An Introduction to Six Sigma and Process Improvement 2nd Edition
Solutions Manual Evans Lindsay

Solutions Manual, Answer key, Instructor Reserve Problems, Student Projects, Solution Excel File for all chapters are included


CHAPTER 1

Foundations of Six Sigma: Principles of Quality Management

Teaching Notes

The first chapter provides an overview of the foundations of the Six Sigma philosophy and methodology and its relation to principles of quality in a rapidly changing business environment. Actually, that has become a cliché. Perhaps we should use the phrase: “a chaotic business environment.” Students at both the undergraduate and graduate level are likely to be taking this course as an elective, or using this text as a supplement to a quality or project management course, so you may have a tendency to assume that they are "self-motivated" by simply being there. This is not necessarily the case. The terms “TQM,” “total quality,” “Six Sigma” or even “Lean-Six Sigma” may be looked upon by some as outdated. For some, they may have become such an accepted practice in some industries that students may say “ho-hum, what’s new?” You should try to "hook” them on the excitement of quality by pointing out that if quality management and the implementation of Six Sigma were “easy,” everyone would have a smoothly operating system with few errors or product recalls. Because adopting and implementing the philosophy is difficult, those who can actually “do it” will be in demand. Key objectives should include:

- To define the concept of “breakthrough” and its key relationship to Six Sigma.
- To show how Six Sigma has evolved from several disciplines and is based on solid quality principles.
- To introduce the concept of quality assurance -- providing consumers with goods and services of appropriate quality, as a point of reference. This is often how the average person thinks of quality, but it requires pointing out its limitations, as a technical, rather than a managerial, approach.
To review the history of quality from the Craftsmanship era in the 1700’s, through the Japanese post-World War II challenge brought on by attention to quality and international competitiveness, to the “Quality revolution” in the U.S. and elsewhere in the 1980’s through the early 21st Century. The “revolution” came about as a result of consumer pressures, technological change, outmoded managerial thinking, and competitive pressures that changed the way that U.S. and managers around the world viewed the role of quality.

To explore the differences between Six Sigma and total quality management (TQM).

To understand how different perspectives on quality are necessary, and related definitions.

To develop an understanding of the differences between consumers, external customers and internal customers and the importance of “critical to quality” (CTQ) characteristics in meeting customer needs.

To explore the promise of Six Sigma for revitalizing the focus on quality in the 21st century.

To instill in every student the idea that quality and its derivative, the Six Sigma approach, is a managerial concept first, and a technical concept, second, and to point out that quality is vital to every organization at every level, not just to manufacturing firms in their production areas.

To reinforce the concept of the role of quality and the use of Six Sigma to enhance a firm's profitability and competitive advantage. Studies have shown that quality is positively related to increased market share and profitability.

In the first class session we provide a few introductory remarks about the importance of quality (see PowerPoint© slides for use in your lectures) and then often show a video or YouTube segment. The annual YouTube video versions of NIST’s Malcolm Baldrige National Quality Award winners’ profiles provides for an ever-expanding and rich source of inexpensive case studies that can supplement the text materials. These are available through YouTube (http://www.youtube.com/playlist?list=PL914FB9D44BF49C14).

Also, associations such as the American Society for Quality (ASQ), Society for Manufacturing Engineers (SME), the Institute of Industrial Engineers (IIE), and the Institute for Operations Research and Management Science (INFORMS) are excellent sources for quality films and materials. As mentioned above, the Baldrige award series continues to be updated, year-by-year, featuring the videos filmed by NIST at the Baldrige Awards, and includes profiles of the awardees. Another source for various Baldrige, quality, and Six Sigma materials is the Baldrige Foundation’s website at: http://www.baldrigepe.org/

ANSWERS TO REVIEW QUESTIONS

1. Define the term “breakthrough.” Why is it an important concept for modern organizations?
Ans. **Breakthrough** can be defined as the accomplishment of any improvement that takes an organization to unprecedented levels of performance. It is important for modern organizations because every organization needs to improve in order to compete in today’s world. Mere incremental improvement is seldom sufficient, because of the disruptive technological changes that seem to be taking place at an increasingly rapid pace. It is hard to believe, but the iPhone was only introduced in 2007. Now, some seven years later, it is considered a “mature” design, even though it was a “breakthrough” technology at the time that it was introduced.

2. Define Six Sigma. Where did the term originate?

Ans. Six Sigma is a business improvement approach that seeks to find and eliminate causes of defects and errors in manufacturing and service processes by focusing on outputs that are critical to customers and a clear financial return for the organization. The term *six sigma* is based on a statistical measure that equates to 3.4 or fewer errors or defects per million opportunities.

3. What does the acronym DMAIC stand for?

Ans. **DMAIC** stands for Define, Measure, Analyze, Improve, and Control. It is a simple problem solving methodology that incorporates a wide variety of statistical and other types of process improvement tools.

4. List the four key metrics on which Six Sigma is focused.

Ans. Six Sigma is focused on four key issues of: **quality, productivity, cost, and profitability.** The quality of the goods and services that create customer satisfaction, productivity (the measure of efficiency defined as the amount of output achieved per unit of input), and the cost of operations, and all contribute to profitability.

5. Explain the difference between the terms “Six Sigma” and “six sigma.”

Ans. The term *six sigma* is based on a statistical measure that equates to 3.4 or fewer errors or defects per million opportunities. (The key difference between *six sigma* – the defect- or error-based metric, and *Six Sigma* – the approach and philosophy is that one is quantitative and the other is qualitative – in an organizational sense.) An ultimate “stretch” goal of all organizations that adopt a Six Sigma philosophy is to have all critical processes, regardless of functional area, at a six-sigma level of capability.

6. What are the core concepts of the Six Sigma philosophy?

Ans. The core philosophy of Six Sigma is based on the following key concepts.

1. Think in terms of key organizational processes and customer requirements with a clear focus on overall strategic objectives.
2. Focus on high-level executive sponsors responsible for championing projects, supporting team activities, helping to overcome resistance to change, and obtaining resources.
3. Emphasize such quantifiable measures as defects per million opportunities (dpmo) that can be applied to all parts of an organization: manufacturing, service, engineering, administrative, software, and so on.

4. Ensure that appropriate metrics are identified early in the process and that they focus on business results, thereby providing incentives and accountability.

5. Provide extensive training followed by project team deployment to improve profitability, reduce non-value-added activities, and achieve cycle time reductions.

6. Create highly qualified process improvement experts who can apply improvement tools and lead teams.

7. Set stretch objectives for improvement.

7. Describe the evolution of quality management and how it influenced the Six Sigma philosophy.

Ans. Evidence of the search for quality dates back to ancient Egypt, as indicated in the precision and uniformity of methods used in the construction of the pyramids. The craftsperson of the Middle Ages took special care to ensure quality in his/her product, a necessary step since he/she dealt directly with the customer. In the late 18th Century, Eli Whitney helped trigger the Industrial Revolution with his development of interchangeable machine parts. The Industrial Revolution itself was a key turning point, since it made quality assurance a critical component of the production process. However, quality was determined only after the products were finished, rather than during the manufacturing process, so as volume increased and costs decreased, craftsmanship decreased.

Quality control techniques were further developed in the early 20th Century, when methods of inspection to improve and maintain quality were gradually separated from production techniques. The significant difference between early and late 20th Century quality approaches was the development of the concept of “total quality” as applied to every area of an organization, not just the production and/or operations functions. In the early 21st Century, the emphasis has been placed on bringing quality improvement to the “bottom line” results by alignment of quality objectives with organizational goals.

Motorola pioneered the concept of Six Sigma as an approach to measuring product and service quality. The late Bill Smith, a reliability engineer at Motorola, is credited with originating the concept during the mid-1980s and selling it to Motorola’s CEO, Robert Galvin. Smith noted that system failure rates were substantially higher than predicted by final product test, and suggested several causes, including higher system complexity that resulted in more opportunities for failure, and a fundamental flaw in traditional quality thinking. He concluded that a much higher level of internal quality was required and convinced Galvin of its importance.

The recognized benchmark for Six Sigma implementation is General Electric, with implementation initially driven by former CEO, Jack Welch. Quality emerged as a concern of many employees at GE in the mid-1990’s, so Welch invited Larry Bossidy, CEO of Allied Signal, to talk about it at a Corporate Executive Council meeting. The meeting caught the
attention of GE managers and Six Sigma was launched, as the most ambitious task the company had ever taken on. To ensure success, GE: 1) changed its incentive compensation plan so that 40 percent of the bonus was based on Six Sigma, 2) provided stock option grants to employees in Six Sigma training, 3) trained 30,000 employees at a cost of $200 million and got back about $150 million in savings, increased the number of Six Sigma projects from 3,000 to 6,000 (1996-1997) and achieved $320 million in productivity gains and profits, generated $750 million in Six Sigma savings over and above their investment, and received $1.5 billion savings in 1998. GE also had many early success stories, and credits Six Sigma with a 10-fold increase in the life of CT scanner X-ray tubes, a 400 percent improvement in return on investment in its industrial diamond business, a 62 percent reduction in turnaround time at railcar repair shops, and $400 million in savings in its plastics business.

8. How does Six Sigma differ from TQM (total quality management)? How is it similar?

Ans. Six Sigma is more than simply a repackaging of older quality approaches, such as the traditional notion of TQM. Some of the contrasting features include:

- TQM is based largely on worker empowerment and teams; Six Sigma is owned by business leader champions.
- TQM activities generally occur within a function, process, or individual workplace; Six Sigma projects are truly cross-functional.
- TQM training is generally limited to simple improvement tools and concepts; Six Sigma focuses on a more rigorous and advanced set of statistical methods and a structured problem-solving methodology DMAIC—define, measure, analyze, improve, and control — discussed in detail in Chapter 2.
- TQM is focused on improvement with little financial accountability; Six Sigma requires a verifiable return on investment and focus on the bottom line.

In addition, Six Sigma has elevated the importance of statistics and statistical thinking in quality improvement. Six Sigma’s focus on measurable bottom-line results, a disciplined statistical approach to problem solving, rapid project completion, and organizational infrastructure make it a powerful methodology for improvement. They are similar because they both focus on improvement, teamwork, and customer satisfaction.

9. Explain the definitions of quality from design, operations, and customer perspectives.

Ans. Neither consultants nor business professionals agree on a universal definition. A study that asked managers of 86 firms in the eastern United States to define quality produced several dozen different responses. The ANSI/ASQ definition states quality is "the totality of features and characteristics of a product or service that bears on its ability to satisfy given needs." Quality must be defined from a number of different perspectives in order to focus on features that are essential to both the producer and the customer. No single definition is adequate because customer needs are constantly changing and because quality is "situational" -- e.g. a good design for one purpose, and in the eyes of one set of customers, may represent a poor design for another use or another set of customers. Reliance on a single definition of quality is frequently a source of problems.
10. Explain the concept of specifications and provide examples in both manufacturing and service.

Ans. **Specifications** are targets and tolerances determined by designers of products and services. Targets are the ideal values for which production is to strive; tolerances are specified because designers recognize that it is impossible to meet targets all of the time in manufacturing. For example, a part dimension might be specified as “0.236 ± 0.003 cm.” These measurements would mean that the target, or ideal value, is 0.236 centimeters, and that the allowable variation is 0.003 centimeters from the target (a tolerance of 0.006 cm). Thus, any dimension in the range 0.233 to 0.239 centimeters is deemed acceptable and is said to conform to specifications. Likewise, in services, “on-time arrival” for an airplane might be specified as within 15 minutes of the scheduled arrival time. The target is the scheduled time, and the tolerance is specified to be 15 minutes.

11. Distinguish among consumers, external customers, and internal customers. Illustrate how these concepts apply to a McDonald’s restaurant, a Pizza Hut, or a similar franchise.

Ans. One often-quoted definition of quality is: **Quality is meeting or exceeding customer expectations.** To better understand this definition, one must first understand the meanings of “customer.” At Pizza Hut or McDonald’s the ultimate purchaser is generally the one who eats the product. These customers are precisely referred to as **consumers.** Before a product reaches consumers, however, it may flow through a chain of many firms or departments, each of which adds some value to the product. For example, Pizza Hut, which is owned by PepsiCo, may purchase its soft drink products from another Pepsi company, while McDonald’s may purchase their soft drinks from Coca Cola. The soft drink company is a supplier to the franchiser, and the franchiser sells to the consumer. These customers (franchisers) are called **external customers** of the soft drink firms. Fast food purchasers are external customers of the front counter attendants, as well.

Every employee in a company also has **internal customers** who receive goods or services from suppliers within the company. The “front counter,” or “drive-through window,” is an internal customer of the pizza bakers or fry cooks, and managers are internal customers of the front counter attendants. Thus, the job of an employee is not simply to please his or her supervisor; it is to satisfy the needs of particular internal and external customers. A poor design for a computerized order-taking system makes it difficult for front counter and drive-through attendants to do their job, and consequently affects consumers’ satisfaction. Identifying who one’s customers are and understanding their expectations are fundamental to achieving customer satisfaction.

12. State and briefly explain the eight fundamental principles of quality management.

Ans. The eight fundamental principles are:

*Principle 1: Customer Focus*

Organizations depend on their customers and therefore should understand current and future customer needs, should meet customer requirements, and strive to exceed customer...
Principle 2: Leadership
Leaders establish unity of purpose and direction of the organization. They should create and maintain the internal environment in which people can become fully involved in achieving the organization’s objectives.

Principle 3: Involvement of People
People at all levels are the essence of an organization and their full involvement enables their abilities to be used for the organization’s benefit.

Principle 4: Process Approach
A desired result is achieved more efficiently when activities and related resources are managed as a process.

Principle 5: System Approach to Management
Identifying, understanding, and managing interrelated processes as a system contributes to the organization’s effectiveness and efficiency in achieving its objectives.

Principle 6: Continual Improvement
Continual improvement of the organization’s overall performance should be a permanent objective of the organization.

Principle 7: Factual Approach to Decision Making
Effective decisions are based on the analysis of data and information.

Principle 8: Mutually Beneficial Supplier Relationships
An organization and its suppliers are interdependent and a mutually beneficial relationship enhances the ability of both to create value.

Despite their obvious simplicity, these principles are quite different from traditional management practices due to a new focus on understanding external customer requirements, and internal customer needs. In the past, managers and specialists controlled and directed production systems, workers were told what to do and how to do it, and only rarely were asked for their input. Teamwork was virtually nonexistent. A certain amount of waste and error was tolerable and was controlled by postproduction inspection. Improvements in quality generally resulted from technological breakthroughs instead of a relentless mindset of continuous improvement. With a true focus on quality, an organization actively seeks to identify customer needs and expectations, to build quality into work processes by tapping the knowledge and experience of its workforce, and to continually improve every facet of the organization. Understanding and implementing these principles is vital to Six Sigma.

13. What is a process? State some examples in both manufacturing and service.

Ans. A process is defined as a sequence of activities that is intended to achieve some result. More simply, it can be said that it is the steps required to achieve an outcome. A process focus in an organization requires different thinking from the traditional organization’s approach, because one must step away from the vertical “organization chart” view (sometimes called “chimneys” or “silos”) and adopt a horizontal, or cross-functional view of how work gets done.

14. To what does the term “improvement” refer? Provide some examples of types of improvements.
Ans. The term improvement refers to both incremental changes, which are small and gradual, and breakthrough, or large and rapid ("breakthrough"), improvements. Performance improvement can include: enhancing value to the customer through new and improved products and services; reducing errors, defects, waste, and their related costs, increasing productivity and effectiveness in the use of all resources; and improving responsiveness and cycle time performance. For example, in processes such as resolving customer complaints or new product introduction, improvements may involve better design of goods and services, reduction of manufacturing defects and service errors, more streamlined and efficient operations, faster customer response, or better employee skills. Improvement requires the right methodologies and tools including a structured approach, disciplined thinking, and the engagement of everyone in the organization.

15. Explain the concept of learning. What stages comprise a learning cycle?
Ans. The concept of learning, refers to understanding why changes are successful through feedback between practices and results, and leads to new goals and approaches. A learning cycle has four stages:

1. planning
2. execution of plans
3. assessment of progress, and
4. revision of plans based upon assessment findings.

Learning from completed Six Sigma projects helps to improve the application of Six Sigma in the future.

16. What are the key determinants of profitability that underline Six Sigma? How does Six Sigma address these and support the achievement of a competitive advantage?
Ans. The key determinants of profitability are: Productivity (the measure of efficiency defined as the amount of output achieved per unit of input), the cost of operations, and the quality of the goods and services that create customer satisfaction all contribute to profitability. Of these three determinants, perhaps the most significant factor in determining the long-run success or failure of any organization is quality. High-quality goods and services can provide an organization with a competitive edge. High quality reduces costs due to returns, rework, and scrap. It increases productivity, profits, and other measures of success. Most importantly, high quality generates satisfied customers, who reward the organization with continued patronage and favorable word-of-mouth advertising.

Considerable evidence exists that Six Sigma initiatives directly addresses profitability by positively impacting bottom-line results. Companies that invest in such efforts experience outstanding returns and improvements in performance. Various research studies show that quality-focused companies achieved better employee participation and relations, improved product and service quality, higher productivity, greater customer satisfaction, increased market share, and improved profitability.
A product's value in the marketplace, and hence, its profitability, is influenced by the quality of its design. Improvements in performance, features, and reliability within the product will differentiate it from its competitors, improving the firm's quality reputation and the perceived value of the product, and allowing the company to command higher prices and achieve a greater market share. This leads to increased revenues, which offset the costs of improving the design. Improved conformance to quality standards in production also saves rework, scrap, and warranty expenses, thus decreasing manufacturing and service costs.

ANSWERS TO DISCUSSION QUESTIONS

1. Discuss how Six Sigma might benefit you personally.
   Ans. Students should have numerous personal examples of how good and poor quality has affected them. Often, they are harder pressed to come up with an example of good quality than one of poor quality. For example, one of the authors experienced outstanding quality when he went to a computer store and selected a printer. After completing the paperwork and payment part of the transaction, the store employee went to the back, retrieved a sealed box containing the printer model that was purchased, cut the tape on the box, attached the printer to a computer with the correct cord which he picked from many on the rack, ran through a print test, repacked the printer, retaped the box, carried the printer to the author’s car, and placed it carefully in the trunk!

2. Do you believe that William Cooper Procter’s statement from 1887 is still true today? Why or why not?
   Ans. As pointed out by William Cooper Procter, grandson of the founder of Procter & Gamble, “The first job we have is to turn out quality merchandise that consumers will buy and keep on buying. If we produce it efficiently and economically, we will earn a profit, in which you will share.” Procter’s statement addresses four key issues: quality, productivity, cost, and profitability. The quality of the goods and services that create customer satisfaction, productivity (the measure of efficiency defined as the amount of output achieved per unit of input), and the cost of operations, and all contribute to profitability. The weight of the evidence appears to be in favor of the statement still being applicable, today.

3. Do you believe that Motorola’s quest for zero defects is realistic and achievable? Why or why not? In either case, what benefit would there be to setting such a goal?
   Ans. Motorola set a goal in 1987 to improve product and service quality ten times by 1989, at least one hundred fold by 1991, and to achieve six-sigma capability by 1992. Their objective was to foster quality in every facet of the corporation, and achieve a culture of continual improvement to assure total customer satisfaction. As they noted “There is only one ultimate goal: zero defects—in everything we do.” They achieved all of those goals prior to 1992 in most of their processes. Whether this can be done in every organization is certainly debatable. However, if it cannot, just setting the goal and the effort to approach that goal will benefit the overall quality of any organization and its products or services.
4. How might the key concepts of Six Sigma be used to improve a quality process in a school or university? What elements of the Six Sigma philosophy might be difficult to obtain support for in the educational environment? Why?

Ans. The key concepts of the Six Sigma core philosophy are:

- Think in terms of key business processes and customer requirements with a clear focus on overall strategic objectives.
- Focus on corporate sponsors responsible for championing projects, support team activities, help to overcome resistance to change, and obtain resources.
- Emphasize such quantifiable measures as defects per million opportunities (dpmo) that can be applied to all parts of an organization: manufacturing, engineering, administrative, software, and so on.
- Ensure that appropriate metrics are identified early in the process and that they focus on business results, thereby providing incentives and accountability.
- Provide extensive training followed by project team deployment to improve profitability, reduce non-value-added activities, and achieve cycle time reductions.
- Create highly qualified process improvement experts (“green belts,” “black belts,” and “master black belts”) who can apply improvement tools and lead teams.
- Set stretch objectives for improvement.

Therefore, to develop better processes, such as a system for distributing scarce athletic tickets to football or basketball events, a Six Sigma process might be used. The strategic objectives of student entertainment, team development, and organizational pride would have to be considered, along with alumni loyalty and fund-raising. Corporate sponsors might have to be drawn from several areas affected by the process, such as student activities and alumni affairs. A cross functional team would have to be selected and trained in Six Sigma methods. A process improvement specialist (Six Sigma Black Belt or similarly-trained resource) would have to be assigned. Finally, stretch goals for improvement might be set, such as a significant improvement in alumni and student satisfaction with the new process versus the previous one.

Two areas might prove difficult in a university environment. First, getting “buy-in” to use a systematic Six Sigma approach to solving problems and improving processes. Second, getting the necessary funds and providing people and training needed to develop Six Sigma Black Belts.

5. How might the different perspectives of quality apply to your college or university? Provide some specific examples.

Ans. Various quality perspectives include the design perspective, the manufacturing perspective, and the customer perspective. These perspectives use definitions such as the user-base, value-based, and even manufacturing-based quality concepts and can be applied in a university setting. Fitness for intended use (customer perspective) may be seen by the example of a small liberal-arts college that provides an outstanding science curriculum for people who wish to go to work in industry. It would not be appropriate for students who wish
to go into a genetic research career. This example also can be related to the user-based definition (design perspective), based on how well the product performs its intended function. Someone who chooses a respected regional university rather than attending an expensive nationally known private university, would be seen as applying the value-based definition, based on how well the selected university provides performance at an acceptable price or conformance to perceived quality standards at an acceptable cost. The manufacturing-based definition measures quality by the product's "conformance to specifications;" in other words, how much does the product resemble the perfected prototype when it rolls off the assembly line? Students may look at the catalog description or course syllabus, when doing a course evaluation, and make a judgment as to whether the resulting course “conformed to specifications” given in these documents.

6. Think of a product or a service that you are considering purchasing. Develop a list of fitness-for-use criteria that are meaningful to you.

Ans. Student answers will vary here, according to the product or service that they select and how they apply the “fitness for use” definition of quality. After picking a specific product (e.g. The XYZ smartphone) then they should apply the quality definition to it. Fitness for intended use should answer questions such as: Does the product perform as advertised? Is the product user-friendly, and affordable for both consumers AND the manufacturer? Is the product durable (drop test results)? How does the product stack up against other smartphones, which may have different features, use different programs/ methods of downloading data, etc.

In applying these definitions to a service (e.g. a cellular phone service provider), students should ask questions such as: Is the service affordable? Cost-efficient? Are employees sensitive to customer needs? Does it have any “hidden” requirements or misleading claims? How does this service compare with, a competitor’s phone service in price, features, and reliability? How often does the service incur “dropped” calls? What about geographic area coverage?

7. Select a service activity with which you are familiar. What might be some critical to quality (CTQ) characteristics associated with it?

Ans. Student answers will vary here, also, according to their experience. For this question, students will need to determine the targets and tolerances for their individual service activities that permit "conformance-to-specifications" to be measured. Targets will be the specific services that employees should provide, and the specific values that employees will demonstrate. Tolerances will be the standards set up to determine what is necessary when employees miss the mark; in other words, what is acceptable (i.e. an employee being five minutes late 5 times) and what is unforgivable (an employee being two hours late three times)? For example they might choose a package delivery service, such as UPS or FedEx. Then the “conformance to specifications” to monitor would be such things as: percent of output sorting to incorrect locations, in the sorting hub; percentage of packages loaded on the wrong truck at the distribution center; and percentage of packages not delivered on-time, based on route statistics.

8. Discuss how a learning cycle might be useful to you as a student?
Ans. A learning cycle has four stages:

1. planning
2. execution of plans
3. assessment of progress
4. revision of plans based upon assessment findings

Students can adapt these stages to study habits, from preparing for exams to carrying out weekly assignments and course projects.

9. Choose an organization that you have read about or with which you have personal experience and describe their sources of competitive advantage. What role might Six Sigma play in this organization?

Ans. A firm that is “market driven,” such as Amazon.com, would exhibit several customer-focused characteristics that a “marketing driven” company might not have. In fact, it would be rare for a “marketing driven” firm to pay much attention to developing a customer relationship management (CRM) system. This attention to customer needs would be more typical of a “market driven” firm. A CRM system requires that an organization establish effective strategies for listening to, and learning from, customers, as well as developing approaches to measure of satisfaction relative to competitors.

Six Sigma might play a very useful role in Amazon.com. A Six Sigma study might be done on how to improve the CRM system. Correcting the problems of improving the system would require using all of the steps of the DMAIC process. The project must be accurately defined. Critical to Quality characteristics must be defined as measurement progresses. After analysis of the current situation and consideration of what is needed for improvement, the system must be re-designed. The goal of improvement would be to build relationships, in order to understand present and future customer needs, and keep pace with changing markets. The “marketing driven” firm may be much more focused on “selling” the customer a product that may or may not meet the customer’s needs. As the PIMS studies have shown, quality is directly related to market share and to profitability. Other studies have shown that people are willing to pay more for products that they perceive as having high quality. Thus, without high quality, good marketing of products and services would appear to be impossible, since salespeople would have little to sell that would meet the needs of their customer. However, without good marketing, where salespeople listen and respond to the needs of customers, even the best-designed products will remain unsold. Finally, the control stage will provide evidence that the changes have been beneficial.

10. What was the “breakthrough” result achieved by Therma-Tru in the Six Sigma in Practice feature, based on their Six Sigma training of workers? What principle of quality management did this illustrate?

Ans. Therma-Tru obtained a “breakthrough” result after training their workers in Six Sigma concepts and tools. This helped the company address a defect problem that had affected production for over a decade by adopting a new measurement system. They also conducted an analysis to pinpoint the cause of cycle time variation. The project resulted in $100,000 in
cost savings, a 95% reduction in defects, and a 25% improvement in productivity. The key quality principle involved was: The factual approach to decision-making which results in making effective decisions based on the analysis of data and information.

11. What improvement needs did Gates Corporation identify in the *Six Sigma in Practice* feature, and what results were obtained from their “plus two Six Sigma class”? How did the changeover project and its solution address the four key issues of: quality, productivity, cost, and profitability?

Ans. Gates Corporation identified the need to reinstate the company’s Lean Six Sigma projects including improvement of cycle times, to incorporate an inventory management system and to reduce materials costs. Their “plus two Six Sigma class” generated the completion of 13 projects, some of which involved reducing materials costs. The company was also able to incorporate Six Sigma methodology to improve the delivery system whereby everything is now tracked electronically. A changeover reduction allowed for additional safety and ergonomic benefits in addition to a $750,000 savings. In this process, not only was the changeover time dramatically reduced, but the machine precision improved also making the process safer for the operator. As a result of their efforts, the company increased sales by $500,000, reduced costs by $1.7M, and created 15 jobs. These all addressed quality improvement, especially in safety and ergonomic dimensions. In turn, productivity, costs, and profitability were positively impacted.

**COMMENTS ON THINGS TO DO**

1. Find some examples of organizations that are using Six Sigma. What results have they achieved? What challenges have they faced?

   Suggestion: The results will vary, depending on the organizations and media which the student uses. Students should be encouraged to use multiple sources. For example, if there is a division of a national firm, locally, the student could find out about the parent firm from the company website, then go talk to a manager about how he/she gets guidance from headquarters on how Six Sigma is to be developed and implemented. Challenges will often be found in training, startup, buy-in of employees and managers, sustaining results, and continuing to find improvement projects.

2. Investigate the ISO 9000 standards and the Baldrige Award by researching their web sites. How might Six Sigma support each of these quality management frameworks?

   Suggestion: This assignment will introduce students to use of the Internet for obtaining quality information. The "Web" has many excellent sites for exploring quality topics, corporate practices, and case information in many sites around the globe. In addition to the NIST website, another excellent source is ASQ’s website, [www.asq.org](http://www.asq.org).

3. Examine the annual reports of one company over a period of years. Summarize how quality and performance improvement are discussed or implied in the company’s statements and
philosophy. Are any changes in their practices evident over time? For example, have they instituted a Six Sigma process?

Suggestion: There is a great deal of information available on the annual reports of companies available in college library databases, as well as corporate websites. This exercise is also designed to give students the opportunity to examine the impact of Six Sigma on “real-world” organizations.

4. Prepare a feature similar to the Therma-Tru or Gates examples using sources such as business periodicals, personal interviews, and so on. Focus your discussion on how their approach to total quality and Six Sigma supports their competitive strategy.

Suggestion: As in 3, above, there is a great deal of information available in the annual reports of companies to be found in business periodicals, college library databases, corporate websites, and personal networking. This exercise is also designed to give students the opportunity to examine the impact of quality initiatives and Six Sigma on “real-world” organizations, as part of their competitive strategy.

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