the consumer research that determines the quality characteristics that consumers want and need, and the price they are willing to pay for it. Marketing also informs the consumer about the quality characteristics of a product through advertising and promotion. Sales provides feedback information through its interaction with the consumer, which is a determinant of product design. Research and development will explore new ideas for products and be actively involved in product innovation.

Engineering translates the product quality characteristics determined by marketing and top management into a product design, including technical specifications, material and parts requirements, equipment requirements, workplace and job design, and operator training and skills. Overdesigning the product is a drain on the company's resources and can erode profits, whereas underdesigned products will generally not meet the customer's quality expectations. Genichi Taguchi, the Japanese quality expert, estimates that poor product design is the cause of as much as 80 percent of all defective items. It is much cheaper and easier to make changes at the design stage than at the production stage, so companies need to focus on quality at all stages of the design process.

Purchasing must make sure that the parts and materials required by the product design are of high quality. Quality of the final product will only be as good as the quality of the materials used to make it. Purchasing must select vendors who share the company's commitment to quality and who maintain their own quality management program for providing high-quality service, materials, and parts. In TQM a partnership exists between supplier and customer in which the supplier is expected to manage its own quality so the customer will not have to inspect incoming materials and parts. In a competitive global environment this means American suppliers must adopt TQM to do business with companies around the world.

Personnel is responsible for hiring employees that have the required abilities and skills, and training them for specific job tasks. Employees not well trained in their tasks will probably contribute to poor quality or service. Personnel also has responsibility for educating employees about quality and ways to achieve quality in their tasks. TQM requires that all employees throughout the organization be responsible for quality. Employees, collectively and individually, must not only perform their tasks according to design specifications but also be responsible for identifying poor quality or problems that may lead to poor quality and taking action to correct these problems. Performance appraisal under TQM focuses more on quality improvement and group and company achievement than on individual job performance.

Management at all levels must implement the product design according to quality specifications, controlling labor, materials, and equipment. Failure to manage effectively can result in employee errors, equipment breakdown, bottlenecks, interrupted service, and the like, which contribute to poor quality.

Packing, storing, and *shipping* make sure that high-quality products are not damaged en route to the customer. Packaging methods and materials, storage facilities and procedures, and shipping modes must ensure that final products are protected and that customers receive them on time.

After-sale support (or customer service) has the responsibility of providing the customer with good instructions for the product's installation and use, with personal assistance if required. If the product fails to function properly, the company is responsible for repair or replacement. This is of major importance in TQM, since it represents a direct point of contact with the customer.

To have a successful TQM program, each of these areas in a business--as well as all other organizational support groups--must be committed to quality. However, this commitment must begin at the top and spread down through the organization. A successful TQM program must be planned, established, and initiated by top management and implemented by the various functions and employees in the organization. Although it is popular to say that quality is everyone's responsibility in a company, TQM generally requires a total commitment from top management to monitor and maintain quality throughout the organization.

Pause and Reflect

***3-10.** Read more about Joseph Juran, then explore the Juran Institute. Choose one of Juran's articles to download. Write a brief summary highlighting the contents of the article.

3-11. What traits of quality management are generally consistent among most current quality philosophies and trends?

3-12. Describe the primary contribution to quality management of each of the following: W. E. Deming, Joseph Juran, Phillip Crosby, Armand Feigenbaum, and Kaoru Ishikawa.

***3-13.** Clemson University maintains a vast collection of quality articles from a multitude of sources at their Continuous Improvement Server. Download an article of interest to you and summarize what you learned. Also, link to the Deming Institute and summarize the purpose of that organization.

These exercises require a direct link to a specific Web site. Click **Internet Exercises for the list of internet links for these exercises.*

Strategic Implications of TQM

A *strategy* is a set of decisions a company makes that establishes a plan to achieve its long-term goals. A company's success in implementing its strategy, or strategic plan, through its operations is a key to its long-term competitiveness. In today's global business environment, since a company competes on quality, it is likely the most important aspect of its strategic plan. For some companies, their strategic plan is embodied in their quality management program or, at the very least, quality is a key part of a company's strategic plan. In this section we will look at the relationship between strategy and TQM in those companies in which quality is the driving force.

Companies where quality drives their competitive strategy have certain common characteristics. They have a clear *strategic goal, vision,* or *mission* that focuses on customer satisfaction through quality. Ford's slogan that "Quality Is Job 1," Motorola's company objective of "Total Customer Satisfaction," and AT&T Universal Card Services headquarters inscription, "Customers are the center of our universe," all reflect their commitment to customer satisfaction and quality as part of their overall strategy or vision.

High goals for quality are characteristic of the strategic plans for these companies. Motorola's six sigma goal of 3.4 defects per million products is a policy of virtually no defective items. AT&T Consumer Communication Services, which provides long-distance services to 80 million residential customers, has the goal of providing a perfect connection every time.

Strategic planning also includes a set of programs, or *operational plans and policies,* to achieve the company's goals. Establishing goals without telling employees how to achieve them will be fruitless. In a quality management program goals and objectives are established at all levels, and the means and resources for achieving these goals are provided to employees and managers. This may include new or improved processes, employee training, and quality tools and techniques.

Strategic quality planning includes *a mechanism for feedback* to adjust, update, and make corrections in the strategic plan. Original quality goals may prove to be so easily attained that employees become complacent, or so impossible that employees become frustrated. Goals need to be continuously reevaluated and revised. The strategic plan also needs to be capable of quickly reflecting changing technology and market changes.

Strong leadership is a key to successfully integrating quality into a company's strategic plan. Robert Galvin, the former CEO of Motorola, often made quality the first item on the agenda at his staff meetings. David Kearns, the president of Xerox, was the driving force behind the development of his company's quality strategy that resulted in the 1989 Baldrige Award for Xerox's Leadership Through Quality program. However, strong leadership is not only about making the decision that quality will be an important component of a company's strategy; it is also about creating a company environment that is conducive to quality management. Such an environment actively involves management and employees in the strategic planning process, promotes teamwork between and among managers and employees, makes employees responsible for quality, and encourages managers and employees to take risks and talk openly about quality. It also rewards employees for quality improvement. If this type of environment is not created, then the company's quality strategy is not likely to be successful.

THE COMPETITIVE EDGE

Strategy, Leadership, and Quality at Blue Cross/Blue Shield of Ohio

During the past decade the $1 trillion health-care industry has been in a state of crisis. Hospitals, health-care providers, and insurance companies have had to reassess their uncertain future. Blue Cross/Blue Shield of Ohio (BCBSO), a $1.7 billion mutual health-care insurer, undertook a series of far-reaching changes to better position itself to cope with its future.

In 1987 BCBSO lost $99 million. The company then established a strategic plan to achieve financial stability and sales growth, and drastically improve service performance. The strategic plan required BCBSO to establish well-defined goals, commit top management to achieve the goals, develop an incentive system to support the goals, unify management at all levels, and develop plans to carry out the changes the plan required. Employees who previously were outside the planning process found themselves directly involved, which excited them because they were able to see how their department and themselves fit into the overall plan and convinced them the planning process was worthwhile.

The strategic plan was a total quality program. Initially the program consisted of the traditional approach to quality improvement--educational programs on statistical quality control techniques, flowcharting techniques, and quick 90-day goals. It also included a "seize the day" philosophy that encouraged employees to address opportunities for improvement whenever they were identified. For example, a customer service representative decided to record the reasons for customer calls to see if a pattern existed, and discovered that a confusing code on the explanation-of-benefits statement generated a large number of help calls. The representative suggested altering the codes, an improvement that resulted in a 35% reduction in customer calls. In addition, extensive process improvement was conducted in the information technology area, resulting in the development of three new major information systems at a cost of $35 million.

However, in 1991, when the strategic initiative seemed to be stalling, a Malcolm Baldrige National Quality Award examiner was hired to review the quality management program and recommend new initiatives. The examiner recommended that the company make the CEO's role more visible, reformulate steering committees with employees at every level, and target the Baldrige Award as a goal. Participation in the Baldrige Award process rejuvenated the quality management program and renewed employee enthusiasm. New goals included daily performance management in customer satisfaction, process improvement, and individual development. The strategic planning process and the quality management program were successful because of strong leadership at the top. Executive teams were willing to take the initiative to sustain the strategic plan even when it appeared it might falter.

In 1993, Blue Cross/Blue Shield of Ohio achieved $68 million in income and had

enrolled 130,000 new members since the start of its strategic plan in 1987. It had reduced the time to turnaround claims from approximately four weeks to five to six calendar days, and increased the accuracy of claims processing, reducing numerous costly errors to achieve over 98% accuracy. Its overall rank among BC/BS plans rose from 72 out of 73 in 1987 to 4th out of 73 in 1993.

Source: S. J. Smith "Blue Cross/Blue Shield of Ohio: A Profile in Change," *Quality Progress* 28, no. 10 (October 1995): 87-90.

Pause and Reflect

3-14. Explain why strategic planning might benefit from a TQM program.

TQM in Service Companies

TQM evolved out of applications in manufacturing companies such as Toyota, IBM, and Motorola. In the 1990s service companies began to realize that they could benefit from quality management. This is important since the service sector is the largest segment of the U.S. economy employing almost three times as many people as manufacturing industries.

Service organizations and manufacturing companies both convert inputs into outputs--products or services--through a productive process. Both manufacturing and services use the same kinds of inputs--resources such as physical facilities, capital, materials, equipment, and people. In some instances the processes and products are similar. For example, both Ford and McDonald's produce a tangible, physical product (cars and hamburgers) assembled from component parts. However, in pure service industries such as law, hotels, entertainment, communication, engineering, education, clubs, real estate, banks, retail, health care, and airlines, the processes are less similar and the products are not as tangible. The "products" provided by these organizations are not typically a physical item that can be held or stored. The customer of a manufacturer tends to interact only at the output end of the production process. The customer of a service often interacts directly with the production process, consuming services like legal advice, a classroom lecture, or an airline flight as they are being produced. Services tend to be customized and provided at the convenience of the customer; for example, doctors prescribe individually to patients. In addition, services are labor intensive while manufacturing is more capital intensive. Thus, human contact and its ramifications are an important part of the process of producing services.

Manufactured products are physical items; they can be observed, held, felt, stored, and used again. If a manufactured item is defective, the defect can be felt or seen, and counted or measured. The improvement (or deterioration) in a product's quality can be measured. To implement a TQM program for a product, goals are established, and success or failure is measured against these goals.

It's not the same for service. A service cannot be held, felt, stored, and used again. A service output is not usually tangible; thus, it is not as easy to measure service defects. The dimensions of quality for manufactured items include such things as performance, features, reliability, conformance, and durability that can be quantitatively measured. The dimensions of service quality include timeliness, courtesy, consistency, accuracy, convenience, responsiveness, and completeness--all hard to measure beyond a subjective assessment by the customer. This does not mean that the potential for poor quality is any less in services. Each day thousands of travelers check into and out of Ritz Carlton Hotels, UPS handles and delivers millions of packages, and VISA processes millions of credit transactions worldwide. However, it is more difficult to assess defects in service and thus more difficult to measure customer satisfaction.

Avis's well-known company slogan that it introduced in 1962, "We try harder," reflects its total commitment to customer satisfaction and quality management. Avis recognizes that its primary means of increasing market share is to constantly improve customer service. Avis's Worldwide Reservation Center handles over 23 million calls and 6.5 million reservations annually with a state-of-the-art information system that lets agents service most customers with little or no delay. Avis's Employee Participation Group (EPG) program enables employees to work with management to improve communications and develop quality improvement strategies that will improve the workplace environment, improve employee performance and increase job satisfaction. Employees are empowered to use their own initiative to assist customers in order to increase customer satisfaction. Employee training is extensive and Avis has been referred to as one of the "100 best companies to work for in America." Avis queries all customers when they return their car to monitor trends and customer satisfaction. The company also calls 1,500 customers each month to get a detailed assessment of customer satisfaction in each of their nine service delivery areas. Avis, an employee-owned company, is recognized as a leader in quality management. Baldrige Award examiners visiting the company noted that "Customer-relationship management is a major strength of the company," and that "there is substantial evidence of a high level of customer satisfaction."

Service organizations must often rely on talking directly with customers in the form of surveys or interviews--both subjective responses--to measure the attributes of quality. Timeliness, or how quickly a service is provided, is an important dimension of service quality, and it is not difficult to measure. The difficulty is determining what is "quick" service and what is "slow" service. How long must a caller wait to place a phone catalog order before it is considered poor service?

Despite these differences, the definition of quality that we developed earlier in this chapter and the basic principles of TQM can apply equally well to services as to manufacturing. Quality service can be defined as "how well the service does what the customer thinks it is supposed to do." This is essentially the same fitness for use definition we developed earlier in this chapter. However, the differences between providing services and manufacturing products makes the management of service quality a challenging process.

Competing at Lands' End

"Guaranteed. Period." The team approach to quality improvement at Lands' End

To back up their unique guarantee of customer satisfaction, "Guaranteed. Period." Lands' End addresses product development and improvement through a team approach. For example, the Adult Sleepwear and Slippers team, headed by merchandiser, Kelli Larke, includes an inventory manager to make sure sufficient quantities are ordered to meet customer needs; a quality-assurance specialist to make sure the products *exceed* customer expectations; a copywriter responsible for catalog presentations of products; an art director to make sure product features come across clearly in photography; and, a team-support member who provides assistance for all team members. A team like this frequently meets in a meeting area, but they also share a unique work area that includes individual workstations in a generally open area with no walls that facilitates communication between team members.

Quality problems are typically brought to the team's attention from the customer returns area or directly from customer comments. In one case, customer returns brought a pair of pajamas to the attention of Priscilla, the team's quality assurance specialist. The customer commented on the return slip that there was a problem with color bleeding after the pajamas had been washed a few times. Priscilla sent the pajamas to the lab and it was discovered that the piping on the garment bled into the fabric when washed with cold water. This set in motion activity by the team leader, Kelli, and other team members. Priscilla contacted the vendor who produces the pajamas for Lands' End and they immediately begin work on correcting the problem. Kelli alerts Dave, the inventory manager, so that he can begin determining the effect on stocking if they pull all the pajamas they currently have out of stock if it proves necessary. Ellen and Kelli begin discussing the need to provide more visible washing instructions on the pajamas to alert the customer to the cold water problem. The team approach enables Lands' End to move quickly with clear lines of communication to address quality problems and maintain customer satisfaction.

Quality management in services must focus on employee performance related to intangible, difficult-to-measure quality dimensions. The most important of these quality dimensions is how quickly, correctly, and pleasantly employees are able to provide service. That is why service companies such as Federal Express, Lands' End, Avis, Disney, and Ritz Carlton Hotels have well-developed quality management programs that focus on employee performance, behavior, and training. These companies design their TQM programs to treat employees well, as if they were customers. Federal Express's slogan is "People, Service, Profits," and its treatment of employees, including its no layoff policy, is viewed as a TQM model or **benchmark** that other companies try to copy. Disneyland's 12,000 park employees are treated as "cast members," and Disney's mission is to keep cast members happy so they will make customers happy.

McDonald's has a reputation for high-quality service resulting from its application of established TQM principles. Its food preparation process has been simplified into small autonomous units just as a manufacturing firm might do. It provides fresh food promptly on demand, which is essentially an inventory situation. Restaurant managers meet with customer groups on a regular basis and use questionnaires to identify quality "defects" in its operation. It monitors all phases of its process continuously from purchasing to restrooms to restaurant decor and maintenance in a total quality approach. It empowers all employees to make spot decisions to dispose of unfresh food or to speed service. The McDonald's work force is flexible so that changes in customer traffic and demand can be met promptly by moving employees to different tasks. Food is sampled regularly for taste and freshness. Extensive use is made of information technology for scheduling, cash register operation, food inventory, cooking procedures, and food assembly processes--all with the objective of faster service. All of these quality improvement procedures are standard and similar to quality improvement techniques that could be found in a manufacturing firm.

McDonald's is the largest food service retailer in the world with more than 18,000 locations in 91 countries, including the McDonald's shown here in Tokyo. System-wide sales for McDonald's was almost $30 billion in 1995. McDonald's goal is to dominate the global food service industry by setting performance standards for customer satisfaction, convenience, and value. Fast-food restaurants are generally recognized as having high quality standards in terms of cleanliness and service, and McDonald's is recognized as a quality leader in the industry. All phases of the food preparation and delivery process are closely monitored for quality. Food items are expected to be of the highest quality and fresh, and employees are expected to be well-trained, efficient, knowledgeable, helpful, and friendly. Restaurant managers meet with customer groups and use customer questionnaires to monitor quality and identify weaknesses and areas of improvement, and food items are sampled (tasted) on a regular basis to insure quality. Employee training emphasizes the customer first and the method of doing a job second and employees are trained to do different jobs so they can fill in as needed to maintain quick service. Employees have the freedom to make decisions such as replacing food items for customers in order to insure customer satisfaction. McDonald's embodies a commitment to total quality management as organized, pervasive and focused as any manufacturing company.

THE COMPETITIVE EDGE

Quality Management at Kentucky Fried Chicken

Kentucky Fried Chicken (KFC) Corporation, USA, includes 2,000 company-owned and 3,000 franchised restaurants with annual sales exceeding $3 billion from more

than 600 million customers. The fast-food restaurant industry is very competitive. Quick, high-quality service is essential to maintain and increase market share. KFC measures quality at its restaurants using two programs: a quality, service, and cleanliness (QSC) program for evaluating service from a customer's perspective; and an operations facility review (OFR) program for measuring process implementation relative to specifications. To measure its performance against other companies, KFC uses customer and market surveys. In the QSC program, independent "mystery shoppers" are hired to evaluate each restaurant twice a month. In the OFR program, KFC uses in-house specially trained evaluators.

Declining profit margin in its South Central (Oklahoma and Texas) division resulted in a major quality improvement project whose objective was to improve service time for the drive-through window (DTW) operations at four test restaurants. Speed is the most important dimension of service quality in this type of operation. The quality project team set a goal to reduce service speed at drive-in windows from over two minutes per customer to 60 seconds--considered an unrealistic goal by KFC management. The team set short-term, incremental goals of 10-second reductions in service time until the one minute goal was realized. These short-run achievable goals helped keep employees from getting discouraged. Large, visible timers were placed at each identifiable step in the order process to help employees see if they were taking too long. It was discovered that there are three primary service components at a DTW: time at the menu board, travel time from the menu once an order has been placed to the service window, and time at the window waiting for the order and paying for it. Observations showed that 58% of total customer time was at the window, so the team concentrated on this area. Employees were provided with notebooks to identify causes for delays whenever customer service was not completed within the target time as shown by the timers. Causes of slow service were identified in the process including headset problems, being out of menu items, and poor equipment layout. Changes in the drive-in window process included improved equipment layout to eliminate wasted motion (such as putting food items and food packing in more convenient locations), streamlined menus eliminating slow-moving items, even-dollar tax-inclusive pricing to speed the payment process, more extensive use of headsets, clearer signs for customers to read easily, more rigorous employee training, and, most important, the continued use of the timers as a constant reminder that customers were waiting. Within 10 months the 60-second service goal was achieved at the test restaurants--and profit margin increased from 5 to 9 percent, customer orders increased by almost 30 percent, sales volume increased by 17.5 percent, and labor productivity measured as drive-in window transactions per labor hour increased by 12.3 percent. In the past two years more than 1,300 franchised KFC restaurants have adopted all or part of the test team's quality-improvement program for drive-through window operations.

Source: U. M. Apte and C. Reynolds "Quality Management at Kentucky Fried Chicken," *Interfaces* 25, no. 3 (1995): 6-21.

Service industries like fast-food restaurants, airlines, entertainment, and hotel lodging are extremely competitive. Companies in these and similar industries lose more customers

because either their customer service is poor or their competitors are providing better service, than for any other reason, including price.

Pause and Reflect

***3-15.** TQM is also widespread in government. Read about TQM at NASA and at Langley Research Center. Find at least one other site that describes how TQM has been applied in government. Write a summary of your findings.

3-16. Select a service company or organization and discuss the dimensions of quality that a customer might evaluate it on.

3-17. Select two competing service companies that you are familiar with or can visit, such as fast-food restaurants, banks, or retail stores, and compare how they interact with customers in terms of quality.

These exercises require a direct link to a specific Web site. Click **Internet Exercises for the list of internet links for these exercises.*

The Cost of Quality

Quality costs fall into two categories, the cost of achieving good quality, also known as the *cost of quality assurance,* and the cost associated with poor-quality products, also referred to as the *cost of not conforming* to specifications.

The Cost of Achieving Good Quality

The costs of a quality management program are *prevention costs* and *appraisal costs.* **Prevention costs** are the costs of trying to prevent poor-quality products from reaching the customer. Prevention reflects the quality philosophy of "do it right the first time," the ultimate goal of a quality management program. Examples of prevention costs include the following:

> *Quality planning costs:* The costs of developing and implementing the quality management program.
> *Product design costs:* The costs of designing products with quality characteristics.
> *Process costs:* The costs expended to make sure the productive process conforms to quality specifications.
> *Training costs:* The costs of developing and putting on quality training programs for employees and management.
> *Information costs:* The costs of acquiring and maintaining (typically on computers) data related to quality, and the development and analysis of reports on quality performance.

Appraisal costs are the costs of measuring, testing, and analyzing materials, parts, products, and the productive process to ensure that product quality specifications are being met. Examples of appraisal costs include the following:

Inspection and testing: The costs of testing and inspecting materials, parts, and the product at various stages and at the end of the process.
Test equipment costs: The costs of maintaining equipment used in testing the quality characteristics of products.
Operator costs: The costs of the time spent by operators to gather data for testing product quality, to make equipment adjustments to maintain quality, and to stop work to assess quality.

In a service organization appraisal costs tend to be higher than in a manufacturing company and, therefore, are a greater proportion of total quality costs. Quality in services is related primarily to the interaction between an employee and a customer, which makes the cost of appraising quality more difficult. Quality appraisal in a manufacturing operation can take place almost exclusively in-house; appraisal of service quality usually requires customer interviews, surveys, questionnaires, and the like.

The Cost of Poor Quality

Costs associated with poor quality are also referred to as the cost of nonconformance, or failure costs. The cost of failures is the difference between what it actually costs to produce a product or deliver a service and what it would cost if there were no failures. This is generally the largest quality cost category in a company, frequently accounting for 70 percent to 90 percent of total quality costs. This is where the greatest cost improvement is possible.

The cost of poor quality can be categorized as *internal failure costs* or *external failure costs.* **Internal failure costs** are incurred when poor-quality products are discovered before they are delivered to the customer. Examples of internal failure costs include the following:

Scrap costs: The costs of poor-quality products that must be discarded, including labor, material, and indirect costs.
Rework costs: The costs of fixing defective products to conform to quality specifications.
Process failure costs: The costs of determining why the production process is producing poor-quality products.
Process downtime costs: The costs of shutting down the productive process to fix the problem.
Price-downgrading costs: The costs of discounting poor-quality products--that is, selling products as "seconds."

External failure costs are incurred after the customer has received a poor-quality product and are primarily related to customer service. Examples of external failure costs include the following:

Customer complaint costs: The costs of investigating and satisfactorily responding to a customer complaint resulting from a poor-quality product.
Product return costs: The costs of handling and replacing poor-quality products returned by the customer.
Warranty claims costs: The costs of complying with product warranties.
Product liability costs: The litigation costs resulting from product liability and customer injury.

Lost sales costs: The costs incurred because customers are dissatisfied with poor-quality products and do not make additional purchases.

Internal failure costs tend to be low for a service, while external failure costs can be quite high. A service organization has little opportunity to examine and correct a defective internal process, usually an employee-customer interaction, before it actually happens. At that point it becomes an external failure. External failures typically result in an increase in service time or inconvenience for the customer. Examples of external failures include a customer waiting to place a catalog phone order; a catalog order that arrives with the wrong item, requiring the customer to repackage and send it back; an error in a charge card billing statement, requiring the customer to make phone calls or write letters to correct it; not sending a customer's orders or statements to the correct address; or an overnight mail package that does not arrive overnight.

Measuring and Reporting Quality Costs

Collecting data on quality costs can be difficult. The costs of lost sales, of responding to customer complaints, of process downtime, of operator testing, of quality information, and of quality planning and product design are all costs that may be difficult to measure. These costs must be estimated by management. Training costs, inspection and testing costs, scrap costs, the cost of product downgrading, product return costs, warranty claims, and liability costs can usually be measured. Many of these costs are collected as part of normal accounting procedures.

Management wants quality costs reported in a manner that can be easily interpreted and is meaningful. One format for reporting quality costs is with **index numbers,** or **indices.** Index numbers are ratios that measure quality costs relative to some base value, such as the ratio of quality costs to total sales revenue or the ratio of quality costs to units of final product. These index numbers are used to compare quality management efforts between time periods or between departments or functions. Index numbers themselves do not provide very much information about the effectiveness of a quality management program. They usually will not show directly that a company is producing good- or poor-quality products. These measures are informative only when they are compared to some standard or other index. Some common index measures are:

Labor index: The ratio of quality cost to direct labor hours; it has the advantage of being easily computed (from accounting records) and easily understood, but it is not always effective for long-term comparative analysis when technological advances reduce labor usage.

Cost index: The ratio of quality cost to manufacturing cost (direct and indirect cost); it is easy to compute from accounting records and is not affected by technological change.

Sales index: The ratio of quality cost to sales; it is easily computed, but it can be distorted by changes in selling price and costs.

Production index: The ratio of quality cost to units of final product; it is easy to compute from accounting records but is not effective if a number of different products exist.

The following example illustrates several of these index numbers.

EXAMPLE 3.1 An Evaluation of Quality Costs and Quality Index Numbers

The H&S Motor Company produces small motors (e.g. 3hp,) for use in lawnmowers and garden equipment. The company instituted a quality management program in 1996 and has recorded the following quality cost data and accounting measures for four years.

	YEAR			
	1996	*1997*	*1998*	*1999*
Quality Costs				
Prevention	$ 27,000	41,500	74,600	112,300
Appraisal	155,000	122,500	113,400	107,000
Internal failure	386,400	469,200	347,800	219,100
External failure	242,000	196,000	103,500	106,000
Total	$810,400	829,200	639,300	544,400
Accounting Measures				
Sales	$4,360,000	4,450,000	5,050,000	5,190,000
Manufacturing costs	1,760,000	1,810,000	1,880,000	1,890,000

The company wants to assess its quality assurance program and develop quality index numbers using sales and manufacturing cost bases for the four-year period.

SOLUTION:

The H&S Company experienced many of the typical outcomes when its quality assurance program was instituted. Approximately 78 percent of H&S's total quality costs are a result of internal and external failures, not unlike many companies. Failure costs frequently contribute 50 to 90 percent of overall quality costs. The typical reaction to high failure costs is to increase product monitoring and inspection to eliminate poor-quality products resulting in high appraisal costs. This appeared to be the strategy employed by H&S when its quality management program was initiated in 1996. In 1997 H&S was able to identify more defective items, resulting in an apparent increase in internal failure costs and lower external failure costs (as fewer defective products reached the customer).

During 1996 and 1997 prevention costs were modest. However, prevention is critical in reducing both internal and external failures. By instituting quality training programs, redesigning the production process, and planning how to build in product quality, companies are able to reduce poor-quality products within the production process and prevent them from reaching the customer. This was the case at H&S, because prevention costs increased by more than 300 percent during the four-year period. Since fewer poor-quality products are being made, less monitoring and inspection is necessary, and appraisal costs thus decline. Internal and external failure costs are also reduced because of a reduction in defective products. In general, an increase in expenditures for prevention will result in a decrease in all other quality-cost categories. It is also not uncommon for a quality management program to isolate one or two specific quality problems that, when prevented, have a large impact on overall quality cost reduction. Quality problems are not usually evenly

distributed throughout the product process; a few isolated problems tend to result in the majority of poor-quality products.

The H&S Company also desired to develop index numbers using quality costs as a proportion of sales and manufacturing costs, generally two of the more popular quality indexes. The general formula for these index numbers is

$$\text{Quality index} = \frac{\text{total quality costs}}{\text{base}}(100)$$

For example, the index number for 1996 sales is

$$\text{Quality cost per sale} = \frac{\$810,400(100)}{1,360,000}$$
$$= 18.58$$

The quality index numbers for sales and manufacturing costs for the four-year period are given in the following table.

Year	Quality Sales Index	Quality Manufacturing Cost Index
1996	18.58	46.04
1997	18.63	45.18
1998	12.66	34.00
1999	10.49	28.80

These index numbers alone provide little insight into the effectiveness of the quality management program; however, as a standard to make comparisons over time they can be useful. The H&S Company quality index numbers reflect dramatically improved quality during the four-year period. Quality costs as a proportion of both sales and manufacturing costs improved significantly. Quality index numbers do not provide information that will enable the company to diagnose and correct quality problems in the production process. They are useful in showing trends in product quality over time and reflecting the impact of product quality relative to accounting measures with which managers are usually familiar.

The Quality-Cost Relationship

In Example 3.1 we showed that when the sum of prevention and appraisal costs increased, internal and external failure costs decreased. Recall that prevention and appraisal costs are costs of achieving good quality, and internal and external failure costs are the costs of poor quality. In general, when the cost of achieving good quality increases, the cost of poor quality declines.

U.S. and foreign companies committed to TQM believe that the increase in sales and market share resulting from increased consumer confidence in the quality of their products offsets the higher costs of achieving good quality. Further, as a company focuses on good quality, the cost of achieving good quality will be less because of the innovations in technologies,

processes, and work methods that will result from the quality-improvement effort. These companies frequently seek to achieve 100 percent quality and *zero defects.*

The Japanese first recognized that the costs of poor quality had been traditionally underestimated. These costs did not take into account the customer losses that can be attributed to a reputation for poor quality. Costs of poor quality were hard to quantify, so they were ignored. The Japanese viewed the cost associated with a reputation for poor quality to be quite high. The traditional quality-cost relationship does not reflect the total impact of an effective quality management program on a company's performance. A General Accounting Office report on companies that were Baldrige Quality Award finalists has shown that corporate-wide quality-improvement programs result in higher worker motivation, improved employee relations, increased productivity, higher customer satisfaction, and increased market share and profitability.[4]

Another reason for Japanese success has been their commitment to achieving quality at minimum cost. One way they have done this is to focus more on improving the capabilities and training of employees, getting them more involved in preventing poor quality and focusing less on "engineering" solutions. The Japanese have also concentrated on improving quality at the new product development stage instead of trying to build in quality during the production process for products already developed. This tends to reduce appraisal costs. Finally, the Japanese recognized that if they provided higher-quality products, they could charge higher prices. The traditional view of quality costs implied that a "satisfactory" quality level was optimal because higher levels of quality would require prices higher than the customer would be willing to pay to offset the higher costs. The Japanese showed that this was not the case; in fact, they created a market for higher quality, for which consumers were willing to pay.

The Bottom Line--Profitability

Quality improvement, as initiated by Japanese companies, was not intended to improve profitability but to gain customer focus and be more competitive. Quality management was considered to be a longer-term commitment than simply short-run cost savings and profits. However, quality management has been around now for more than a decade, and researchers have begun to look at it to see if it has been profitable.

Some research studies suggest that quality management does not contribute to the "bottom line." A survey of 5,000 U.S. firms showed that only a third of the companies' bottom lines benefited from TQM. A similar study of 100 British companies showed an 80 percent failure rate of TQM based on profitability as a measure of success. However, such results must be observed cautiously. Many companies in these surveys implemented TQM programs without the total commitment required for their success. These studies also take a short-run view of success, failing to recognize that TQM typically results in a decline in profitability in the short run with the promise of greater financial rewards in the long run.

It is more informative to observe how companies that have demonstrated a stronger, long-term commitment to TQM have fared. A survey of 26 Japanese Deming Quality Prize-winning companies committed to TQM showed that all gained higher-than-average results for different financial performance indicators. Several surveys of Baldrige Award winners in the United States have consistently shown that their financial performance exceeds industry averages. Researchers at PIMS Associates, Inc., a subsidiary of the Strategic Planning

Institute, have found that quality "is an important determinant of business profitability," and that "quality is positively and significantly related to a higher return on investment" among 1,200 companies it studied.[5] In his book *Quality Is Free,* quality pioneer Philip Crosby states that, "Quality is not only free, it is an honest-to-everything profit maker. . . ."[6] Gary L. Tooker, CEO and vice chairman of Motorola, in response to the question, "Is there a link between quality and profitability?" responded that, "We've saved several billion dollars over the last year because of our focus on quality improvement and the six sigma initiative. . . . there is no doubt about the fact that it has enhanced our bottom line."[7]

THE COMPETITIVE EDGE

Providing Quick Service at Taco Bell

Taco Bell, an international fast-food chain owned by PepsiCo, Inc., has more than 6,500 owned, licensed and franchised locations in the United States and around the world with annual sales of approximately $4.6 billion. In the fast-food business the operating objective is, in general, to provide quality food with good service in a clean environment. Although Taco Bell sees these three attributes (food, service, and environment) as equally important, good service, as measured by speed of service, has the greatest impact on its revenues.

The three-hour lunch period from 11:00 am to 2:00 pm accounts for approximately 52 percent of Taco Bell's daily sales. Most fast-food restaurants have waiting lines during this period, thus speed of service determines sales capacity. If service time decreases, sales capacity increases and vice versa. However, as speed of service increases labor costs also increase. Products must be prepared when they are ordered (since very few menu items can be produced in advance and inventoried) making food preparation very labor intensive. Thus, speed of service depends on labor availability.

Taco Bell research studies showed that when a customer is in line up to five minutes their perception is that waiting time is only a couple of minutes, however, after waiting time exceeds five minutes, customer perception of how long they have been waiting increases exponentially. The higher the perceived waiting time the more likely the customer is to leave the restaurant without ordering. The company determined that a three-minute average waiting time would result in only 2.5 percent of waiting customers leaving. The company believed this was an acceptable level of customer attrition, and it established this waiting time as its service goal. In order to achieve this service goal Taco Bell developed a labor-management system to forecast customer traffic for every fifteen-minute interval during the day and to schedule employees accordingly to meet customer demand.

Source: J. Hueter and W. Swart "An Integrated Labor-Management System for Taco Bell," *Interfaces* 28, no. 1 (January-February 1998): 75-91.

This is only the tip of a mountain of conclusive evidence that *in the long run* quality improvement and profitability are closely related. As quality improves, the costs associated with poor quality decline. Quality improvements result in increased productivity. As the quality of a company's products or services improve, it becomes more competitive and its market share increases. Customers' perception of a company's products as being of high quality and its competitive posture enables the company to charge higher prices. Taken together, these things result in higher long-run profitability.

Pause and Reflect

3-18. Define the two major categories of quality cost and how they relate to each other.

3-19. A defense contractor manufacturers rifles for the military. The military has exacting quality standards that the contractor must meet. The military is very pleased with the quality of the products provided by the contractor and rarely has to return products or has reason for complaint. However, the contractor is experiencing extremely high quality-related costs. Speculate on the reasons for the contractor's high quality-related costs.

3-20. Explain how the Japanese perspective on the cost of quality originally differed from the traditional American perspective.

3-21. The Aurora Electronics Company has been receiving a lot of customer complaints and returns of a front-loading VCR that it manufactures. When a video-tape is pushed into the loading mechanism, it can stick inside with the door open; the recorder cannot run, and it is difficult to get the tape out. Consumers will try to pull the tape out with their fingers or pry the tape out with an object such as a knife, pencil, or screwdriver, frequently damaging the VCR, tearing up the tape cartridge, or hurting themselves. What are the different costs of poor quality and costs of quality assurance that might be associated with this quality problem?

3-22. AMERICARD, a national credit card company, has a toll-free, 24-hour customer service number. Describe the input for this system function and the final product. What quality-related costs might be associated with this function, and how might a quality management program impact on this area?

3-23. A number of quality management philosophies hold that prevention costs are the most critical quality-related costs. Explain the logic behind this premise.

3-24. Why is it important for companies to measure and report quality costs?

3-25. What is the difference between internal and external failure costs?

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[4] Robert E. Cole, "The Quality Revolution," *Production and Operations Management* 1, no. 1 (1992): 118-20.

[5] James R. Evans and William M. Lindsay, *The Management and Control of Quality,* 3d ed. (St. Paul, Minn.: West, 1996), p. 18.

[6] Philip Crosby, *Quality Is Free* (New York: McGraw-Hill, 1979).

[7] K. Bemowski, "Motorola's Fountain of Youth, *Quality Progress* 28, no. 10 (October 1995): 29-31.

The Effect of Quality Management on Productivity

In the previous section we saw how an effective quality management program can help to reduce quality-related costs and improve market share and profitability. Quality management can also improve productivity--the number of units produced from available resources.

Productivity

Productivity is a measure of a company's effectiveness in converting inputs into outputs. It is broadly defined as,

$$\text{Productivity} = \frac{\text{output}}{\text{input}}$$

An output is the final product from a service or production process, such as an automobile, a hamburger, a sale, or a catalog order. Inputs are the parts, material, labor, capital, and so on that go into the productive process. Productivity measures, depending on the outputs and inputs used, are labor productivity (output per labor-hour) and machine productivity (output per machine-hour).

Improving quality by reducing defects will increase good output and reduce inputs. In fact, virtually all aspects of quality improvement have a favorable impact on different measures of productivity. Improving product design and production processes, improving the quality of materials and parts, and improving job designs and work activity will all increase productivity.

Measuring Product Yield and Productivity

Product **yield** is a measure of output used as an indicator of productivity. It can be computed for the entire production process (or for one stage in the process) as follows:

$$\text{Yield} = (\text{total input})(\%\ \text{good units}) + (\text{total input})(1 - \%\ \text{good units})(\%\ \text{reworked})$$

or

$$Y = (I)(\%G) + (I)(1 - \%G)(\%R)$$

where

I = planned number units of product started in the production process

$\%G$ = percentage of good units produced

$\%R$ = percentage of defective units that are successfully reworked

In this formula, yield is the sum of the percentage of products started in the process (or at a stage) that will turn out to be good quality plus the percentage of the defective (rejected)

products that are reworked. Any increase in the percentage of good products through improved quality will increase product yield.

EXAMPLE 3.2 Computing Product Yield

The H&S Motor Company starts production for a particular type of motor with a steel motor housing. The production process begins with 100 motors each day. The percentage of good motors produced each day averages 80 percent and the percentage of poor-quality motors that can be reworked is 50 percent. The company wants to know the daily product yield and the effect on productivity if the daily percentage of good-quality motors is increased to 90 percent.

SOLUTION:

$$\text{Yield} = (I)(\%G) + (I)(1 - \%G)(\%R)$$
$$Y = 100(0.80) + 100(1 - 0.80)(0.50)$$
$$= 90 \text{ motors}$$

If product quality is increased to 90 percent good motors, the yield will be

$$Y = 100(0.90) + 100(1 - 0.90)(0.50)$$
$$= 95 \text{ motors}$$

A 10 percentage-point increase in quality products results in a 5.5 percent increase in productivity output.

Now we will expand our discussion of productivity to include product manufacturing cost. The manufacturing cost per (good) product is computed by dividing the sum of total direct manufacturing cost and total cost for all reworked units by the yield, as follows:

$$\text{Product cost} = \frac{(\text{direct manufacturing cost per unit})(\text{input}) + (\text{rework cost per unit})(\text{reworked units})}{\text{yield}}$$

or

$$\text{Product cost} = \frac{(K_d)(I) + (K_r)(R)}{Y}$$

where

K_d = direct manufacturing cost per unit
I = input
K_r = rework cost per unit
R = reworked units
Y = yield

EXAMPLE 3.3 — Computing Product Cost Per Unit

The H&S Motor Company has a direct manufacturing cost per unit of $30, and motors that are of inferior quality can be reworked for $12 per unit. From Example 3.2, 100 motors are produced daily, 80 percent (on average) are of good quality and 20 percent are defective. Of the defective motors, half can be reworked to yield good-quality products. Through its quality management program, the company has discovered a problem in its production process that, when corrected (at a minimum cost), will increase the good-quality products to 90 percent. The company wants to assess the impact on the direct cost per unit of improvement in product quality.

SOLUTION:

The original manufacturing cost per motor is

$$\text{Product cost} = \frac{(K_d)(I) + (K_r)(R)}{Y}$$

$$\text{Product cost} = \frac{(\$30)(100) + (\$12)(10}{90 \text{ motors}}$$

$$= \$34.67 \text{ per motor}$$

The manufacturing cost per motor with the quality improvement is

$$\text{Product cost} = \frac{(\$30)(100) + (\$12)(5)}{95 \text{ motors}}$$

$$\text{Product cost} = \$32.21 \text{ per motor}$$

The improvement in the production process as a result of the quality management program will result in a decrease of $2.46 per unit, or 7.1 percent, in direct manufacturing cost per unit as well as a 5.5 percent increase in product yield (computed in Example 3.2) with a minimal investment in labor, plant, or equipment.

In Examples 3.2 and 3.3 we determined productivity measures for a single production process. However, it is more likely that product quality would be monitored throughout the production process at various stages. Each stage would result in a portion of good-quality, "work-in-process" products. For a production process with n stages, the yield, Y (without reworking), is,

$$Y = (I)(\%g_1)(\%g_2)\cdots(\%g_n)$$

where

I = input of items to the production process that will result in finished products

g_i = good-quality, work-in-process products at stage i

EXAMPLE 3.4 Computing Product Yield for a Multistage Process

At the H&S Motor Company, motors are produced in a four-stage process. Motors are inspected following each stage with percentage yields (on average) of good quality in-process units as follows.

Stage	Average Percentage Good Quality
1	0.93
2	0.95
3	0.97
4	0.92

The company wants to know the daily product yield for product input of 100 units per day. Further, it would like to know how many input units it would have to start with each day to result in a final daily yield of 100 good quality units.

SOLUTION:

$$\begin{aligned} Y &= (I)(\%_{g1})(\%_{g2})(\%_{g3})(\%_{g4}) \\ &= (100)(0.93)(0.95)(0.97)(0.92) \\ Y &= 78.8 \text{ motors} \end{aligned}$$

Thus, the production process has a daily good-quality product yield of 78.8 motors.

To determine the product input that would be required to achieve a product yield of 100 motors, I is treated as a decision variable when Y equals 100:

$$\begin{aligned} I &= \frac{Y}{(\%_{g1})(\%_{g2})(\%_{g3})(\%_{g4})} \\ I &= \frac{100}{(0.93)(0.95)(0.97)(0.92)} \\ &= 126.8 \text{ motors} \end{aligned}$$

To achieve output of 100 good-quality motors, the production process must start with approximately 127 motors.

The Quality-Productivity Ratio

Another measure of the effect of quality on productivity combines the concepts of quality index numbers and product yield. Called the **quality-productivity ratio** (QPR),[8] it is computed as follows:

$$\text{QPR} = \frac{\text{good - quality units}}{(\text{input})(\text{processing cost}) + (\text{defective units})(\text{rework cost})}(100)$$

This is actually a quality index number that includes productivity and quality costs. The QPR increases if either processing cost or rework costs or both decrease. It increases if more good-quality units are produced relative to total product input (i.e., the number of units that begin the production process).

EXAMPLE 3.5 Computing the Quality-Productivity Ratio (QPR)

The H&S Motor Company produces small motors at a processing cost of $30 per unit. Defective motors can be reworked at a cost of $12 each. The company produces 100 motors per day and averages 80 percent good-quality motors, resulting in 20 percent defects, 50% of which can be reworked prior to shipping to customers. The company wants to examine the effects of (1) increasing the production rate to 200 motors per day; (2) reducing the processing cost to $26 and the rework cost to $10; (3) increasing through quality improvement the product yield of good-quality products to 95 percent; and (4) the combination of 2 and 3.

SOLUTION:

The QPR for the base case is computed as follows.

$$QPR = \frac{80 + 10}{(100)(\$30) + (10)(\$12)}(100)$$
$$= 2.89$$

Case 1. Increase input to production capacity of 200 units.

$$QPR = \frac{160 + 20}{(200)(\$30) + (20)(\$12)}(100)$$
$$= 2.89$$

Increasing production capacity alone has no effect on the QPR; it remains the same as the base case.

Case 2. Reduce processing cost to $26 and rework cost to $10.

$$QPR = \frac{80 + 10}{(100)(\$26) + (10)(\$10)}(100)$$
$$= 3.33$$

These cost decreases caused the QPR to increase.

Case 3. Increase initial good-quality units to 95 percent.

$$QPR = \frac{95 + 2.5}{(100)(\$30) + (2.5)(\$12)}(100)$$
$$= 3.22$$

Again, the QPR increases as product quality improves.

Case 4. Decrease costs and increase initial good-quality units.

$$QPR = \frac{95 + 2.5}{(100)(\$26) + (2.5)(\$10)}(100)$$
$$= 3.71$$

The largest increase in the QPR results from decreasing costs and increasing initial good-quality product through improved quality.

Indirect Productivity Gains

We have shown how quality improvement can have a direct impact on productivity. However, we focused on the effect of fewer defective items, less scrap, and less rework on productivity. There are also quality improvements that indirectly increase productivity. For example, the increased output achieved from process improvements can result in increased productivity. In general, any quality improvements or improved designs that enhance the workplace, remove congestion, and work to smooth out and speed up the productive process increase output, which improves productivity. A recent study has shown that the indirect productivity gains from quality improvements may outweigh the direct ones by a factor of two or three.[9] If companies focus on the usual productivity measures they may underestimate the extent of productivity gains that can be achieved from quality improvement.

Pause and Reflect

3-26. Discuss how a quality management program can affect productivity.

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[8] E. E. Adam, J. E. Hershauer, and W. A. Ruch, *Productivity and Quality: Measurement as a Basis of Improvement,* 2d ed. (Columbia, Mo.: Research Center, College of Business and Public Administration, University of Missouri, 1986).

[9] C. D. Ittner, "An Examination of the Indirect Productivity Gains from Quality Improvement," *Production and Operations Management* 3, no. 3 (summer 1994): 153-70.

Quality Improvement and the Role of Employees

To achieve high quality, it is absolutely necessary that management and employees cooperate and that each have an equally strong commitment to quality. Cooperation and commitment are not possible when management "dictates" quality to employees. Cooperation in a quality

management program is achieved when employees are allowed to participate in the quality management process--that is, when they are given a voice.

When employees are directly involved in the quality management process it is referred to as **participative problem solving.** Employee participation in identifying and solving quality problems has been shown to be effective in improving quality, increasing employee satisfaction and morale, improving job skills, reducing job turnover and absenteeism, and increasing productivity.

Mickey Mouse is not just a costumed character at the various Disney parks in the United States and abroad; he is a host who represents all the other costumed hosts and hostesses to Disney's thousands of "guests" each day. Every employee at a Disney park from janitors to Mickey has undergone extensive training to provide quality service to Disney's guests.

Participative problem solving is usually within an *employee-involvement* (EI) program, with a team approach. We will look at some of these programs for involving employees in quality management, beginning with quality circles and process improvement teams.

Quality Circles and Process Improvement Teams

One of the first team-based approaches to quality improvement was quality circles. Called quality control circles in Japan when they originated during the 1960s, they were introduced in the United States in the 1970s. A **quality circle** is a small, voluntary group of employees and their supervisor(s), comprising a team of about eight to ten members from the same work area or department. The supervisor is typically the circle moderator, promoting group discussion but not directing the group or making decisions; decisions result from group consensus. A circle meets about once a week during company time in a room designated especially for that purpose, where the team works on problems and projects of their own choice. These problems may not always relate to quality issues; instead, they focus on productivity, costs, safety, or other work-related issues in the circle's area. Quality circles follow an established procedure for identifying, analyzing, and solving quality-related (or other) problems. Figure 3.3 is a graphical representation of the quality circle process.

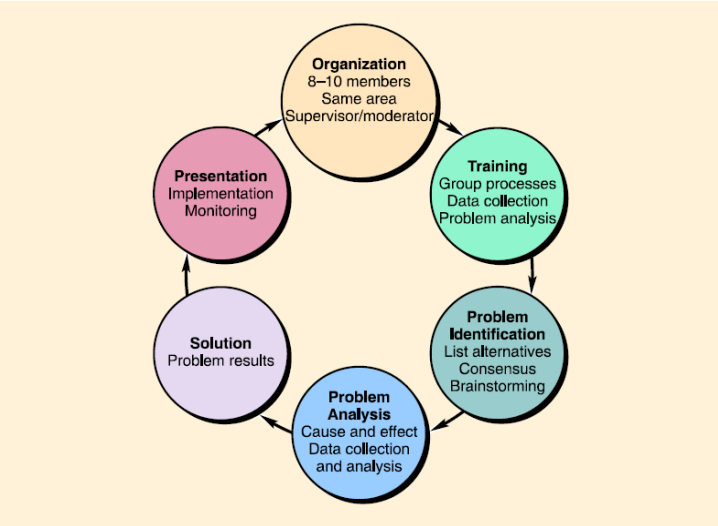


FIGURE 3.3 The Quality Circle Process

A group technique for identifying and solving problems is *brainstorming* to generate ideas. Free expression is encouraged, and criticism is not allowed. Only after brainstorming is completed are ideas evaluated.

THE COMPETITIVE EDGE

Employee Quality Awareness at Disneyland

For 36 years Disneyland (of California) has maintained a reputation of exceptional quality. It has achieved this valued reputation by focusing on customer satisfaction and by an almost fanatical attention to detail. Employees, or "cast members," are especially important in the Disney quality effort. Disneyland has more than 12,000 cast members in more than 400 different roles (not simply jobs). Each cast member is considered to be a host or hostess to the park's guests (not just customers). Disney hiring and training programs are thorough and extensive, emphasizing the nature of the business, the Disney product, and how the employee's role contributes to the product. Training includes basic communication skills for interacting with other cast members and park guests. Focus groups of cast members meet regularly to assess the effectiveness of training programs, and cast members are regularly surveyed on issues such as training, wages, and management, from which action plans are developed. All Disneyland cast members have a strong quality awareness perspective and participate in routine maintenance. Cast members can point out any problem or item that needs attention. All cast members, from janitors to stage performers, learn that their jobs are important to overall quality and performance. The mission of Disneyland cast members is to create happiness, and this mission has been accomplished because Disney management attempts to make them happy.

Source: Based on B. Stratton "How Disneyland Works," *Quality Progress* 24, no. 7 (1991): 17-30.

Quality circle members are trained to conduct meetings and address problems as a group, as well as to collect data and analyze problems. When needed, outside technical and managerial assistance is available to the circle. The circle sometimes includes an advisor, who provides guidance but is not a team member.

Quality circles have been very successful in Japan. Their development has been credited to Dr. Kaoru Ishikawa of the University of Tokyo, who adapted many of the approaches to quality promoted by W. Edwards Deming and Joseph Juran. It is estimated that approximately 10 million Japanese workers and supervisors have participated in quality circles, and several million projects have been undertaken, with an average return of several thousand dollars each since their inception in the 1960s.

The popularity of quality circles achieved in Japan has not been duplicated in the United States. The Japanese seem to have a cultural affinity for group participation that U.S. employees and supervisors do not always share. U.S. managers have been reluctant to share any of their functional responsibilities with employees. They view the analysis and solution of problems as a part of their own job domain that should not be delegated. In addition, workers sometimes perceive themselves in an adversarial role with management and have not felt a responsibility to help managers improve quality performance.

Despite these obstacles, some U.S. firms such as Lockheed, Westinghouse, Ford, Coors, and General Electric, among others, have established successful quality circle programs.

A survey by the International Association of Quality Circles showed that the most effective quality circle programs were in larger, nonmanufacturing organizations with older, more established programs. The average net savings contributed by each circle member was estimated to be about $1,000.

Quality circles like this one at a General Electric assembly plant are part of many TQM programs. They provide an organized format for allowing workers and supervisors to work together as a team to solve operational problems and improve quality. Quality circles originated in Japan, where they have been popular and successful. They were introduced in the United States, where they have been less popular but generally no less successful. Normally a circle consists of eight to ten members who meet once a week to address problems and projects of their own choosing. They frequently make use of various techniques and tools for identifying causes of quality problems including brainstorming, Pareto charts, fish bone diagrams, process control charts, scatter diagrams, check sheets, and histograms.

Process improvement teams, also called quality improvement teams (QIT), reflect the recent management trend of focusing attention on business processes rather than separate company functions. It was noted previously that quality circles are generally composed of employees and supervisors from the same work area or department, whereas process improvement teams reflect a broader approach. A process improvement team would include members from the various interrelated functions or departments that constitute a process. For example, a process improvement team for customer service might include members from distribution, packaging, manufacturing and human resources. A key objective of a process improvement team is to understand the process the team is addressing in terms of how all the parts (functions and departments) work together. The process is then measured and evaluated, with the goal of improving the process to make it more efficient and the product or service better. A key tool in helping the team understand how the process works is a *process flowchart,* a quality improvement tool we will discuss in greater detail in the section "Identifying Quality Problems and Causes."

Employee Suggestions

The simple suggestion box is an example of a way to include employees in quality improvement as individuals, not as part of a group. A key to any type of employee suggestion program is a strong commitment and reinforcement from management at all levels. Equally important, operators must be sufficiently trained to identify quality problems so that they can make good suggestions. The suggestion box alone is not sufficient to achieve active employee involvement in quality management. A structured program is required that provides a convenient means for making quality suggestions, a commitment from management, and a reward structure. However, some companies view suggestion boxes as a hindrance to quality improvement because they inhibit direct communication between employees and management. Nevertheless, many U.S. companies and organizations have achieved some degree of employee involvement through suggestion programs for a number of years; in lieu of group participative programs, they are an effective alternative.

THE COMPETITIVE EDGE

Employee Suggestions at Johnson Controls Inc.

Johnson Controls Inc.'s FoaMech auto-parts factory in Georgetown, Kentucky, is a key supplier to Toyota Motors' auto-assembly plant also in Georgetown. In 1995 the 230 employees at Johnson Controls made 631 suggestions, 221 of which were implemented. Workers, as individuals or as part of teams, who submit successful suggestions improve their chances for group bonuses and individual awards such as large-screen TVs. In one instance a machine operator, who was also a team leader, found it difficult to locate maintenance specialists when machines on her team went down. The factory noise prevented her from yelling out so she had to leave her machine to track down a maintenance specialist. The operator suggested an electronic display located high on the factory wall like an outfield scoreboard on which an operator could illuminate a light if his or her machine needed maintenance or supplies. This suggestion enabled maintenance specialists to quickly respond to machines that were down and resulted in a reduction in machine downtime from 9%

to 2%. In a second case, the factory shipped foam seat pads to a seat-assembly plant by stuffing them into plastic bags, putting the bags in large boxes and carrying them by forklift to the loading dock for transport. A team leader in the packaging department suggested the construction of large metal carts with shelves that the foam pads could be stacked on and then wheeled to the loading dock, loaded onto trailers, trucked to the car-seat assembly plant, and then returned. The returnable carts eliminated the need for thousands of plastic bags costing $1 apiece and saved the company an estimated $304,000 per year. Another team, noticing that workers were discarding many usable items like gloves, hoses, brass fittings, and wires as they left work, made a simple suggestion to place receptacles near the plant exits for employees to empty their pockets into. The company was able to save thousands of dollars by recovering good items from the receptacles.

Source: R. Rose "Kentucky Plant Workers Are Cranking Out Good Ideas," *The Wall Street Journal* (August 13, 1996): B1, B6.

Pause and Reflect

3-27. Consider your school (university or college) as a production system in which the final product is a graduate. For this system:

- **a.** Define quality from the producer's and customer's perspectives.
- **b.** Develop a fitness-for-use description for final product quality.
- **c.** Give examples of the cost of poor quality (internal and external failure costs) and the cost of quality assurance (prevention and appraisal) costs.
- d. Describe how quality circles might be implemented in a university setting. Do you think they would be effective?

3-28. Describe the differences between the American and Japanese business environments and cultures that make it difficult for American companies to duplicate successfully Japan's quality management programs such as quality circles.

Identifying Quality Problems and Causes

Some of the most popular techniques for identifying the causes of quality problems are Pareto charts, flowcharts, check sheets, histograms, scatter diagrams, process control charts, and cause-and-effect diagrams. These well-known tools are sometimes known as the "magnificent seven," the *"seven QC tools"* and the seven process improvement tools. We discuss each in the following sections.

Pareto Analysis

Pareto analysis is a method of identifying the causes of poor quality. It was devised in the early 1950s by the quality expert Joseph Juran. He named this method after a nineteenth century Italian economist, Vilfredo Pareto, who determined that a small percentage of the people accounted for most of the wealth. Pareto analysis is based on Juran's finding that most quality problems and costs result from only a few causes. For example, he discovered in a textile mill that almost 75 percent of all defective cloth was caused by only a few weavers, and in a paper mill he studied, more than 60 percent of the cost of poor quality was attributable to a single category of defects. Correcting the few major causes of most of the quality problems will result in the greatest cost impact.

Pareto analysis can be applied by tallying the number of defects for each of the different possible causes of poor quality in a product or service and then developing a fre-quency distribution from the data. This frequency distribution, referred to as a *Pareto diagram,* is a useful visual aid for focusing on major quality problems.

Consider a product for which the causes of poor quality have been identified as follows.

Cause	*Number of Defects*	*Percentage*
Poor design	80	64%
Wrong part dimensions	16	13
Defective parts	12	10
Incorrect machine calibration	7	6
Operator errors	4	3
Defective material	3	2
Surface abrasions	3	2
	125	100%

For each cause of poor quality, the number of defects attributed to that cause has been tallied over a period of time. This information is then converted into the Pareto chart shown in Figure 3.5.

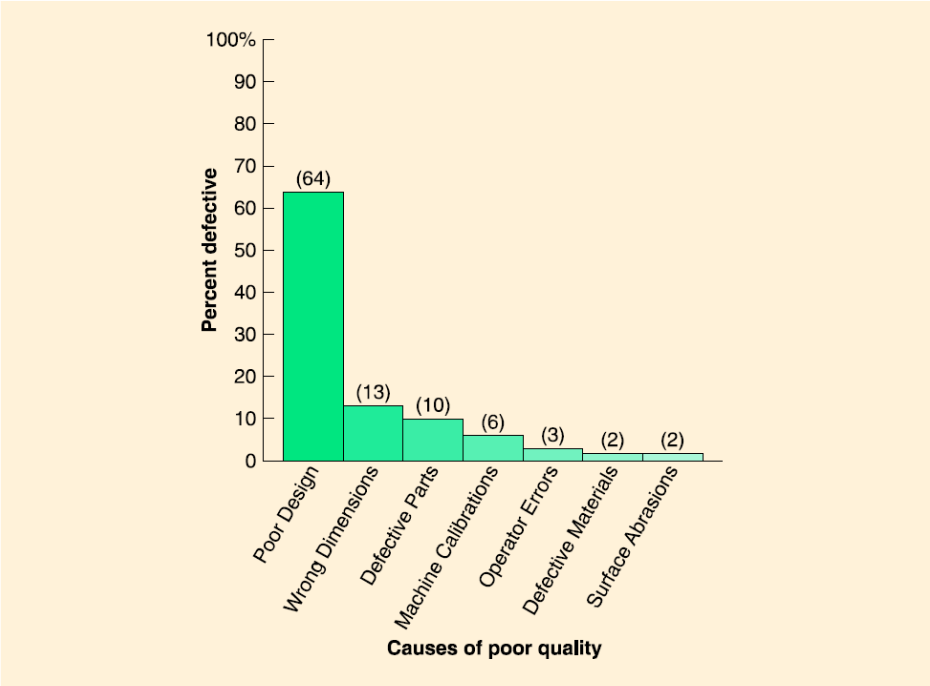


FIGURE 3.5 Pareto Chart

This Pareto chart identifies the major cause of poor quality to be poor design. Correcting the design problem will result in the greatest quality cost savings with the least expenditure. However, the other problems should not be ignored. TQM teaches us that total and continual quality improvement is the long-term goal. The Pareto diagram simply identifies the quality problems that will result in the greatest immediate impact in quality improvement.

Flowcharts

A *flowchart* or process flowchart is a diagram of the steps in a job, operation, or process. It enables everyone involved in identifying and solving quality problems to have a clear picture of how a specific operation works and a common frame of reference. It also enables a process improvement team to understand the interrelationship of the departments and functions that constitute a process. This helps focus on where problems might occur and if the process itself needs fixing. Development of the flowchart can help identify quality problems by helping the problem solvers better understand the process. Flowcharts are described in greater detail in Chapter 6 ("Process Planning and Technology Decisions") and Chapter 8 ("Human Resources in Operations Management").

Check Sheets and Histograms

Check sheets are frequently used in conjunction with histograms, as well as with Pareto diagrams. A *check sheet* is a fact-finding tool used to collect data about quality problems. A typical check sheet for quality defects tallies the number of defects for a variety of previously identified problem causes. When the check sheet is completed, the total tally of defects for each cause can be used to create a *histogram* or a Pareto chart.

Scatter Diagrams

Scatter diagrams graphically show the relationship between two variables, such as the brittleness of a piece of material and the temperature at which it is baked. One temperature reading should result in a specific degree of brittleness representing one point on the diagram. Many such points on the diagram visually show a pattern between the two variables and a relationship or lack of one. This diagram could be used to identify a particular quality problem associated with the baking process.

Process Control Charts and Statistical Quality Control

We discuss control charts and other statistical quality control methods in Chapter 4, "Statistical Quality Control." For now, it is sufficient to say that a control chart includes a horizontal line through the middle of a chart representing the process average or norm. It also has a line below this center line representing a lower control limit and a line above it for the upper control limit. Samples from the process are taken over time and measured according to some attribute. In its simplest form, if the measurement is within the two control limits, the process is said to be in control and there is no quality problem, but if the measurement is outside the limits, then a problem probably exists and should be investigated.

Statistical quality control methods such as the process control chart are important tools for quality improvement. Japanese employees at all levels, and especially in production, are

provided with extensive training in statistical quality control methods. This enables them to identify quality problems and their causes and to make suggestions for improvement.

Cause-and-Effect Diagrams

A cause-and-effect diagram, also called a "fishbone" diagram, is a graphical description of the elements of a specific quality problem and the relationship between those elements. It is used to identify the causes of a quality problem so it can be corrected. Cause-and-effect diagrams are usually developed as part of participative problem solving to help a team of employees, supervisors, and managers identify causes of quality problems. This tool is a normal part of the problem-solving activity of quality circles in Japanese companies; however, in the United States it is often used separately, outside the quality circle program.

Figure 3.6 illustrates the general structure of the cause-and-effect diagram. The "effect" box at the end of the diagram is the quality problem that needs correction. A center line connects the effect box to the major categories of possible problem causes, displayed as branches off of the center line. The box at the end of each branch (or fishbone) describes the cause category. The diagram starts out in this form with only the major categories at the end of each branch. Individual causes associated with each category are attached as separate lines along the length of the branch during the brainstorming process. Sometimes the causes are rank-ordered along the branches in order to identify those that are most likely to affect the problem. The cause-and-effect diagram is a means for thinking through a problem and recording the possible causes in an organized and easily interpretable manner. The causes listed along the branches under each category in Figure 3.6 are generic, but for a specific quality problem with an actual product, the causes would be product and problem specific.

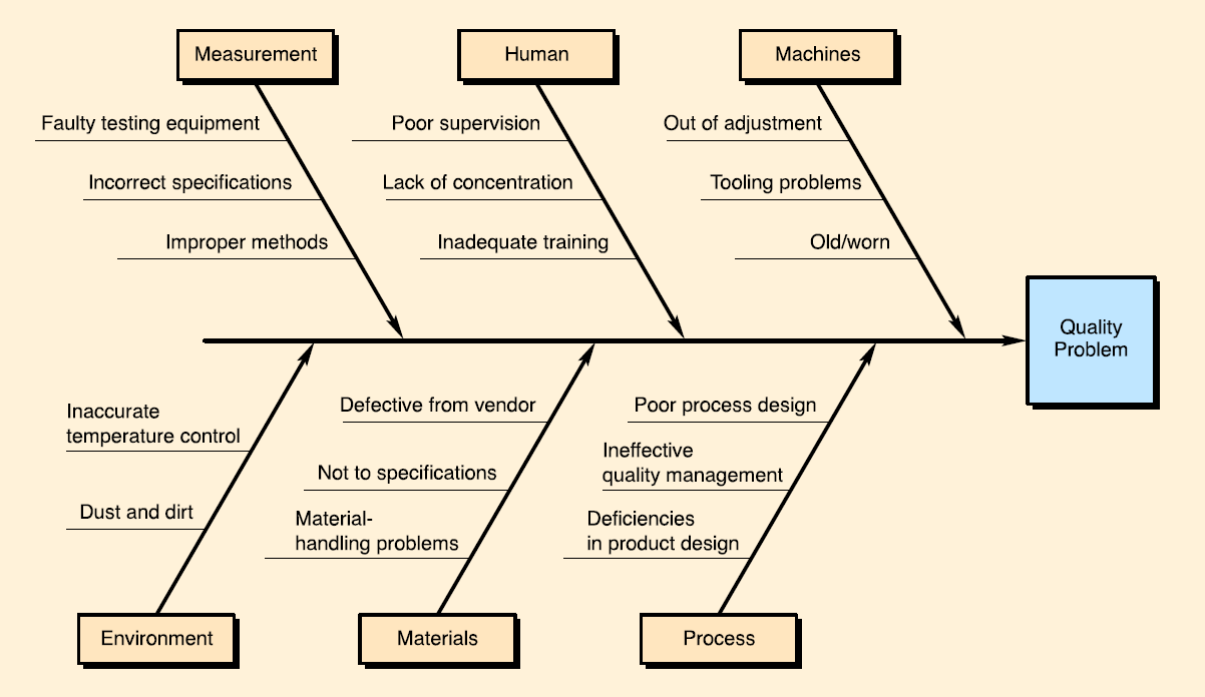


FIGURE 3.6 A General Cause-and-Effect Diagram

Pause and Reflect

***3-29.** How well do you know the tools of quality control? Review the 7 QC tools, then take a short quiz. When you pass (you're allowed multiple attempts), complete the case study of QC tools written by students at Clemson University.

***3-30.** For a look at how the seven tools are applied in the software industry, link to this case study about advanced RISC machines.

These exercises require a direct link to a specific Web site. Click **Internet Exercises for the list of internet links for these exercises.*

Quality Awards and the Competitive Spirit

The Baldrige Award, Deming Prize, and other award competitions have given American firms the impetus to commit to quality management programs because they appeal to the American competitive spirit. The Baldrige Award in America has become a valuable and coveted prize to American companies eager to benefit from the aura and reputation for quality that awaits the winners. It has also provided a widely used set of guidelines to help companies implement an effective quality management program.

The Malcolm Baldrige Award

The Malcolm Baldrige National Quality Award is given annually to one or two companies in each of three categories: manufacturing, services, and small businesses (with less than 500 full-time employees). It was created by law in 1987 (named after former Secretary of Commerce Malcolm Baldrige, who died in 1987) to (1) stimulate U.S. companies to improve quality, (2) establish criteria for businesses to use to evaluate their individual quality improvement efforts, (3) set as examples those companies that were successful in improving quality, and (4) help other U.S. organizations learn how to manage quality by disseminating information about the award winners' programs.

The award criteria focus on the soundness of the approach to quality improvement, the overall quality management program as it is implemented throughout the organization, and customer satisfaction. The seven major categories of criteria over which companies are examined are leadership, information and analysis, strategic quality planning, human resource utilization, quality assurance of products and service, quality results, and customer satisfaction.

The Baldrige Award competition has had a marked influence on those companies who have been finalists and winners. They have achieved higher productivity, better employee relations, increased market share, greater customer relations, and higher profitability. The Baldrige Award has also had a major influence on U.S. companies by promoting the need for quality improvement. Thousands of U.S. companies request applications from the government each year to obtain a copy of the award guidelines and criteria for internal use in establishing quality management programs. Many companies have made the Baldrige criteria for quality their own. Some companies have demanded that their suppliers submit applications for the

Baldrige Quality Award. Since its inception in 1987, companies that have won the Baldrige Quality Award and have become known as leaders in quality include Motorola, Xerox, Cadillac, Milliken, Federal Express, and IBM, among others. These and other Baldrige Award winners have become models or benchmarks for other companies to emulate in establishing their own TQM programs.

Other Awards for Quality

The Deming Prize was created in 1957 in Japan in honor of W. Edwards Deming to recognize organizations that "successfully apply companywide quality control based on statistical quality control." The Deming Prize is extremely prominent in Japan and, like the Baldrige Award, is highly coveted and sought after. Japanese and overseas companies can apply as well as individuals in Japan who have made outstanding contributions in statistical quality control theory, application, or popularity. The first American company to receive the Deming Prize for Overseas Companies was the Florida Power and Light Company.

The President's Award was established in 1988 to recognize federal government organizations with 500 or more employees that provide products or services to the public (except the Department of Defense). Two winners are selected annually. Past recipients include the Naval Air Systems Command and the Air Force Logistics Command. A companion prize is the Quality Improvement Prototype Award for federal organizations with at least 100 employees. Past recipients include the Equal Employment Opportunity Commission, the Norfolk Naval Shipyard, the IRS Federal Tax Deposit System, and the VA Kansas City Medical Center.

The Award for Excellence in Productivity Improvement has been provided annually since 1980 by the Institute of Industrial Engineers (IIE) to recognize companies that have achieved a competitive advantage through productivity and quality programs. The four award categories include small and large companies and manufacturing and service companies. Past winners include Anheuser-Busch, Inc., Chrysler Corporation, Black and Decker Corporate Management, the Norfolk Naval Shipyard, Ford Motor Company, and Texas Instruments (Johnson City, Tennessee).

The George M. Low trophy, NASA's Quality and Excellence Award, is awarded annually to NASA contractors, subcontractors, and suppliers demonstrating excellence in quality and productivity for three or more years. Past recipients include Thiokol Corporation and Grumman Corporation.

The European Quality Award is a European version of the Baldrige Award awarded by the European Foundation for Quality Management. The 1994 winner of this award was Design to Distribution, a British electronics firm.

Pause and Reflect

3-31. Describe the impact that the creation of the Malcolm Baldrige Award had on quality improvement in the United States.

3-32. Research several companies that have won the Malcolm Baldrige Award in the library, and describe any common characteristics that the quality management programs in those companies have.

***3-33.** Link to the Malcolm Baldrige Award web site. What are the award criteria? Do the criteria change over time? Describe the award process. How would a company apply for the award? How are the winners chosen? Who are the most recent winners? Choose one company from each category of the winner 's showcase to read about in more detail. What did each company do particularly well to win the award? What did all the winners have in common?

***3-34.** Link to the European Quality Award web site. How does this award differ from the Malcolm Baldrige Award? Who are its most recent winners? Read a brief description of the Deming Prize. How does the Deming Prize differ from these other awards? When and why was the Deming Prize established? Find some companies on the web who have won the Deming prize. Are any of the sites American companies?

These exercises require a direct link to a specific Web site. Click* ***Internet Exercises* *for the list of internet links for these exercises.*

ISO 9000

The International Organization for Standardization (ISO), headquartered in Geneva, Switzerland, has as its members the national standards organizations for more than ninety countries. The ISO member for the United States is the American National Standards Institute (ANSI). The purpose of ISO is to facilitate global consensus agreements on international quality standards. It has resulted in a system for certifying suppliers to make sure they meet internationally accepted standards for quality management. It is a nongovernment organization and is not a part of the United Nations.

During the 1970s it was generally acknowledged that the word *quality* had different meanings within and among industries and countries and around the world. In 1979 the ISO member representing the United Kingdom, the British Standard Institute (BSI), recognizing the need for standardization for quality management and assurance, submitted a formal proposal to ISO to develop international standards for quality assurance techniques and practices. Using standards that already existed in the United Kingdom and Canada as a basis, ISO established generic quality standards primarily for manufacturing firms that could be used worldwide.

The ISO 9000 series of quality management and assurance standards was first published in 1978. ISO 9000, the first standard in the series, titled *Quality Management and Quality Assurance Standards for Selection and Use,* is a guide for using four other standards.

ISO 9001, *Quality Systems--Model for Quality Assurance in Design/Development, Production, Installation, and Servicing,* applies to suppliers who have a responsibility for the design and development, production, installation, and servicing of a product. It includes a set of requirements for the suppliers' quality management program, beginning with top management responsibility and providing objective criteria to verify that key elements in the total quality management approach are present. It defines requirements for product handling, storage, packaging, and delivery and includes requirements for conducting internal quality audits to verify the effectiveness of the quality management system.

ISO 9002, *Quality Systems--Model for Quality Assurance in Production and Installation,* is similar to ISO 9001 except that it is limited to suppliers that only produce and install a product and do not design, develop, or service the product.

ISO 9003, *Quality Systems--Model for Quality Assurance in Final Inspection and Test,* is limited to guidelines for final inspection and testing because of the relative simplicity of the product. This standard shifts responsibility for quality to the supplier so the customer is assured of the level of quality when the product is received.

ISO 9004, *Quality Management and Quality System Elements--Guidelines,* provides guidelines for developing and implementing the quality management programs required in ISO 9001, 9002, and 9003. These guidelines and suggestions help management develop an effective quality management program so their companies can be qualified to meet ISO 9001, 9002, and 9003 requirements. The ISO 9000 standards can generally be applied to the service sector by making such simple modifications as substituting terms--for example, *process* for *production* and *service* for *product.*

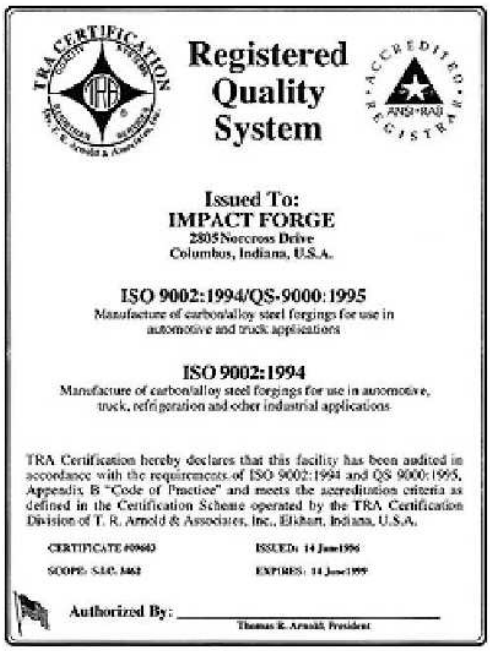
Implications of ISO 9000 for U.S. Companies

Originally, ISO 9000 was adopted by the twelve countries of the European Community (EC)--Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, and the United Kingdom. The governments of the EC countries adopted ISO 9000 as a uniform quality standard for cross-border transactions within the EC and for international transactions. The EC was soon joined by the countries of the European Free Trade Association (EFTA), including Austria, Finland, Iceland, Liechtenstein, Norway, Sweden, and Switzerland. In addition Australia, Japan, and many other Pacific Rim countries plus South America and Africa have adopted ISO 9000.

These countries (especially those in the EC) are specifically acknowledging that they prefer suppliers with ISO 9000 certification. To remain competitive in international markets, U.S. companies must comply with the standards in the ISO 9000 series. Some products in the EC, for example, are "regulated" to the extent that the products must be certified to be in ISO 9000 compliance by an EC-recognized accreditation registrar. Most of these products have health and safety considerations. However, companies have discovered that to remain competitive and satisfy customer preferences, their products must be in compliance with ISO 9000 requirements even if these products are not specifically regulated.

The United States exports more than $100 billion annually to the European Community market, most of it to France, Germany, Italy, Spain, and the United Kingdom. More than half of these exports are impacted in some way by ISO 9000 standards.

Companies are also being pressured within the United States to comply with ISO 9000 by more and more customers. For example, the United States Department of Defense, and specifically the Department of the Navy, has adopted ISO 9000, as have such private companies as Du Pont, 3M, and AT&T. They recognize the value of these standards for helping to assure top-quality products and services and require that their suppliers comply with ISO 9000.



Registered Quality System

Issued To:
IMPACT FORGE
2805 Norcross Drive
Columbus, Indiana, U.S.A.

ISO 9002:1994/QS-9000:1995
Manufacture of carbon/alloy steel forgings for use in automotive and truck applications

ISO 9002:1994
Manufacture of carbon/alloy steel forgings for use in automotive, truck, refrigeration and other industrial applications

TRA Certification hereby declares that this facility has been audited in accordance with the requirements of ISO 9002:1994 and QS 9000:1995, Appendix B "Code of Practice" and meets the accreditation criteria as defined in the Certification Scheme operated by the TRA Certification Division of T. R. Arnold & Associates, Inc., Elkhart, Indiana, U.S.A.

CERTIFICATE #9960 ISSUED: 14 June 1996
SCOPE: S.I.C. 3462 EXPIRES: 14 June 1999

Authorized By: _____
Thomas R. Arnold, President

Thousands of businesses have improved their operations by fully implementing a quality system based on the international standards known as ISO 9001 and ISO 9002. Almost all of those companies have in turn gained recognition for their achievement by undergoing an assessment of that quality system by an independent third party, known as a quality system registrar. When the company has met all the requirements of the standards, the registrar will certify/register them. This status is represented by a certificate, such as this one for Impact Forge of Columbus, Indiana. The automotive industry is beginning to practice an enhancement of the ISO standards known as QS 9000. This certificate includes that designation.

ISO 9000 Accreditation

In ISO 9000 an accredited registrar, for a fee, assesses a company's quality program and determines if it is in compliance with ISO 9000 standards. If the company's quality program is in compliance, the registrar issues it a certificate and registers that certificate in a book that is widely distributed.

In the EC registration system, the third-party assessors of quality are referred to as *notified bodies*; that is, the twelve EC governments *notify* one another as to which organization in their country is the officially designated government-approved quality assessor. The notified bodies ultimately certify a company with a European Conformity (CE) mark. The CE mark must be on any product exported from the United States that is ISO 9000-regulated. It is illegal to sell a regulated product in a store in the EC without the CE mark. For a supplier in the United States to export regulated products to an EC country, it must be accredited by European registrars--notified bodies within the EC. However, more and more EC companies are requiring ISO 9000 certification for suppliers of products that fall in the unregulated categories, and eventually all products exported to the EC will probably require certification.

The AT&T Quality Registrar was one of the first accredited by the RAB in the United States. Because of its extensive experience in working with the quality systems of its own suppliers and its experience with ISO 9000 standards, AT&T was to provide a great deal of knowledge to the development of the U.S. registration system. As a result, AT&T formed its own quality registrar and went through the RAB accreditation process in order to assist in the actual development of the process as it went through it. The AT&T quality registrar was accredited in 1991 and began to register companies in the United States. They could concentrate on a broad range of product areas because AT&T suppliers historically included many varied products, such as electronic components, textile products, printing products, chemicals and plastics, rubber products, and fabricated metal products.

The ISO 9000 registration process employed by AT&T has nine steps. First, an application form is submitted by the supplier. This form includes a four-page questionnaire that provides general information about the company, including the type of product it makes, its locations, and so on. Next, the company is provided with a "Quality Manual Desk Audit" in order to determine the current extent to which the company is complying with ISO 9000 standards. This step is followed by a preliminary audit, which may last from one to several days. The next step is a full audit, which typically requires two auditors and takes approximately three days. In this audit the auditors go through the whole facility to see if the company complies with ISO 9000 standards; the company is given verbal feedback immediately and a written report in a few weeks. The auditing team does not make the actual registration decision, but it presents a report to a registration board, which either approves or rejects the auditors' recommendation. The question the board members ask is, "If we were the customer, would we want this company to provide us with products or service?" If the board approves the company, it provides the company with a certificate and the right to use AT&T's mark and the RAB mark in its advertising and correspondence. However, the mark cannot be used on a product. The company receives a semiannual follow-up audit and a full audit every three years. Formal recognition of registration by the AT&T Quality Registrar has met with some resistance in the EC. However, AT&T works with the supplier's European customers, explaining its registration process and credentials in order to obtain informal recognition with that particular company. AT&T provides the supplier with whatever support is needed to prove to a European customer that it and the RAB are credible accreditation bodies. As the AT&T quality registrar and other U.S. registrars successfully convince more and more EC companies of their credibility, U.S. suppliers will find it easier to move products into and within EC markets.

Source: Based on "The AT&T Quality Registrar" *Profile of ISO 9000* (Needham Heights, Mass.: Allyn and Bacon, 1992), pp. 67-74.

It is also important that U.S. companies obtain accreditation with a notified body that has widespread positive recognition in the EC so that they will have broad access to markets in the EC. In Germany and the United Kingdom, there appears to be preference for ISO

registrars located within that country; in other countries such as the Netherlands, France, and Spain there seems to be less prejudice over where certification is obtained.

Because the third-party quality registration system has become accepted in the EC and so many countries trade with EC countries, third-party registration has become important in the rest of the world, particularly the United States. However, it has not been as easy for the United States to develop a registration system because of the separation between government and business that exists in the United States but not in most EC countries.

The U.S. member of the ISO, the American National Standards Institute (ANSI), designated the American Society for Quality Control (ASQC), as the sponsoring organization for ISO 9000 in the U.S. ASQC and ANSI created the Registrar Accreditation Board (RAB) to act as the third-party registrar in the United States.

In 1992 RAB developed an auditing system for the registration of supplier companies and accreditation of registrars based on the ISO standards. A registrar is an organization that conducts audits by individual auditors. Auditors are skilled in quality systems and the manufacturing and service environments in which an audit will be performed. The registrar develops an audit team of one or more auditors to evaluate a company's quality program and then report back to the registrar. An organization that wants to become a registrar must be accredited by RAB. Once RAB accredits a registrar, the registrar can then authorize its registered suppliers to use the RAB certificate in advertising, indicating compliance with ISO 9000.

Pause and Reflect

***3-35.** Find out more about ISO 9000 from the web. What is ISO? What does ASQC have to do with ISO 9000? What are the latest changes in ISO 9000? Describe the process for becoming ISO 9000 certified. Approximately how many ISO registrars are there in the U.S.? What problems do companies typically face in the process of becoming certified?

3-36. Why has ISO 9000 become so important to U.S. firms that do business overseas?

3-37. Develop a hypothetical improvement program for the class in which you are using this text. Include goals for quality improvement and ways to measure success.

3-38. Write a one- to two-page summary of an article from *Quality Progress, Quality Forum, Quality and Productivity Management,* or *Quality Review* about quality management in a company or organization.

3-39. Many more companies probably fail at implementing quality management programs than succeed. Discuss the reasons why a quality management program might fail.

These exercises require a direct link to a specific Web site. Click* ***Internet Exercises* *for the list of internet links for these exercises.*

Summary

In our discussion of quality management in this chapter, certain consistencies or commonalities have surfaced. The most important perspective of quality is the customer's; products and services must be designed to meet customer expectations and needs for quality. A total commitment to quality is necessary throughout an organization for it to be successful in improving and managing product quality. This commitment must start at the top and filter down through all levels of the organization and across all areas and departments. Employees need to be active participants in the quality-improvement process and must feel a responsibility for quality. Employees must feel free to make suggestions to improve product quality without fear of reprisal, and a systematic procedure is necessary to involve workers and solicit their input. Improving product quality is cost-effective; the cost of poor quality greatly exceeds the cost of attaining good quality. Quality can be improved with the effective use of statistical quality control methods. In fact, the use of statistical quality control has been a pervasive part of our discussions on quality management, and it has been identified as an important part of any quality management program. In the following chapter we concentrate on statistical quality control methods and principles.

Key Formulas

Quality Index Numbers

$$\text{Quality index} = \frac{\text{total quality costs}}{\text{base}}(100)$$

Product Yield

$$Y = (I)(\%G) + (I)(1 - \%G)(\%R)$$

Manufacturing Cost per Product

$$\text{Product cost} = \frac{(K_d)(I) + (K_r)(R)}{Y}$$

Multistage Product Yield

$$Y = (I)(\%g_1)(\%g_2)\cdots(\%g_n$$

Quality-Productivity Ratio

$$\text{QPR} = \frac{\text{good-quality units}}{(\text{input})(\text{processing cost}) + (\text{defective units})(\text{rework cost})}(100)$$

Case Problems

CASE PROBLEM 3.1

Designing a Quality Management Program for the Internet at D_4Q

Design for Quality (D_4Q) is a consulting firm that specializes in the design and implementation of quality management programs for service companies and organizations. It has had success designing quality programs for retail stores and catalog order services. Recently D_4Q was approached by a catalog order company, BookTek Media, Inc., with the offer of a job. BookTek sells books, CDs, cassettes, and videos through its mail-order catalog operation. BookTek has decided to expand its service to the Internet. BookTek is experienced in catalog telephone sales and has a successful quality management program in place. Thus the company is confident that it can process orders and make deliveries on time with virtually no errors.

A key characteristic of BookTek's quality management program is the company's helpful, courteous, and informative phone representatives. These operators can answer virtually any customer question about BookTek products with the help of an information system. Their demeanor toward customers is constantly monitored and graded. Their telephone system is so quick that customers rarely have to wait for a representative to assist them. However, the Internet ordering system BookTek virtually eliminates direct human contact with the customer. Since there will be no human contact, BookTek is concerned about how it will be able to make customers feel that they are receiving high-quality service. Further, the company is unsure how its employees can monitor and evaluate the service to know if the customer thinks it is good or poor. The primary concern is how to make customers feel good about the company in such an impersonal, segregated environment. At this point BookTek is unconcerned with costs; management simply wants to develop the highest quality, and friendliest web site possible.

D_4Q indicated that it would like to take on the job, but while it is familiar with BookTek's type of catalog order system, it is relatively unfamiliar with the Internet and how things are ordered on the Internet. It suggested that its first order of business might be to investigate what other companies were doing on the Internet.

Help D_4Q develop a quality management plan for BookTek. Include in your plan the quality dimensions and characteristics of an Internet ordering system, suggestions for achieving customer satisfaction, ways to measure defective service, and how to evaluate the success of the order system in terms of quality.

CASE PROBLEM 3.2

TQM at State University

As a result of several years of severe cuts to its operating budget by the state legislature, the administration at State University has raised tuition annually for the past five years. Five years ago an education at State was a bargain for both in-state and out-of-state students; now it is one of the more expensive state universities. An immediate repercussion has been a decline in applications for admission. Since a portion of state funding is tied to enrollments, State has kept its enrollments up at a constant level by going deeper into its pool of applications, taking some less qualified students.

The increase in the cost of a State degree has also caused legislators, parents, and students to be more conscious of the value of a State education--that is, the value parents and students are receiving for their money. This increased scrutiny has been fueled by numerous media reports about the decreased emphasis on teaching in universities, low teaching loads by faculty, and the large number of courses taught by graduate students. This, in turn, has led the state legislature committee on higher education to call for an "outcomes assessment program" to determine how well State University is achieving its mission of producing high-quality graduates.

On top of those problems, a substantial increase in the college-age population is expected in the next decade, resulting from a "baby boom" during the early 1980s. Key members of the state legislature have told the university administration that they will be expected to absorb their share of the additional students during the next decade. However, because of the budget situation, they should not expect any funding increases for additional facilities, classrooms, dormitory rooms, or faculty. In effect, they will be expected to do more with their existing resources. State already faces a classroom deficit, and faculty have teaching loads above the average of its peer institutions. Legislators are fond of citing a study that shows that if the university simply gets all the students to graduate within a four-year period or reduces the number of hours required for graduation, they can accommodate the extra students they will be expected to accommodate.

This entire scenario has made the university president, Fred McMahan, consider retirement. He has summarized the problems to his administration staff as "having to do more, better, with less." One of the first things he did to address these problems was to set up a number of task forces made up of faculty and administrators to brainstorm a variety of topics. Among the topics and problems these task forces addressed were quality in education, educational success, graduation rates, success rates in courses (i.e., the percentage of students passing), teaching, the time to graduation, faculty issues, student issues, facilities, class scheduling, admissions, and classroom space.

Several of the task forces included faculty from engineering and business. These individuals noted that many of the problems the university faced would benefit from the principles and practices of a total quality management (TQM) approach. This recommendation appealed to Fred McMahan and the academic vice president, Anne Baker.

Discuss in general terms how TQM philosophy and practices might be instituted at State University.

CASE PROBLEM 3.3

Product Yield at Continental Luggage Company

The Continental Luggage Company manufactures several different styles of soft- and hardcover luggage, briefcases, hanging bags, and purses. Their best-selling item is a line of hardcover luggage called the "Trotter." It is produced in a basic five-stage assembly process that can accommodate several different outer coverings and colors. The assembly process includes constructing a heavy-duty plastic and metal frame; attaching the outer covering; joining the top and bottom and attaching the hinge mechanism; attaching the latches, lock, and handle: and doing the finishing work, including the luggage lining.

The market for luggage is extremely competitive, and product quality is a very important component in product sales and market share. Customers normally expect luggage to be able to withstand rough handling while retaining its shape and an attractive appearance and protecting the clothing and personal items inside the bag. They also prefer the bag to be lightweight and not cumbersome. Furthermore, customers expect the latches and locks to work properly over an extended period of time. Another key factor in sales is that the luggage must be stylish and visually appealing.

Because of the importance of quality, company management has established a process control procedure that includes inspection at each stage of the five major stages of the assembly process. The following table shows the percentage of good-quality units yielded at each stage of the assembly process and the percentage of bad units that can be reworked, on average.

Assembly Stage	*Average Percentage Good Quality*	*Average Percentage Reworked*
1	0.94	0.23
2	0.96	0.91
3	0.95	0.67
4	0.97	0.89
5	0.98	0.72

The first stage of the process is construction of the frame, and it is very difficult to rework the frame if an item is defective, which is reflected in the low percentage of reworked items.

Five hundred new pieces of luggage of a particular style and color are initiated through the assembly process each week. The company would like to know the weekly product yield and the number of input units that would be required to achieve a weekly yield of 500 units. Further, the company would like to know the impact on product yield (given 500 initial starting units) if a quality-improvement program were introduced that would increase the average percentage of good-quality units at each stage by 1 percent.

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