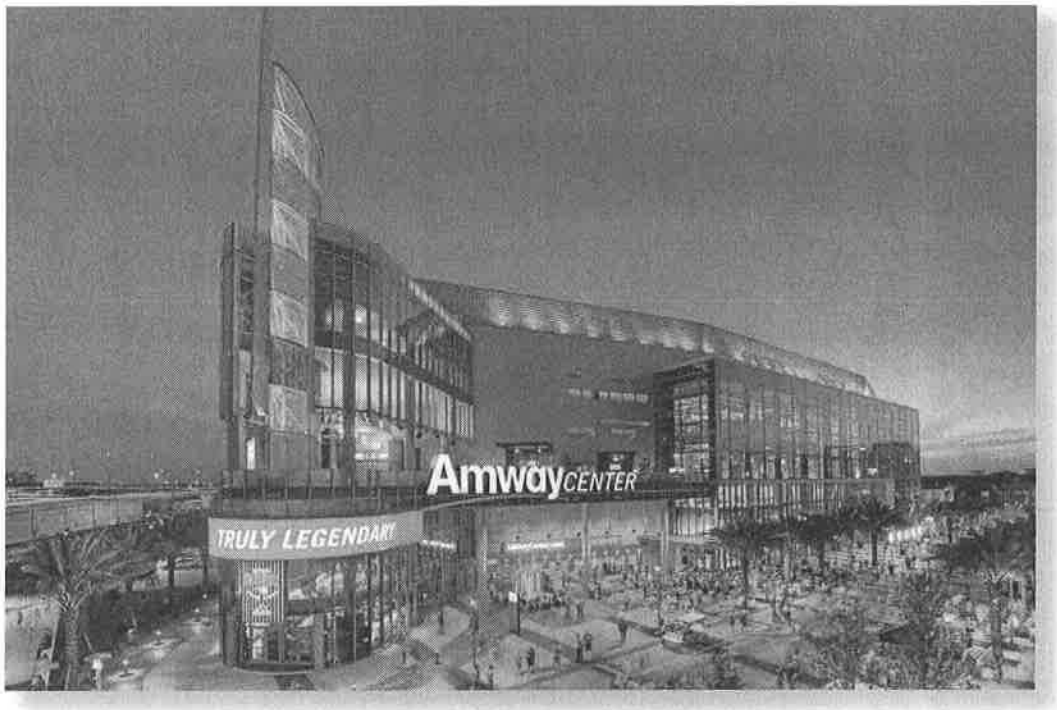
Managing Quality

CHAPTER 6

CHAPTER OUTLINE

GLOBAL COMPANY PROFILE: *Arnold Palmer Hospital*



10 OM STRATEGY DECISIONS

- Design of Goods and Services
- *Managing Quality*
- Process Strategy
- Location Strategies
- Layout Strategies
- Human Resources
- Supply-Chain Management
- Inventory Management
- Scheduling
- Maintenance

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GLOBAL COMPANY PROFILE
Arnold Palmer Hospital

Managing Quality Provides a Competitive Advantage at Arnold Palmer Hospital

Since 1989, Arnold Palmer Hospital, named after its famous golfing benefactor, has touched the lives of over 7 million children and women and their families. Its patients come not only from its Orlando location but from all 50 states and around the world. More than 12,000 babies are delivered every year at Arnold Palmer, and its huge neonatal intensive care unit boasts one of the highest survival rates in the U.S.

Every hospital professes quality health care, but at Arnold Palmer quality is the mantra—practiced in a fashion like the Ritz-Carlton practices it in the hotel industry. The hospital typically scores in the top 10% of national benchmark studies in terms of patient satisfaction. And its managers follow patient questionnaire results daily. If anything is amiss, corrective action takes place immediately.

Virtually every quality management technique we present in this chapter is employed at Arnold Palmer Hospital:

- *Continuous improvement:* The hospital constantly seeks new ways to lower infection rates, readmission rates, deaths, costs, and hospital stay times.

Jonathan Bailey Associates

The lobby of Arnold Palmer Hospital, with its 20-foot-high Genie, is clearly intended as a warm and friendly place for children.

Jonathan Bailey Associates

The Storkboard is a visible chart of the status of each baby about to be delivered, so all nurses and doctors are kept up to date at a glance.

Operations Management: Sustainability and Supply Chain Management, Eleventh Edition, by Jay Heizer and Barry Render. Published by Pearson.

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CareFusion Pyxis

This PYXIS inventory station gives nurses quick access to medicines and supplies needed in their departments. When the nurse removes an item for patient use, the item is automatically billed to that account, and usage is noted at the main supply area.

Jonathan Bailey Associates

The hospital has redesigned its neonatal rooms. In the old system, there were 16 neonatal beds in an often noisy and large room. The new rooms are semiprivate, with a quiet simulated-night atmosphere. These rooms have proven to help babies develop and improve more quickly.

- *Employee empowerment:* When employees see a problem, they are trained to take care of it; staff are empowered to give gifts to patients displeased with some aspect of service.
- *Benchmarking:* The hospital belongs to a 2,000-member organization that monitors standards in many areas and provides monthly feedback to the hospital.

Jonathan Bailey Associates

When Arnold Palmer Hospital began planning for a new 11-story hospital across the street from its existing building, it decided on a circular pod design, creating a patient-centered environment. Rooms use warm colors, have pull-down Murphy beds for family members, 14-foot ceilings, and natural lighting with oversized windows. The pod concept also means there is a nursing station within a few feet of each 10-bed pod, saving much wasted walking time by nurses to reach the patient. The Video Case Study in Chapter 9 examines this layout in detail.

- *Just-in-time:* Supplies are delivered to Arnold Palmer on a JIT basis. This keeps inventory costs low and keeps quality problems from hiding.
- *Tools such as Pareto charts and flowcharts:* These tools monitor processes and help the staff graphically spot problem areas and suggest ways they can be improved.

From their first day of orientation, employees from janitors to nurses learn that the patient comes first. Staff standing in hallways will never be heard discussing their personal lives or commenting on confidential issues of health care. This culture of quality at Arnold Palmer Hospital makes a hospital visit, often traumatic to children and their parents, a warmer and more comforting experience.

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LEARNING OBJECTIVES

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Quality and Strategy

As Arnold Palmer Hospital and many other organizations have found, quality is a wonderful tonic for improving operations. Managing quality helps build successful strategies of *differentiation*, *low cost*, and *response*. For instance, defining customer quality expectations has helped Bose Corp. successfully *differentiate* its stereo speakers as among the best in the world. Nucor has learned to produce quality steel at *low cost* by developing efficient processes that produce consistent quality. And Dell Computers rapidly *responds* to customer orders because quality systems, with little rework, have allowed it to achieve rapid throughput in its plants. Indeed, quality may be the key success factor for these firms, just as it is at Arnold Palmer Hospital.

VIDEO 6.1
The Culture of Quality at Arnold Palmer Hospital

STUDENT TIP ☆
High-quality products and services are the most profitable.

As Figure 6.1 suggests, improvements in quality help firms increase sales and reduce costs, both of which can increase profitability. Increases in sales often occur as firms speed response, increase or lower selling prices, and improve their reputation for quality products. Similarly, improved quality allows costs to drop as firms increase productivity and lower rework, scrap, and warranty costs. One study found that companies with the highest quality were five times as productive (as measured by units produced per labor-hour) as companies with the poorest quality. Indeed, when the implications of an organization's long-term costs and the potential for increased sales are considered, total costs may well be at a minimum when 100% of the goods or services are perfect and defect free.

Quality, or the lack of quality, affects the entire organization from supplier to customer and from product design to maintenance. Perhaps more importantly, *building* an organization that can achieve quality is a demanding task. Figure 6.2 lays out the flow of activities for an organization to use to achieve total quality management (TQM). A successful quality strategy begins with an organizational culture that fosters quality, followed by an understanding of the principles of quality, and then engaging employees in the necessary activities to implement quality. When these things are done well, the organization typically satisfies its customers and obtains a competitive advantage. The ultimate goal is to win customers. Because quality causes so many other good things to happen, it is a great place to start.

Figure **6.1**
Ways Quality Improves Profitability

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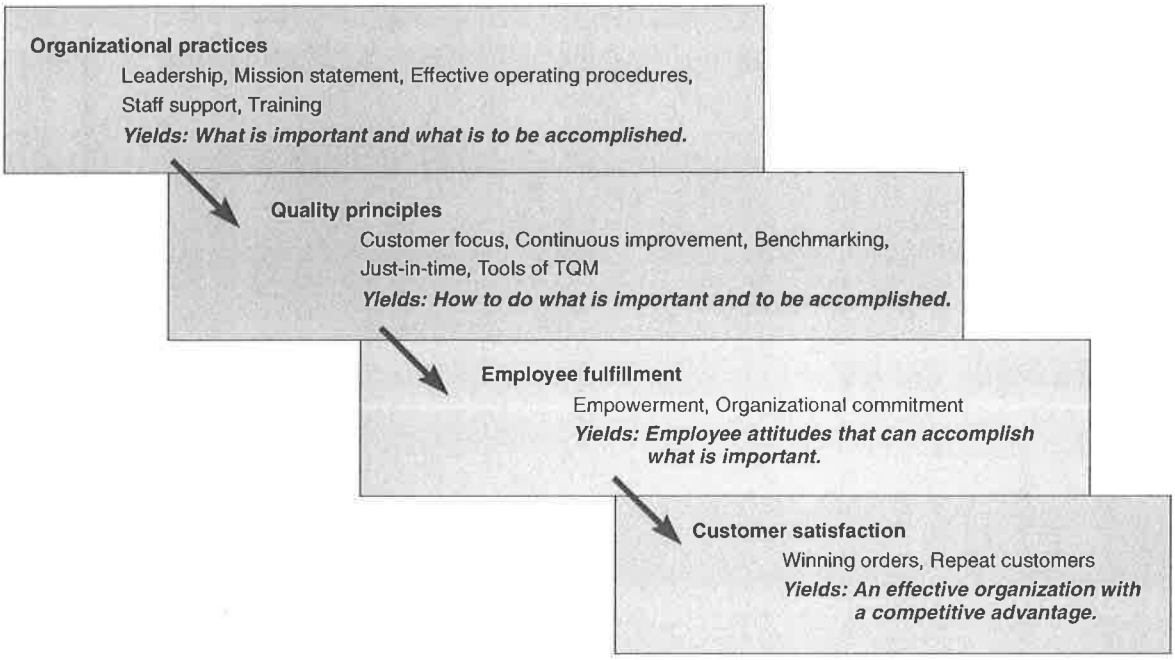

Figure **6.2**
The Flow of Activities Necessary to Achieve Total Quality Management

Defining Quality

An operations manager's objective is to build a total quality management system that identifies and satisfies customer needs. Total quality management takes care of the customer. Consequently, we accept the definition of quality as adopted by the American Society for Quality (ASQ; **www.asq.org**): "The totality of features and characteristics of a product or service that bears on its ability to satisfy stated or implied needs."

Quality
The ability of a product or service to meet customer needs.

LO1 *Define* quality and TQM

Others, however, believe that definitions of quality fall into several categories. Some definitions are *user based*. They propose that quality "lies in the eyes of the beholder." Marketing people like this approach and so do customers. To them, higher quality means better performance, nicer features, and other (sometimes costly) improvements. To production managers, quality is *manufacturing based*. They believe that quality means conforming to standards and "making it right the first time." Yet a third approach is *product based*, which views quality as a precise and measurable variable. In this view, for example, really good ice cream has high butterfat levels.

This text develops approaches and techniques to address all three categories of quality. The characteristics that connote quality must first be identified through research (a user-based approach to quality). These characteristics are then translated into specific product attributes (a product-based approach to quality). Then, the manufacturing process is organized to ensure that products are made precisely to specifications (a manufacturing-based approach to quality). A process that ignores any one of these steps will not result in a quality product.

☆ **STUDENT TIP**
To create a quality good or service, operations managers need to know what the customer expects.

Implications of Quality

In addition to being a critical element in operations, quality has other implications. Here are three other reasons why quality is important:

1. *Company reputation:* An organization can expect its reputation for quality—be it good or bad—to follow it. Quality will show up in perceptions about the firm's new products, employment practices, and supplier relations. Self-promotion is not a substitute for quality products.

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2. *Product liability:* The courts increasingly hold organizations that design, produce, or distribute faulty products or services liable for damages or injuries resulting from their use. Legislation such as the Consumer Product Safety Act sets and enforces product standards by banning products that do not reach those standards. Impure foods that cause illness, nightgowns that burn, tires that fall apart, or auto fuel tanks that explode on impact can all lead to huge legal expenses, large settlements or losses, and terrible publicity.
3. *Global implications:* In this technological age, quality is an international, as well as OM, concern. For both a company and a country to compete effectively in the global economy, products must meet global quality, design, and price expectations. Inferior products harm a firm's profitability and a nation's balance of payments.

Malcolm Baldrige National Quality Award

The global implications of quality are so important that the U.S. has established the *Malcolm Baldrige National Quality Award* for quality achievement. The award is named for former Secretary of Commerce Malcolm Baldrige. Winners include such firms as Motorola, Milliken, Xerox, FedEx, Ritz-Carlton Hotels, AT&T, Cadillac, and Texas Instruments. (For details about the Baldrige Award and its 1,000-point scoring system, visit **www.quality.nist.gov**.)

The Japanese have a similar award, the Deming Prize, named after an American, Dr. W. Edwards Deming.

ISO 9000 International Quality Standards

ISO 9000
A set of quality standards developed by the International Organization for Standardization (ISO).

The move toward global supply chains has placed so much emphasis on quality that the world has united around a single quality standard, ISO 9000. ISO 9000 is *the* quality standard with international recognition. Its focus is to enhance success through eight quality management principles: (1) top management leadership, (2) customer satisfaction, (3) continual improvement, (4) involvement of people, (5) process analysis, (6) use of data-driven decision making, (7) a systems approach to management, and (8) mutually beneficial supplier relationships.

LO2 *Describe* the ISO international quality standards

The ISO standard encourages establishment of quality management procedures, detailed documentation, work instructions, and recordkeeping. Like the Baldrige Awards, the assessment includes self-appraisal and problem identification. Unlike the Baldrige, ISO certified organizations must be reaudited every three years.

In 2009, the latest modification of the standard, ISO 9004: 2009, emphasized how an organization can use a quality management approach to achieve *sustained* success. This version encourages organizations to plan for their economic survival through continuing and systematic improvement in performance, efficiency, and effectiveness.

STUDENT TIP ☆
International quality standards grow in prominence every year. See **www.iso.ch.**

Over one million certifications have been awarded to firms in 178 countries, including over 30,000 in the U.S. To do business globally, it is critical for a firm to be certified and listed in the ISO directory.

Cost of Quality (COQ)

Cost of quality (COQ)
The cost of doing things wrong—that is, the price of nonconformance.

Four major categories of costs are associated with quality. Called the cost of quality (COQ), they are:

- *Prevention costs:* costs associated with reducing the potential for defective parts or services (e.g., training, quality improvement programs).
- *Appraisal costs:* costs related to evaluating products, processes, parts, and services (e.g., testing, labs, inspectors).
- *Internal failure costs:* costs that result from production of defective parts or services before delivery to customers (e.g., rework, scrap, downtime).
- *External failure costs:* costs that occur after delivery of defective parts or services (e.g., rework, returned goods, liabilities, lost goodwill, costs to society).

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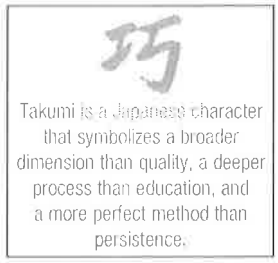
TABLE 6.1 Leaders in the Field of Quality Management

LEADER	PHILOSOPHY/CONTRIBUTION
W. Edwards Deming	Deming insisted management accept responsibility for building good systems. The employee cannot produce products that on average exceed the quality of what the process is capable of producing. His 14 points for implementing quality improvement are presented in this chapter.
Joseph M. Juran	A pioneer in teaching the Japanese how to improve quality, Juran believed strongly in top-management commitment, support, and involvement in the quality effort. He was also a believer in teams that continually seek to raise quality standards. Juran varies from Deming somewhat in focusing on the customer and defining quality as fitness for use, not necessarily the written specifications.
Armand Feigenbaum	His 1961 book *Total Quality Control* laid out 40 steps to quality improvement processes. He viewed quality not as a set of tools but as a total field that integrated the processes of a company. His work in how people learn from each other's successes led to the field of cross-functional teamwork.
Philip B. Crosby	*Quality Is Free* was Crosby's attention-getting book published in 1979. Crosby believed that in the traditional trade-off between the cost of improving quality and the cost of poor quality, the cost of poor quality is understated. The cost of poor quality should include all of the things that are involved in not doing the job right the first time. Crosby coined the term *zero defects* and stated, "There is absolutely no reason for having errors or defects in any product or service."

Source: Based on *Quality Is Free* by Philip B. Crosby, (New York, McGraw-Hill, 1979) p. 58.

The first three costs can be reasonably estimated, but external costs are very hard to quantify. When GE had to recall 3.1 million dishwashers (because of a defective switch alleged to have started seven fires), the cost of repairs exceeded the value of all the machines. This leads to the belief by many experts that the cost of poor quality is consistently underestimated.

Observers of quality management believe that, on balance, the cost of quality products is only a fraction of the benefits. They think the real losers are organizations that fail to work aggressively at quality. For instance, Philip Crosby stated that quality is free. "What costs money are the unquality things—all the actions that involve not doing it right the first time."[1]



Takumi is a Japanese character that symbolizes a broader dimension than quality, a deeper process than education, and a more perfect method than persistence.

Leaders in Quality Besides Crosby there are several other giants in the field of quality management, including Deming, Feigenbaum, and Juran. Table 6.1 summarizes their philosophies and contributions.

Ethics and Quality Management

For operations managers, one of the most important jobs is to deliver healthy, safe, and quality products and services to customers. The development of poor-quality products, because of inadequate design and production processes, results not only in higher production costs but also leads to injuries, lawsuits, and increased government regulation.

If a firm believes that it has introduced a questionable product, ethical conduct must dictate the responsible action. This may be a worldwide recall, as conducted by both Johnson & Johnson (for Tylenol) and Perrier (for sparkling water), when each of these products was found to be contaminated. A manufacturer must accept responsibility for any poor-quality product released to the public.

There are many stakeholders involved in the production and marketing of poor-quality products, including stockholders, employees, customers, suppliers, distributors, and creditors. As a matter of ethics, management must ask if any of these stakeholders are being wronged. Every company needs to develop core values that become day-to-day guidelines for everyone from the CEO to production-line employees.

[1]Philip B. Crosby, *Quality Is Free* (New York: McGraw-Hill, 1979). Further, J. M. Juran states, in his book *Juran on Quality by Design* (The Free Press 1992, p. 119), that costs of poor quality "are huge, but the amounts are not known with precision. In most companies the accounting system provides only a minority of the information needed to quantify this cost of poor quality. It takes a great deal of time and effort to extend the accounting system so as to provide full coverage."

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TABLE 6.2 Deming's 14 Points for Implementing Quality Improvement

1. Create consistency of purpose.
2. Lead to promote change.
3. Build quality into the product; stop depending on inspections to catch problems.
4. Build long-term relationships based on performance instead of awarding business on the basis of price.
5. Continuously improve product, quality, and service.
6. Start training.
7. Emphasize leadership.
8. Drive out fear.
9. Break down barriers between departments.
10. Stop haranguing workers.
11. Support, help, and improve.
12. Remove barriers to pride in work.
13. Institute a vigorous program of education and self-improvement.
14. Put everybody in the company to work on the transformation.

Source: Deming, W. Edwards. *Out of the Crisis*, pp. 23–24, © 2000 W. Edwards Deming Institute, published by The MIT Press. Reprinted by permission.

Total Quality Management

Total quality management (TQM)
Management of an entire organization so that it excels in all aspects of products and services that are important to the customer.

Total quality management (TQM) refers to a quality emphasis that encompasses the entire organization, from supplier to customer. TQM stresses a commitment by management to have a continuing companywide drive toward excellence in all aspects of products and services that are important to the customer. Each of the 10 decisions made by operations managers deals with some aspect of identifying and meeting customer expectations. Meeting those expectations requires an emphasis on TQM if a firm is to compete as a leader in world markets.

STUDENT TIP ☆
Here are 7 concepts that make up the heart of an effective TQM program.

Quality expert W. Edwards Deming used 14 points (see Table 6.2) to indicate how he implemented TQM. We develop these into seven concepts for an effective TQM program: (1) continuous improvement, (2) Six Sigma, (3) employee empowerment, (4) benchmarking, (5) just-in-time (JIT), (6) Taguchi concepts, and (7) knowledge of TQM tools.

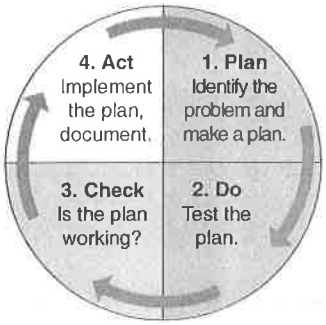
Continuous Improvement

Total quality management requires a never-ending process of continuous improvement that covers people, equipment, suppliers, materials, and procedures. The basis of the philosophy is that every aspect of an operation can be improved. The end goal is perfection, which is never achieved but always sought.

PDCA
A continuous improvement model of plan, do, check, act.

Plan-Do-Check-Act Walter Shewhart, another pioneer in quality management, developed a circular model known as **PDCA** (plan, do, check, act) as his version of continuous improvement. Deming later took this concept to Japan during his work there after World War II. The PDCA cycle (also called a Deming circle or a Shewhart circle) is shown in Figure 6.3 as a circle to stress the continuous nature of the improvement process.

Figure **6.3**
PDCA Cycle



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The Japanese use the word *kaizen* to describe this ongoing process of unending improvement—the setting and achieving of ever-higher goals. In the U.S., *TQM* and *zero defects* are also used to describe continuous improvement efforts. But whether it's PDCA, kaizen, TQM, or zero defects, the operations manager is a key player in building a work culture that endorses continuous improvement.

Six Sigma

Six Sigma
A program to save time, improve quality, and lower costs.

The term **Six Sigma**, popularized by Motorola, Honeywell, and General Electric, has two meanings in TQM. In a *statistical* sense, it describes a process, product, or service with an extremely high capability (99.9997% accuracy). For example, if 1 million passengers pass through the St. Louis Airport with checked baggage each month, a Six Sigma program for baggage handling will result in only 3.4 passengers with misplaced luggage. The more common *three-sigma* program (which we address in the supplement to this chapter) would result in 2,700 passengers with misplaced bags every month. See Figure 6.4.

The second TQM definition of Six Sigma is a *program* designed to reduce defects to help lower costs, save time, and improve customer satisfaction. Six Sigma is a comprehensive system—a strategy, a discipline, and a set of tools—for achieving and sustaining business success:

LO3 *Explain* what Six Sigma is

- It is a *strategy* because it focuses on total customer satisfaction.
- It is a *discipline* because it follows the formal Six Sigma Improvement Model known as **DMAIC**. This five-step process improvement model (1) ***D*efines** the project's purpose, scope, and outputs and then identifies the required process information, keeping in mind the customer's definition of quality; (2) ***M*easures** the process and collects data; (3) ***A*nalyzes** the data, ensuring repeatability (the results can be duplicated) and reproducibility (others get the same result); (4) ***I*mproves**, by modifying or redesigning, existing processes and procedures; and (5) ***C*ontrols** the new process to make sure performance levels are maintained.
- It is a *set of seven tools* that we introduce shortly in this chapter: check sheets, scatter diagrams, cause-and-effect diagrams, Pareto charts, flowcharts, histograms, and statistical process control.

Motorola developed Six Sigma in the 1980s, in response to customer complaints about its products and in response to stiff competition. The company first set a goal of reducing defects by 90%. Within one year, it had achieved such impressive results—through benchmarking competitors, soliciting new ideas from employees, changing reward plans, adding training, and revamping critical processes—that it documented the procedures into what it called Six Sigma. Although the concept was rooted in manufacturing, GE later expanded Six Sigma into services, including human resources, sales, customer services, and financial/credit services. The concept of wiping out defects turns out to be the same in both manufacturing and services.

Implementing Six Sigma Implementing Six Sigma is a big commitment. Indeed, successful Six Sigma programs in every firm, from GE to Motorola to DuPont to Texas Instruments, require a major time commitment, especially from top management. These leaders have to formulate the plan, communicate their buy-in and the firm's objectives, and take a visible role in setting the example for others.

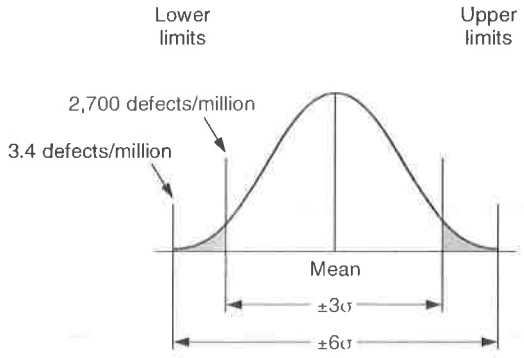

Figure **6.4**
Defects per Million for ±3σ vs. ±6σ

☆ **STUDENT TIP**
Recall that ±3σ provides 99.73% accuracy, while ±6σ is 99.9997%.

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Successful Six Sigma projects are clearly related to the strategic direction of a company. It is a management-directed, team-based, and expert-led approach.[2]

Employee Empowerment

Employee empowerment
Enlarging employee jobs so that the added responsibility and authority is moved to the lowest level possible in the organization.

Employee empowerment means involving employees in every step of the production process. Consistently, research suggests that some 85% of quality problems have to do with materials and processes, not with employee performance. Therefore, the task is to design equipment and processes that produce the desired quality. This is best done with a high degree of involvement by those who understand the shortcomings of the system. Those dealing with the system on a daily basis understand it better than anyone else. One study indicated that TQM programs that delegate responsibility for quality to shop-floor employees tend to be twice as likely to succeed as those implemented with "top-down" directives.[3]

When nonconformance occurs, the worker is seldom wrong. Either the product was designed wrong, the system that makes the product was designed wrong, or the employee was improperly trained. Although the employee may be able to help solve the problem, the employee rarely causes it.

Techniques for building employee empowerment include (1) building communication networks that include employees; (2) developing open, supportive supervisors; (3) moving responsibility from both managers and staff to production employees; (4) building high-morale organizations; and (5) creating such formal organization structures as teams and quality circles.

Quality circle
A group of employees meeting regularly with a facilitator to solve work-related problems in their work area.

Teams can be built to address a variety of issues. One popular focus of teams is quality. Such teams are often known as quality circles. A **quality circle** is a group of employees who meet regularly to solve work-related problems. The members receive training in group planning, problem solving, and statistical quality control. They generally meet once a week (usually after work but sometimes on company time). Although the members are not rewarded financially, they do receive recognition from the firm. A specially trained team member, called the *facilitator*, usually helps train the members and keeps the meetings running smoothly. Teams with a quality focus have proven to be a cost-effective way to increase productivity as well as quality.

Benchmarking

Benchmarking
Selecting a demonstrated standard of performance that represents the very best performance for a process or an activity.

Benchmarking is another ingredient in an organization's TQM program. **Benchmarking** involves selecting a demonstrated standard of products, services, costs, or practices that represent the very best performance for processes or activities very similar to your own. The idea is to

Workers at this TRW airbag manufacturing plant in Marshall, Illinois, are their own inspectors. Empowerment is an essential part of TQM. This man is checking the quality of a crash sensor he built.

[2]To train employees in how to improve quality and its relationship to customers, there are three other key players in the Six Sigma program: Master Black Belts, Black Belts, and Green Belts.

[3]"The Straining of Quality," *The Economist* (January 14, 1995): 55. We also see that this is one of the strengths of Southwest Airlines, which offers bare-bones domestic service but whose friendly and humorous employees help it obtain number-one ranking for quality. (See *Fortune* [March 6, 2006]: 65–69.)

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TABLE 6.3 Best Practices for Resolving Customer Complaints

BEST PRACTICE	JUSTIFICATION
Make it easy for clients to complain.	It is free market research.
Respond quickly to complaints.	It adds customers and loyalty.
Resolve complaints on the first contact.	It reduces cost.
Use computers to manage complaints.	Discover trends, share them, and align your services.
Recruit the best for customer service jobs.	It should be part of formal training and career advancement.

Source: Based on Canadian Government Guide on Complaint Mechanism.

develop a target at which to shoot and then to develop a standard or benchmark against which to compare your performance. The steps for developing benchmarks are:

1. Determine what to benchmark.
2. Form a benchmark team.
3. Identify benchmarking partners.
4. Collect and analyze benchmarking information.
5. Take action to match or exceed the benchmark.

LO4 *Explain* how benchmarking is used in TQM

Typical performance measures used in benchmarking include percentage of defects, cost per unit or per order, processing time per unit, service response time, return on investment, customer satisfaction rates, and customer retention rates.

In the ideal situation, you find one or more similar organizations that are leaders in the particular areas you want to study. Then you compare yourself (benchmark yourself) against them. The company need not be in your industry. Indeed, to establish world-class standards, it may be best to look outside your industry. If one industry has learned how to compete via rapid product development while yours has not, it does no good to study your industry.

This is exactly what Xerox and Mercedes-Benz did when they went to L.L. Bean for order-filling and warehousing benchmarks. Xerox noticed that L.L. Bean was able to "pick" orders three times as fast as it could. After benchmarking, Xerox was immediately able to pare warehouse costs by 10%. Mercedes-Benz observed that L.L. Bean warehouse employees used flowcharts to spot wasted motions. The auto giant followed suit and now relies more on problem solving at the worker level.

Benchmarks often take the form of "best practices" found in other firms or in other divisions. Table 6.3 illustrates best practices for resolving customer complaints.

Likewise, Britain's Great Ormond Street Hospital benchmarked the Ferrari Racing Team's pit stops to improve one aspect of medical care. (See the *OM in Action* box "A Hospital Benchmarks Against the Ferrari Racing Team?")

Internal Benchmarking When an organization is large enough to have many divisions or business units, a natural approach is the internal benchmark. Data are usually much more accessible than from outside firms. Typically, one internal unit has superior performance worth learning from.

Xerox's almost religious belief in benchmarking has paid off not only by looking outward to L.L. Bean but by examining the operations of its various country divisions. For example, Xerox Europe, a $6 billion subsidiary of Xerox Corp., formed teams to see how better sales could result through internal benchmarking. Somehow, France sold five times as many color copiers as did other divisions in Europe. By copying France's approach, namely, better sales training and use of dealer channels to supplement direct sales, Norway increased sales by 152%, Holland by 300%, and Switzerland by 328%!

Benchmarks can and should be established in a variety of areas. Total quality management requires no less.[4]

[4]Note that benchmarking is good for evaluating how well you are doing the thing you are doing compared with the industry, but the more imaginative approach to process improvement is to ask, Should we be doing this at all? Comparing your warehousing operations to the marvelous job that L.L. Bean does is fine, but maybe you should be outsourcing the warehousing function.

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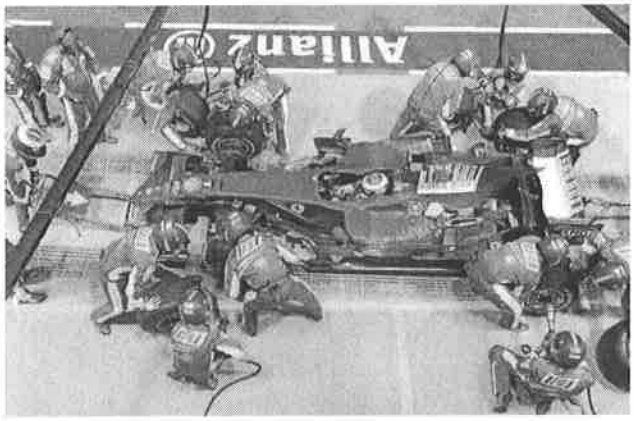
OM in Action A Hospital Benchmarks Against the Ferrari Racing Team?

After surgeons successfully completed a 6-hour operation to fix a hole in a 3-year-old boy's heart, Dr. Angus McEwan supervised one of the most dangerous phases of the procedure: the boy's transfer from surgery to the intensive care unit.

Thousands of such "handoffs" occur in hospitals every day, and devastating mistakes can happen during them. In fact, at least 35% of preventable hospital mishaps take place because of handoff problems. Risks come from many sources: using temporary nursing staff, frequent shift changes for interns, surgeons working in larger teams, and an ever-growing tangle of wires and tubes connected to patients.

Using an unlikely benchmark, Britain's largest children's hospital turned to Italy's Formula One Ferrari racing team for help in revamping patient handoff techniques. Armed with videos and slides, the racing team described how they analyze pit crew performance. It also explained how its system for recording errors stressed the small ones that go unnoticed in pit-stop handoffs.

To move forward, Ferrari invited a team of doctors to attend practice sessions at the British Grand Prix in order to get closer looks at pit stops. Ferrari's technical director, Nigel Stepney, then watched a video of a hospital handoff. Stepney was not impressed. "In fact, he was amazed at how clumsy, chaotic, and informal the process appeared," said one hospital official. At that meeting, Stepney described how each Ferrari crew member



Associated Press

is required to do a specific job, in a specific sequence, and in silence. The hospital handoff, in contrast, had several conversations going on at once, while different members of its team disconnected or reconnected patient equipment, but in no particular order.

Results of the benchmarking process: handoff errors fell over 40%, with a bonus of faster handoff time.

Sources: The Wall Street Journal (December 3, 2007) and (November 14, 2006).

Just-in-Time (JIT)

The philosophy behind just-in-time (JIT) is one of continuing improvement and enforced problem solving. JIT systems are designed to produce or deliver goods just as they are needed. JIT is related to quality in three ways:

- *JIT cuts the cost of quality:* This occurs because scrap, rework, inventory investment, and damage costs are directly related to inventory on hand. Because there is less inventory on hand with JIT, costs are lower. In addition, inventory hides bad quality, whereas JIT immediately *exposes* bad quality.
- *JIT improves quality:* As JIT shrinks lead time, it keeps evidence of errors fresh and limits the number of potential sources of error. JIT creates, in effect, an early warning system for quality problems, both within the firm and with vendors.
- *Better quality means less inventory and a better, easier-to-employ JIT system:* Often the purpose of keeping inventory is to protect against poor production performance resulting from unreliable quality. If consistent quality exists, JIT allows firms to reduce all the costs associated with inventory.

Taguchi Concepts

Most quality problems are the result of poor product and process design. Genichi Taguchi has provided us with three concepts aimed at improving both product and process quality: *quality robustness*, *quality loss function*, and *target-oriented quality*.

Quality robust
Products that are consistently built to meet customer needs in spite of adverse conditions in the production process.

Quality robust products are products that can be produced uniformly and consistently in adverse manufacturing and environmental conditions. Taguchi's idea is to remove the *effects* of adverse conditions instead of removing the causes. Taguchi suggests that removing

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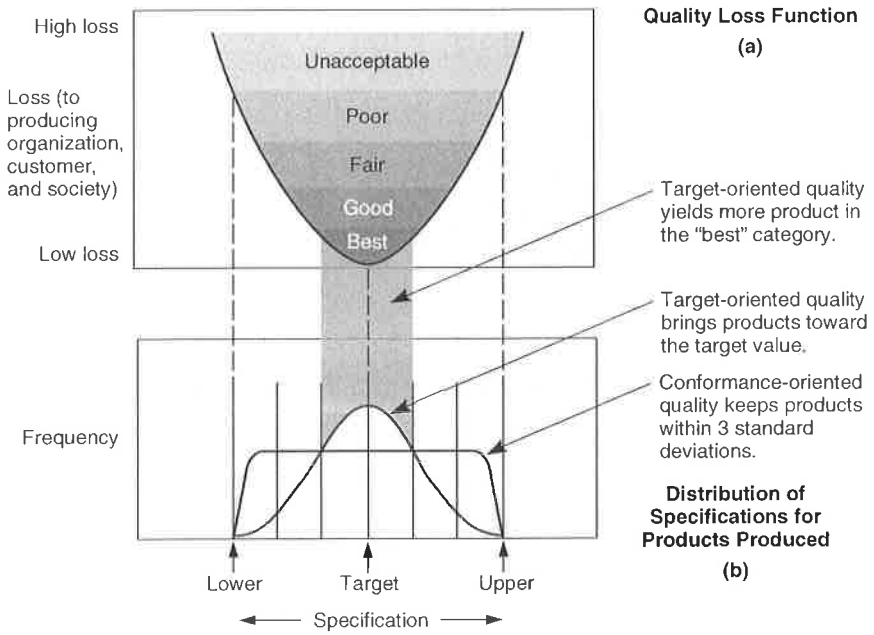

Figure 6.5

(a) Quality Loss Function and (b) Distribution of Products Produced

Taguchi aims for the target because products produced near the upper and lower acceptable specifications result in higher quality loss function.

the effects is often cheaper than removing the causes and more effective in producing a robust product. In this way, small variations in materials and process do not destroy product quality.

A **quality loss function (QLF)** identifies all costs connected with poor quality and shows how these costs increase as the product moves away from being exactly what the customer wants. These costs include not only customer dissatisfaction but also warranty and service costs; internal inspection, repair, and scrap costs; and costs that can best be described as costs to society. Notice that Figure 6.5(a) shows the quality loss function as a curve that increases at an increasing rate. It takes the general form of a simple quadratic formula:

Quality loss function (QLF)
A mathematical function that identifies all costs connected with poor quality and shows how these costs increase as product quality moves from what the customer wants.

LO5 *Explain* quality robust products and Taguchi concepts

$$L = D^2C$$

where L = loss to society

D^2 = square of the distance from the target value

C = cost of the deviation at the specification limit

All the losses to society due to poor performance are included in the loss function. The smaller the loss, the more desirable the product. The farther the product is from the target value, the more severe the loss.

Taguchi observed that traditional conformance-oriented specifications (i.e., the product is good as long as it falls within the tolerance limits) are too simplistic. As shown in Figure 6.5(b), conformance-oriented quality accepts all products that fall within the tolerance limits, producing more units farther from the target. Therefore, the loss (cost) is higher in terms of customer satisfaction and benefits to society. Target-oriented quality, on the other hand, strives to keep the product at the desired specification, producing more (and better) units near the target. **Target-oriented quality** is a philosophy of continuous improvement to bring the product exactly on target.

Target-oriented quality
A philosophy of continuous improvement to bring a product exactly on target.

Knowledge of TQM Tools

To empower employees and implement TQM as a continuing effort, everyone in the organization must be trained in the techniques of TQM. In the following section, we focus on some of the diverse and expanding tools that are used in the TQM crusade.

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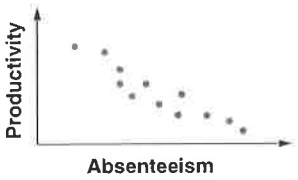
Tools for Generating Ideas

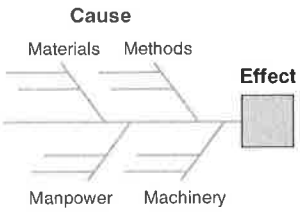
(a) *Check Sheet:* An organized method of recording data

	Hour							
Defect	1	2	3	4	5	6	7	8
A	///	/		/	/	/	///	/
B	//	/	/	/			//	///
C	/	//					//	////

(b) *Scatter Diagram:* A graph of the value of one variable vs. another variable

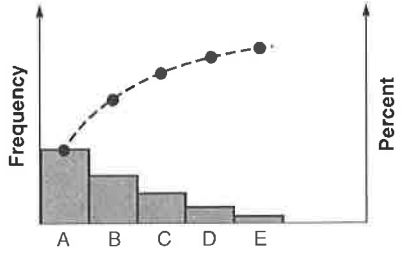


(c) *Cause-and-Effect Diagram:* A tool that identifies process elements (causes) that may affect an outcome

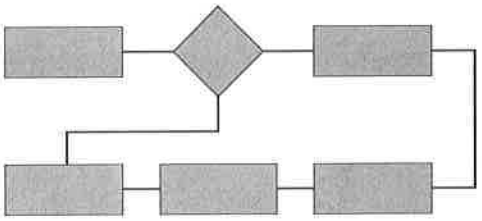


Tools for Organizing the Data

(d) *Pareto Chart:* A graph that identifies and plots problems or defects in descending order of frequency

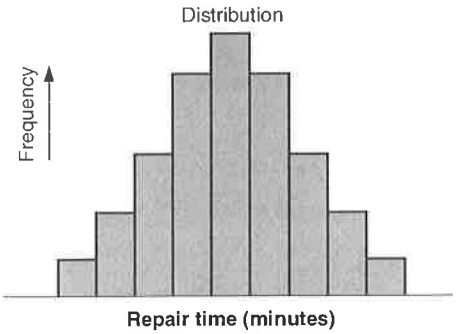


(e) *Flowchart (Process Diagram):* A chart that describes the steps in a process



Tools for Identifying Problems

(f) *Histogram:* A distribution that shows the frequency of occurrences of a variable



(g) *Statistical Process Control Chart:* A chart with time on the horizontal axis for plotting values of a statistic

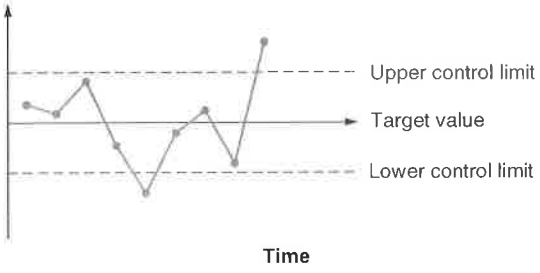


Figure **6.6**
Seven Tools of TQM

STUDENT TIP ☆ These tools will prove useful in many of your courses and throughout your career.

Tools of TQM

Seven tools that are particularly helpful in the TQM effort are shown in Figure 6.6. We will now introduce these tools.

LO6 *Use* the seven tools of TQM

Check Sheets

A check sheet is any kind of a form that is designed for recording data. In many cases, the recording is done so the patterns are easily seen while the data are being taken [see Figure 6.6(a)]. Check sheets help analysts find the facts or patterns that may aid subsequent analysis. An example might be a drawing that shows a tally of the areas where defects are occurring or a check sheet showing the type of customer complaints.

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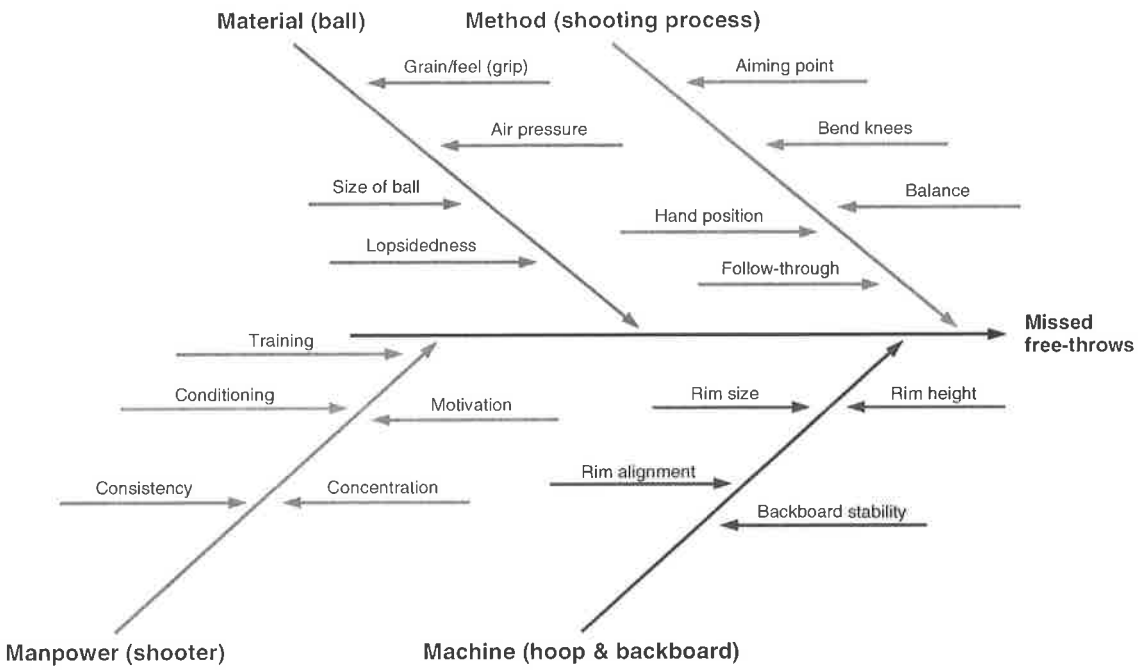

Figure **6.7**

Fish-Bone Chart (or Cause-and-Effect Diagram) for Problems with Missed Free-Throws

Source: Adapted from MoreSteam.com, 2007.

Scatter Diagrams

Scatter diagrams show the relationship between two measurements. An example is the positive relationship between length of a service call and the number of trips a repair person makes back to the truck for parts. Another example might be a plot of productivity and absenteeism, as shown in Figure 6.6(b). If the two items are closely related, the data points will form a tight band. If a random pattern results, the items are unrelated.

Cause-and-Effect Diagrams

Another tool for identifying quality issues and inspection points is the **cause-and-effect diagram**, also known as an **Ishikawa diagram** or a **fish-bone chart**. Figure 6.7 illustrates a chart (note the shape resembling the bones of a fish) for a basketball quality control problem—missed free-throws. Each "bone" represents a possible source of error.

Cause-and-effect diagram
A schematic technique used to discover possible locations of quality problems.

The operations manager starts with four categories: material, machinery/equipment, manpower, and methods. These four *M*s are the "causes." They provide a good checklist for initial analysis. Individual causes associated with each category are tied in as separate bones along that branch, often through a brainstorming process. For example, the method branch in Figure 6.7 has problems caused by hand position, follow-through, aiming point, bent knees, and balance. When a fish-bone chart is systematically developed, possible quality problems and inspection points are highlighted.

Pareto Charts

Pareto charts are a method of organizing errors, problems, or defects to help focus on problem-solving efforts. They are based on the work of Vilfredo Pareto, a 19th-century economist. Joseph M. Juran popularized Pareto's work when he suggested that 80% of a firm's problems are a result of only 20% of the causes.

Pareto charts
A graphic way of classifying problems by their level of importance, often referred to as the 80–20 rule.

Example 1 indicates that of the five types of complaints identified, the vast majority were of one type—poor room service.

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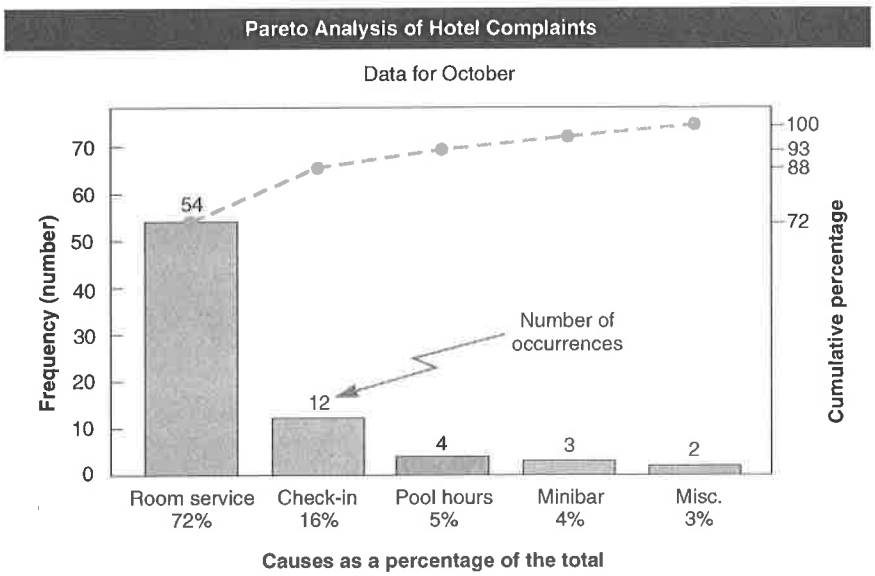
Example 1 A PARETO CHART AT THE HARD ROCK HOTEL

The Hard Rock Hotel in Bali has just collected the data from 75 complaint calls to the general manager during the month of October. The manager wants to prepare an analysis of the complaints. The data provided are room service, 54; check-in delays, 12; hours the pool is open, 4; minibar prices, 3; and miscellaneous, 2.

APPROACH ▶ A Pareto chart is an excellent choice for this analysis.

SOLUTION ▶ The Pareto chart shown below indicates that 72% of the calls were the result of one cause: room service. The majority of complaints will be eliminated when this one cause is corrected.



INSIGHT ▶ This visual means of summarizing data is very helpful—particularly with large amounts of data, as in the Southwestern University case study at the end of this chapter. We can immediately spot the top problems and prepare a plan to address them.

LEARNING EXERCISE ▶ Hard Rock's bar manager decides to do a similar analysis on complaints she has collected over the past year: too expensive, 22; weak drinks, 15; slow service, 65; short hours, 8; unfriendly bartender, 12. Prepare a Pareto chart. [Answer: slow service, 53%; expensive, 18%; drinks, 12%; bartender, 10%; hours, 7%.]

RELATED PROBLEMS ▶ 6.1, 6.3, 6.7b, 6.12, 6.13, 6.16c

ACTIVE MODEL 6.1 This example is further illustrated in Active Model 6.1 at www.pearsonhighered.com/heizer.

Pareto analysis indicates which problems may yield the greatest payoff. Pacific Bell discovered this when it tried to find a way to reduce damage to buried phone cable, the number-one cause of phone outages. Pareto analysis showed that 41% of cable damage was caused by construction work. Armed with this information, Pacific Bell was able to devise a plan to reduce cable cuts by 24% in one year, saving $6 million.

Likewise, Japan's Ricoh Corp., a copier maker, used the Pareto principle to tackle the "callback" problem. Callbacks meant the job was not done right the first time and that a second visit, at Ricoh's expense, was needed. Identifying and retraining only the 11% of the customer engineers with the most callbacks resulted in a 19% drop in return visits.

Flowcharts

Flowcharts
Block diagrams that graphically describe a process or system.

Flowcharts graphically present a process or system using annotated boxes and interconnected lines [see Figure 6.6(e)]. They are a simple but great tool for trying to make sense of a process or explain a process. Example 2 uses a flowchart to show the process of completing an MRI at a hospital.

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Example 2

A FLOWCHART FOR HOSPITAL MRI SERVICE

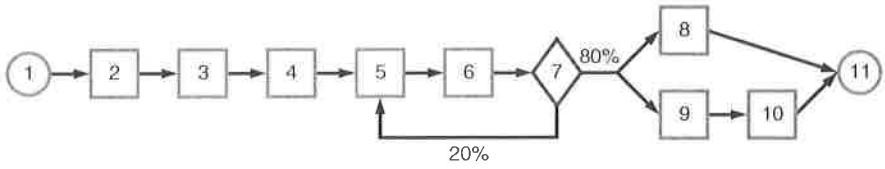
Arnold Palmer Hospital has undertaken a series of process improvement initiatives. One of these is to make the MRI service efficient for patient, doctor, and hospital. The first step, the administrator believes, is to develop a flowchart for this process.

APPROACH ► A process improvement staffer observed a number of patients and followed them (and information flow) from start to end. Here are the 11 steps:

1. Physician schedules MRI after examining patient (START).
2. Patient taken to the MRI lab with test order and copy of medical records.
3. Patient signs in, completes required paperwork.
4. Patient is prepped by technician for scan.
5. Technician carries out the MRI scan.
6. Technician inspects film for clarity.
7. If MRI not satisfactory (20% of time), Steps 5 and 6 are repeated.
8. Patient taken back to hospital room.
9. MRI is read by radiologist and report is prepared.
10. MRI and report are transferred electronically to physician.
11. Patient and physician discuss report (END).

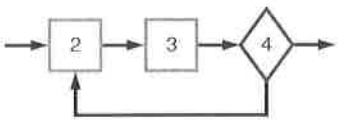
SOLUTION ► Here is the flowchart:

STUDENT TIP ☆ Flowcharting any process is an excellent way to understand and then try to improve that process.



INSIGHT ► With the flowchart in hand, the hospital can analyze each step and identify value-added activities and activities that can be improved or eliminated.

LEARNING EXERCISE ► If the patient's blood pressure is over 200/120 when being prepped for the MRI, she is taken back to her room for 2 hours and the process returns to Step 2. How does the flowchart change? Answer:



RELATED PROBLEMS ► 6.6, 6.15

Histograms

Histograms show the range of values of a measurement and the frequency with which each value occurs [see Figure 6.6(f)]. They show the most frequently occurring readings as well as the variations in the measurements. Descriptive statistics, such as the average and standard deviation, may be calculated to describe the distribution. However, the data should always be plotted so the shape of the distribution can be "seen." A visual presentation of the distribution may also provide insight into the cause of the variation.

Statistical Process Control (SPC)

Statistical process control (SPC) monitors standards, makes measurements, and takes corrective action as a product or service is being produced. Samples of process outputs are examined; if they are within acceptable limits, the process is permitted to continue. If they fall outside certain specific ranges, the process is stopped and, typically, the assignable cause located and removed.

Statistical process control (SPC) A process used to monitor standards, make measurements, and take corrective action as a product or service is being produced.

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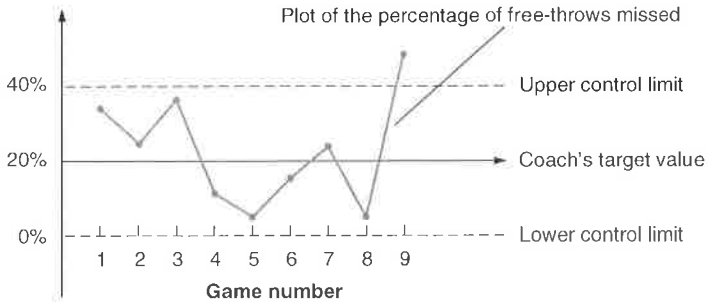
Figure 6.8
Control Chart for Percentage of Free-throws Missed by the Orlando Magic in Their First Nine Games of the New Season



Hedo Turkoglu

Control charts
Graphic presentations of process data over time, with predetermined control limits.

Control charts are graphic presentations of data over time that show upper and lower limits for the process we want to control [see Figure 6.6(g)]. Control charts are constructed in such a way that new data can be quickly compared with past performance data. We take samples of the process output and plot the average of each of these samples on a chart that has the limits on it. The upper and lower limits in a control chart can be in units of temperature, pressure, weight, length, and so on.

Figure 6.8 shows the plot of sample averages in a control chart. When the samples fall within the upper and lower control limits and no discernible pattern is present, the process is said to be in control with only natural variation present. Otherwise, the process is out of control or out of adjustment.

The supplement to this chapter details how control charts of different types are developed. It also deals with the statistical foundation underlying the use of this important tool.

The Role of Inspection

Inspection
A means of ensuring that an operation is producing at the quality level expected.

To make sure a system is producing at the expected quality level, control of the process is needed. The best processes have little variation from the standard expected. The operations manager's task is to build such systems and to verify, often by inspection, that they are performing to standard. This inspection can involve measurement, tasting, touching, weighing, or testing of the product (sometimes even destroying it when doing so). Its goal is to detect a bad process immediately. Inspection does not correct deficiencies in the system or defects in the products; nor does it change a product or increase its value. Inspection only finds deficiencies and defects. Moreover, inspections are expensive and do not add value to the product.

Inspection should be thought of as a vehicle for improving the system. Operations managers need to know critical points in the system: (1) *when to inspect* and (2) *where to inspect*.

When and Where to Inspect

Deciding when and where to inspect depends on the type of process and the value added at each stage. Inspections can take place at any of the following points:

1. At your supplier's plant while the supplier is producing.
2. At your facility upon receipt of goods from your supplier.
3. Before costly or irreversible processes.
4. During the step-by-step production process.
5. When production or service is complete.
6. Before delivery to your customer.
7. At the point of customer contact.

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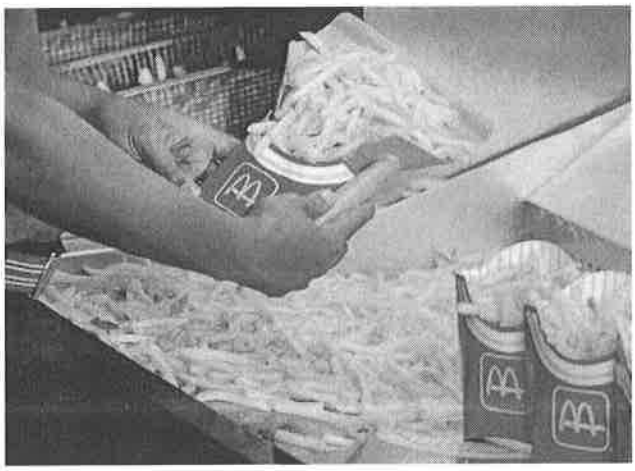

Ralf-Finn Hestoft/Corbis-NY

Good methods analysis and the proper tools can result in poka-yokes that improve both quality and speed. Here, two poka-yokes are demonstrated. First, the aluminum scoop automatically positions the french fries vertically, and second, the properly sized container ensures that the portion served is correct. McDonald's thrives by bringing rigor and consistency to the restaurant business.

The seven tools of TQM discussed in the previous section aid in this "when and where to inspect" decision. However, inspection is not a substitute for a robust product produced by well-trained employees in a good process. In one well-known experiment conducted by an independent research firm, 100 defective pieces were added to a "perfect" lot of items and then subjected to 100% inspection. The inspectors found only 68 of the defective pieces in their first inspection. It took another three passes by the inspectors to find the next 30 defects. The last two defects were never found. So the bottom line is that there is variability in the inspection process. Additionally, inspectors are only human: They become bored, they become tired, and the inspection equipment itself has variability. Even with 100% inspection, inspectors cannot guarantee perfection. Therefore, good processes, employee empowerment, and source control are a better solution than trying to find defects by inspection. You cannot inspect quality into the product.

☆ **STUDENT TIP**
One of our themes of quality is that "quality cannot be inspected into a product."

For example, at Velcro Industries, as in many other organizations, quality was viewed by machine operators as the job of "those quality people." Inspections were based on random sampling, and if a part showed up bad, it was thrown out. The company decided to pay more attention to the system (operators, machine repair and design, measurement methods, communications, and responsibilities) and to invest more money in training. Over time as defects declined, Velcro was able to pull half its quality control people out of the process.

Source Inspection

The best inspection can be thought of as no inspection at all; this "inspection" is always done at the source—it is just doing the job properly with the operator ensuring that this is so. This may be called **source inspection** (or source control) and is consistent with the concept of employee empowerment, where individual employees self-check their own work. The idea is that each supplier, process, and employee *treats the next step in the process as the customer*, ensuring perfect product to the next "customer." This inspection may be assisted by the use of checklists and controls such as a fail-safe device called a *poka-yoke*, a name borrowed from the Japanese.

Source inspection
Controlling or monitoring at the point of production or purchase—at the source.

A **poka-yoke** is a foolproof device or technique that ensures production of good units every time. These special devices avoid errors and provide quick feedback of problems. A simple example of a poka-yoke device is the diesel gas pump nozzle that will not fit into the "unleaded" gas tank opening on your car. In McDonald's, the french fry scoop and standard-size bag used to measure the correct quantity are poka-yokes. Similarly, in a hospital, the prepackaged surgical coverings that contain exactly the items needed for a medical procedure are poka-yokes.

Poka-yoke
Literally translated, "foolproof"; it has come to mean a device or technique that ensures the production of a good unit every time.

Checklists are a type of poka-yoke to help ensure consistency and completeness in carrying out a task. A basic example is a to-do list. This tool may take the form of preflight checklists used by airplane pilots, surgical safety checklists used by doctors, or software quality assurance lists used by programmers. The *OM in Action* box "Safe Patients, Smart Hospitals" illustrates the important role checklists have in hospital quality.

Checklist
A type of poka-yoke that lists the steps needed to ensure consistency and completeness in a task.

The idea of source inspection, poka-yokes, and checklists is to guarantee 100% good product or service at each step of a process.

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OM in Action Safe Patients, Smart Hospitals

Simple and avoidable errors are made in hospitals each day, causing patients to die. Inspired by two tragic medical mistakes—his father's misdiagnosed cancer and sloppiness that killed an 18-month-old child at Johns Hopkins—Dr. Peter Pronovost has made it his mission, often swimming upstream against the medical culture, to improve patient safety and prevent deaths.

He began by developing a basic 5-step checklist to reduce catheter infections. Inserted into veins in the groin, neck, or chest to administer fluids and medicines, catheters can save lives. But every year, 80,000 Americans get infections from *central venous catheters* (or lines) and over 30,000 of these patients die. Pronovost's checklist has dropped infection rates at hospitals that use it down to zero, saving thousands of lives and tens of millions of dollars.

His steps for doctors and nurses are simple: (1) wash your hands; (2) use sterile gloves, masks, and drapes; (3) use antiseptic on the area being opened for the catheter; (4) avoid veins in the arms and legs; and (5) take the catheter out as soon as possible. He also created a special cart, where all supplies needed are stored.

Dr. Provonost believes that many hospital errors are due to lack of standardization, poor communications, and a noncollaborative culture that is "antiquated and toxic." He points out that checklists in the airline industry are a science, and *every* crew member works as part of the safety team. Provonost's book has shown that one person, with small changes, can make a huge difference.

David Joel/Getty Images Inc.-Photographer's Choice Royalty Free

Sources: Safe Patients, Smart Hospitals (Penguin Publishers, 2011); and *The Wall Street Journal* (March 2, 2011).

Service Industry Inspection

In *service*-oriented organizations, inspection points can be assigned at a wide range of locations, as illustrated in Table 6.4. Again, the operations manager must decide where inspections are justified and may find the seven tools of TQM useful when making these judgments.

Inspection of Attributes versus Variables

Attribute inspection
An inspection that classifies items as being either good or defective.

Variable inspection
Classifications of inspected items as falling on a continuum scale, such as dimension or strength.

When inspections take place, quality characteristics may be measured as either *attributes* or *variables*. **Attribute inspection** classifies items as being either good or defective. It does not address the *degree* of failure. For example, the lightbulb burns or it does not. **Variable inspection** measures such dimensions as weight, speed, size, or strength to see if an item falls within an acceptable

TABLE 6.4 Examples of Inspection in Services

ORGANIZATION	WHAT IS INSPECTED	STANDARD
Jones Law Offices	Receptionist performance	Phone answered by the second ring
	Billing	Accurate, timely, and correct format
	Attorney	Promptness in returning calls
Hard Rock Hotel	Reception desk	Use customer's name
	Doorman	Greet guest in less than 30 seconds
	Room	All lights working, spotless bathroom
	Minibar	Restocked and charges accurately posted to bill
Arnold Palmer Hospital	Billing	Accurate, timely, and correct format
	Pharmacy	Prescription accuracy, inventory accuracy
	Lab	Audit for lab-test accuracy
	Nurses	Charts immediately updated
	Admissions	Data entered correctly and completely
Olive Garden Restaurant	Busboy	Serves water and bread within one minute
	Busboy	Clears all entrée items and crumbs prior to dessert
	Waiter	Knows and suggests specials, desserts
Nordstrom Department Store	Display areas	Attractive, well organized, stocked, good lighting
	Stockrooms	Rotation of goods, organized, clean
	Salesclerks	Neat, courteous, very knowledgeable

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range. If a piece of electrical wire is supposed to be 0.01 inch in diameter, a micrometer can be used to see if the product is close enough to pass inspection.

Knowing whether attributes or variables are being inspected helps us decide which statistical quality control approach to take, as we will see in the supplement to this chapter.

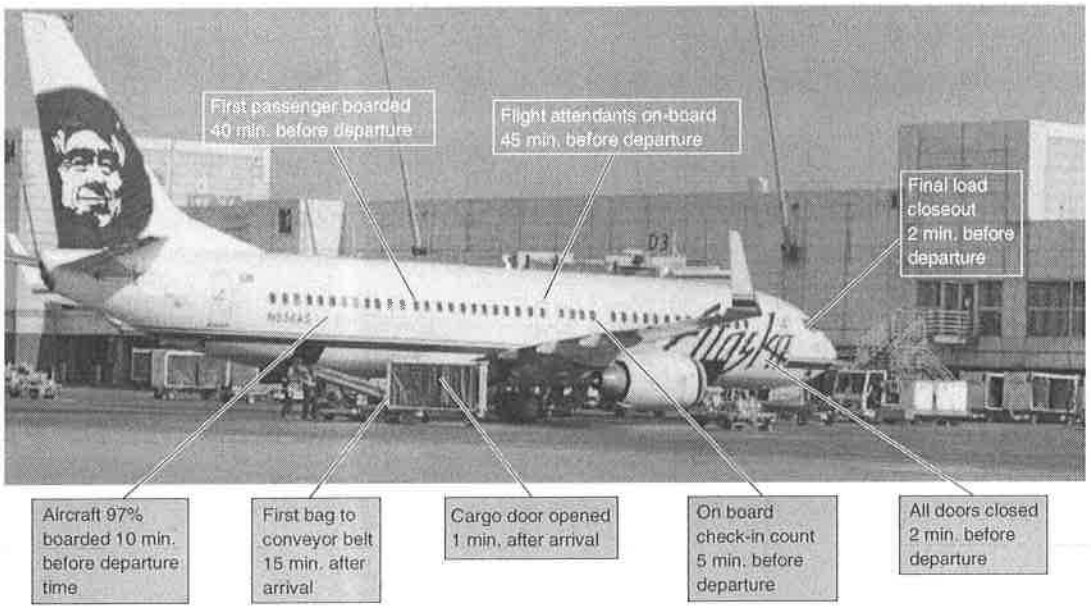
TQM in Services

The personal component of services is more difficult to measure than the quality of the tangible component. Generally, the user of a service, like the user of a good, has features in mind that form a basis for comparison among alternatives. Lack of any one feature may eliminate the service from further consideration. Quality also may be perceived as a bundle of attributes in which many lesser characteristics are superior to those of competitors. This approach to product comparison differs little between goods and services. However, what is very different about the selection of services is the poor definition of the (1) *intangible differences between products* and (2) *the intangible expectations customers have of those products.* Indeed, the intangible attributes may not be defined at all. They are often unspoken images in the purchaser's mind. This is why all of those marketing issues such as advertising, image, and promotion can make a difference.

The operations manager plays a significant role in addressing several major aspects of service quality. First, the *tangible component of many services is important.* How well the service is designed and produced does make a difference. This might be how accurate, clear, and complete your checkout bill at the hotel is, how warm the food is at Taco Bell, or how well your car runs after you pick it up at the repair shop.

Second, another aspect of service and service quality is the process. Notice in Table 6.5 that 9 out of 10 of the determinants of service quality are related to *the service process.* Such things as reliability and courtesy are part of the process. An operations manager can *design processes (service products) that have these attributes* and can ensure their quality through the TQM techniques discussed in this chapter. (See the Alaska Airlines photo).

Third, the operations manager should realize that the customer's expectations are the standard against which the service is judged. Customers' perceptions of service quality result from a comparison of their "before-service expectations" with their "actual-service experience." In



Christophe Testi/Shutterstock

Like many service organizations, Alaska Airlines sets quality standards in areas such as courtesy, appearance, and time. Shown here are some of Alaska Airlines's 50 quality checkpoints, based on a timeline for each departure.

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TABLE 6.5 Determinants of Service Quality

Reliability involves consistency of performance and dependability. It means that the firm performs the service right the first time and that the firm honors its promises.
Responsiveness concerns the willingness or readiness of employees to provide service. It involves timeliness of service.
Competence means possession of the required skills and knowledge to perform the service.
Access involves approachability and ease of contact.
Courtesy involves politeness, respect, consideration, and friendliness of contact personnel (including receptionists, telephone operators, etc.).
Communication means keeping customers informed in language they can understand and listening to them. It may mean that the company has to adjust its language for different consumers—increasing the level of sophistication with a well-educated customer and speaking simply and plainly with a novice.
Credibility involves trustworthiness, believability, and honesty. It involves having the customer's best interests at heart.
Security is the freedom from danger, risk, or doubt.
Understanding/knowing the customer involves making the effort to understand the customer's needs.
Tangibles include the physical evidence of the service.

Sources: Adapted from A. Parasuranam, Valarie A. Zeithaml, and Leonard L. Berry, "A Conceptual Model of Service Quality and Its Implications for Future Research," *Journal of Marketing* (1985): 49. Copyright © 1985 by the American Marketing Association. Reprinted with permission.

other words, service quality is judged on the basis of whether it meets expectations. The *manager may be able to influence both the quality of the service and the expectation.* Don't promise more than you can deliver.

Fourth, the manager must expect exceptions. There is a standard quality level at which the regular service is delivered, such as the bank teller's handling of a transaction. However, there are "exceptions" or "problems" initiated by the customer or by less-than-optimal operating conditions (e.g., the computer "crashed"). This implies that the quality control system must recognize and *have a set of alternative plans for less-than-optimal operating conditions.*

Service recovery
Training and empowering frontline workers to solve a problem immediately.

Well-run companies have service recovery strategies. This means they train and empower frontline employees to immediately solve a problem. For instance, staff at Marriott Hotels are drilled in the LEARN routine—*L*isten, *E*mpathize, *A*pologize, *R*eact, *N*otify—with the final step ensuring that the complaint is fed back into the system. And at the Ritz-Carlton, staff members are trained not to say merely "sorry" but "please accept my apology." The Ritz gives them a budget for reimbursing upset guests.

Designing the product, managing the service process, matching customer expectations to the product, and preparing for the exceptions are keys to quality services. The *OM in Action* box "Richey International's Spies" provides another glimpse of how OM managers improve quality in services.

VIDEO 6.2
TQM at Ritz-Carlton Hotels

OM in Action Richey International's Spies

How do luxury hotels maintain quality? They inspect. But when the product is one-on-one service, largely dependent on personal behavior, how do you inspect? You hire spies!

Richey International is the spy. Preferred Hotels and Resorts Worldwide and Intercontinental Hotels have both hired Richey to do quality evaluations via spying. Richey employees posing as customers perform the inspections. However, even then management must have established what the customer expects and specific services that yield customer satisfaction. Only then do managers know where and how to inspect. Aggressive training and objective inspections reinforce behavior that will meet those customer expectations.

The hotels use Richey's undercover inspectors to ensure performance to exacting standards. The hotels do not know when the evaluators will arrive. Nor what aliases they will use. Over 50 different standards are evaluated before the inspectors even check in at a luxury hotel. Over the next 24 hours, using checklists, tape recordings, and photos, written reports are prepared. The reports include evaluation of standards such as:

- Does the doorman greet each guest in less than 30 seconds?
- Does the front-desk clerk use the guest's name during check-in?
- Are the bathroom tub and shower spotlessly clean?
- How many minutes does it take to get coffee after the guest sits down for breakfast?
- Did the waiter make eye contact?
- Were minibar charges posted correctly on the bill?

Established standards, aggressive training, and inspections are part of the TQM effort at these hotels. Quality does not happen by accident.

Sources: Hotel and Motel Management (August 2002); *The Wall Street Journal* (May 12, 1999); and *Forbes* (October 5, 1998).

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Summary

Quality is a term that means different things to different people. We define quality as "the totality of features and characteristics of a product or service that bears on its ability to satisfy stated or implied needs." Defining quality expectations is critical to effective and efficient operations.

Quality requires building a total quality management (TQM) environment because quality cannot be inspected into a product. The chapter also addresses seven TQM *concepts*: continuous improvement, Six Sigma, employee empowerment, benchmarking, just-in-time, Taguchi concepts, and knowledge of TQM tools. The seven TQM *tools* introduced in this chapter are check sheets, scatter diagrams, cause-and-effect diagrams, Pareto charts, flowcharts, histograms, and statistical process control (SPC).

Key Terms

Quality (p. 209)
ISO 9000 (p. 210)
Cost of quality (COQ) (p. 210)
Total quality management (TQM) (p. 212)
PDCA (p. 212)
Six Sigma (p. 213)
Employee empowerment (p. 214)
Quality circle (p. 214)
Benchmarking (p. 214)
Quality robust (p. 216)
Quality loss function (QLF) (p. 217)
Target-oriented quality (p. 217)
Cause-and-effect diagram, Ishikawa diagram, or fish-bone chart (p. 219)
Pareto charts (p. 219)
Flowcharts (p. 220)
Statistical process control (SPC) (p. 221)
Control charts (p. 222)
Inspection (p. 222)
Source inspection (p. 223)
Poka-yoke (p. 223)
Checklists (p. 223)
Attribute inspection (p. 224)
Variable inspection (p. 224)
Service recovery (p. 226)

Ethical Dilemma

A lawsuit a few years ago made headlines worldwide when a McDonald's drive-through customer spilled a cup of scalding hot coffee on herself. Claiming the coffee was too hot to be safely consumed in a car, the badly burned 80-year-old woman won $2.9 million in court. (The judge later reduced the award to $640,000.) McDonald's claimed the product was served to the correct specifications and was of proper quality. Further, the cup read "Caution—Contents May Be Hot." McDonald's coffee, at 180°, is substantially hotter (by corporate rule) than typical restaurant coffee, despite hundreds of coffee-scalding complaints in the past 10 years. Similar court cases, incidentally, resulted in smaller verdicts, but again in favor of the plaintiffs. For example, Motor City Bagel Shop was sued for a spilled cup of coffee by a drive-through patron, and Starbucks by a customer who spilled coffee on her own ankle.

Are McDonald's, Motor City, and Starbucks at fault in situations such as these? How do quality and ethics enter into these cases?

Discussion Questions

1. Explain how improving quality can lead to reduced costs.
2. As an Internet exercise, determine the Baldrige Award criteria. See the Web site **www.quality.nist.gov.**
3. Which 3 of Deming's 14 points do you think are most critical to the success of a TQM program? Why?
4. List the seven concepts that are necessary for an effective TQM program. How are these related to Deming's 14 points?
5. Name three of the important people associated with the quality concepts of this chapter. In each case, write a sentence about each one summarizing his primary contribution to the field of quality management.
6. What are seven tools of TQM?
7. How does fear in the workplace (and in the classroom) inhibit learning?
8. How can a university control the quality of its output (that is, its graduates)?
9. Philip Crosby said that quality is free. Why?
10. List the three concepts central to Taguchi's approach.
11. What is the purpose of using a Pareto chart for a given problem?
12. What are the four broad categories of "causes" to help initially structure an Ishikawa diagram or cause-and-effect diagram?
13. Of the several points where inspection may be necessary, which apply especially well to manufacturing?
14. What roles do operations managers play in addressing the major aspects of service quality?
15. Explain, in your own words, what is meant by *source inspection*.
16. What are 10 determinants of service quality?
17. Name several products that do not require high quality.
18. What does the formula $L = D^2C$ mean?
19. In this chapter, we have suggested that building quality into a process and its people is difficult. Inspections are also difficult. To indicate just how difficult inspections are, count the number of *E*s (both capital *E* and lowercase *e*) in the *OM in Action* box "Richey International's Spies" on page 226 (include the title but not the source note). How many did you find? If each student does this individually, you are very likely to find a distribution rather than a single number!

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