# *Operations and Supply Chain Management 10th edition Russell Solutions Manual*

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# 2 - Quality Management

## Answers to Questions

2-1. Consumers perceive quality to be how well a product meets its intended use—that is, how well it does what it is supposed to do—whereas from the producers's perspective, quality is how well the product conforms to its design during the production process.

2-2.
1. Performance: operating characteristics of a product
2. Features: extra items added to basic characteristics
3. Reliability: probability that a product will operate properly
4. Conformance: the degree to which a product meets standards
5. Durability: how long the product lasts
6. Serviceability: ease and speed of repair and courtesy of repair person
7. Aesthetics: how a product looks, feels, sounds, smells, or tastes
8. Safety: Assurance that the customer will not suffer harm; especially important for autos.
9. Other: subjective perceptions based on brand name or advertising

2-3. Quality of design is the degree to which quality characteristics are designed into a product, whereas quality of conformance is how effectively the production process is able to conform to the specifications required by design.

2-4. The cost of quality assurance is the cost of maintaining an effective quality program and includes prevention and appraisal costs. The cost of nonconformance, or poor quality, is the result of internal and external failures. These two costs react oppositely to each other; as the cost of quality assurance increases, the cost of poor quality decreases.

2-5. Internal failure costs are incurred when poor quality is discovered before the product is delivered to the customer, whereas external failure costs are incurred after a customer receives a poor-quality product. Internal failure costs include scrap, rework, process failure, and downtime, whereas external failure costs include customer complaints, product returns, warranty claims, product liability, and lost sales.

2-6. The contractor could be experiencing low productivity yields and have extensive internal failure costs, including scrap, rework, process failure, and downtime costs.

2-7.
a. From the consumer's (e.g., student or parent) perspective, quality is probably determined by whether the college education provides the job opportunity expected and whether the graduate perceives he or she has acquired an anticipated level of knowledge that will enable the graduate to perform the job effectively. From the producer's (e.g., university) perspective, quality is how effectively it is able to deliver knowledge (i.e., required courses) and provide the quality of life experience expected by the student.
b. The education achieved by the student provides the job opportunities expected and a level of knowledge that enables the graduate effectively to perform the job achieved.
c. Quality-assurance costs include the cost of hiring the best faculty, administrators, and support personnel, the cost of designing and redesigning courses and curriculum to meet changing needs, the cost of providing a good physical and mental environment (i.e., housing, food, entertainment, security, etc.), the cost of modern technical teaching equipment, the cost of information systems, and the cost of assessing alumni satisfaction with their education. Costs of poor quality include students who fail or drop out, reduced funding from the state or private donors, and fewer

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enrollments.

d. Quality circles could be developed within administrative and operational units and academic departments. Circles might include both faculty or administrators and classified employees. The normal quality circle stages of training, problem identification, analysis, solution, and presentation could be followed.

2-8. Improving quality will increase product yield—that is, the number of acceptable units—thus increasing productivity.

2-9. The cost of poor quality could include external failure costs for customer complaints, returned DVD players to be repaired under warranty, lost future sales, and liability costs if someone is hurt because of the problem. Costs of quality improvement might include improved design costs for the DVD player, process costs, and inspection costs for the final product and at various stages of the production process.

2-10. *Cell phone:* Visual attractiveness, size, weight, clarity of sound and resolution of screen, memory, battery life, etc.
*Pizza:* Size, ingredients, taste, smell, service in delivery, temperature.
*Athletic shoes:* Size, weight, comfort, visual attractiveness, durability.

2-11. The input is customer inquiries and the final product is responses that result in customer satisfaction. Associated quality costs might include prevention costs, such as designing a telephone system to ensure prompt connections without waiting and a properly designed computer system to provide accurate customer account information, and training costs to make certain service operators are courteous and knowledgeable. Appraisal costs might include the cost of monitoring service calls to ascertain response rates and operator courtesy. Poor quality might result in complaints from customers and lost accounts.

A quality management program could incorporate a system to monitor calls to ensure prompt, courteous, and knowledgeable service. An employee-involvement program, wherein operators might identify problems, would be beneficial.

2-12. Prevention costs are directed at preventing poor quality products from reaching the customer, thus avoiding the various internal and external failure costs associated with poor quality.

2-13. It is important to have a means for assessing the impact of quality improvement programs on the organization's profitability and productivity.

2-14. *W.E. Deming:* Introduced the Japanese to quality management principles and philosophy, embodied in his 14 points.
*Joseph Juran:* A major contributor to the Japanese quality movement.
*Phillip Crosby:* Changed general perceptions of cost of quality and promoted zero defects.
*Armand Feigenbaum:* Introduced the concept of total quality control, a total company-wide approach to quality management.
*Kaoru Ishikawa:* Introduced quality circles and cause and effect diagrams.
*Genichi Taguchi:* Developed the Taguchi method for product and process design.

2-15. The Baldrige Award has had a pervasive impact on American companies, in general promoting quality improvement. Thousands of companies request award applications each year to use simply to establish quality management programs based on Baldrige Award criteria.

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2-16. This should be a student project. The journal can be found in most libraries, and the articles are generally easy to read.

2-17. The student could provide many reasons for failure including lack of total commitment, ineffective planning, goals too easy or too difficult to achieve, improper measurement techniques, ineffective leadership, not enough employee training, etc. See G. Salegra and Farzaneh, "Obstacles to Implementing Quality," *Quality Progress*, 33, no. 7 (July 2000): 53–57.

2-18. The dimensions of quality for a service company are located in the text. The student should identify these or similar ones for the company they select.

2-19. The two service companies should be in the community and the quality characteristics the students will tend to focus on will include courtesy and quickness of service.

2-20. Although students in this class might suggest that grades are a quality measurement a more realistic approach to evaluation are student evaluations of the class or surveys of students. Quality characteristics might include course organization, presentation of lectures, class environment, physical appearance of the classroom, schedule (i.e., are the lectures completed on time), the quality of supplementary material, physical appearance and demeanor of the instructor, including friendliness and courtesy, the accuracy and completeness of assignments, etc.

2-21. The answer depends on the company selected by the student. For example, there is a particular hotel that has never gotten a room reservation right for us, and, the instructions for ordering tickets at the web site for the 1996 Olympics in Atlanta were littered with pitfalls. Airlines are a favorite example of a poor quality service for students who travel.

2-22. A similar question to 26. Restaurants, retail stores and grocery stores are examples of local businesses that, in our experience, tend to vary in quality. We have never had a bad ordering experience with L.L. Bean although that's not true of some other mail order operations we have dealt with. In most cases, if a service has been identified by the student it will be because of courteous, helpful employees, while if a manufacturing product has been identified, it will be because of superior physical traits, such as durability.

2-23. TQM tends to give some focus and structure to strategic planning. TQM provides identifiable goals, and many well-documented initiatives for quality improvement such as quality circles, employee training, empowerment, etc. TQM also provides a means for measuring success which is essential in a strategic planning process.

2-24. Many U.S. suppliers cannot do business with companies overseas unless they have ISO certification. In addition, many U.S. companies also desire or request their suppliers to comply with ISO 9000 standards.

2-25. Common characteristics that the students will discover include strong leadership at the top, total company commitment, employee training, involvement and empowerment, challenging goals for quality achievement, focus on customer satisfaction, and extensive use of statistical quality control techniques, among other things.

2-26. Some companies believe their quality is "good enough." However, primary reasons for not implementing a TQM program are lack of time and the cost involved; some companies do not have the resources available to undertake a TQM program.

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2-27. This will depend on the web site the student accesses. In general, they should adapt the attributes described for services.

2-28. This depends on the airline the student selects. Example defects they might mention are flight delays or cancellations, lost luggage or luggage mishandling, discourteous employees, wrong or misleading flight information, uncomfortable seats, etc.

2-29. This will depend on which websites the student selects.

2-30. Categories of possible quality problems might be related to the ordering process, pizza construction, pizza ingredients, packaging/boxing, time to receive order, order accuracy/correctness, and pricing.

2-31. If someone purchases a residence, then the dwelling is more of a product. However, renting a dormitory room or an apartment tends to fall into the service category because it is part of an ongoing process or interaction between the owner and renter. In other words, the owner retains responsibility for the product, i.e., the dwelling. As such, the quality of the living accommodation should be assessed according to the dimensions of quality for a service.

2-32. Unfulfilled, late and erroneous orders, and defective items, would obviously have a negative effect on Amazon's reputation. Amazon asks customers to rate sellers on its "open market" according to a number of criteria, and its assumed that sellers would be banned if they had continued poor performance. In their answer, students could reference the Amazon seller rating system.

2-33. The calculation of the "Power Circle Ratings" can be found on the J.D. Power Website - http://www.jdpower.com/about-us/jdpower-ratings. To calculate Power Circle Ratings, J.D. Power begins with the syndicated study index scores or a specific standard of measurement which can be found, in most cases, in the associated press release. An example of an index score is found in the J.D. Power U.S. Retail Banking Satisfaction Study, where companies are ranked according to overall index scores based upon weighted responses to several survey factors. An example of a specific standard of measurement is found in the J.D. Power Initial Quality Study, where vehicles are ranked according to reported Problems per 100 vehicles (PP100). Using these measurements, Power Circle Ratings are calculated based on the range between the product or service with the highest score and the product or service with the lowest score. J.D. Power generates a Power Circle Rating of five, four, three, or two.

2-34. The answer will depend on the product and service the student selects.

2-35. The K&N Management Website at http://knmanagement.com/our-story/ has extensive information about the company, including several videos, and another source of information is the company profile on the Baldrige Award Website for award recipients at http://patapsco.nist.gov/Award_Recipients/index.cfm.

2-36. The answer will depend on the service provider the student selects.

2-37. They all focus on all aspects of the dining experience including the overall customer experience, including waiting time, service, food and price. As such, in many ways they are clones of each other, and must compete on all quality attributes. The student might want to reference the Darden Restaurant Group (Red Lobster, Olive Garden) and Bloomin' Brands (Outback, Bonefish Grill, Carrabba's).

2-38. According to the Baldrige website, there is increasing pressure in the U.S. to overhaul our

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health care system, and health care organizations around the country are looking for ways to improve safety and outcomes, while reducing cost. The history of the Baldrige Program shows that health care organizations of any size and type and in any location can benefit from using their health care criteria. It is likely that healthcare organizations have made more applications for the Baldrige Award, in part to effectively compete in an industry under close public scrutiny, and partly because health care organizations have the resources to prepare the extensive Baldrige application materials.

2-39. Sustainability, in its broadest sense, focuses on improving the "quality" of the workplace (i.e., human resources), which is one of the seven major categories of criteria for the Baldrige Award criteria.

2-40. The quality management systems used by Amazon and Target can be applied to any number of "different" industries, including airlines; the fact that they have not are due more to the commitment of the company. In the case of airlines, their lack of competition and near monopolies in certain markets contributes to their unwillingness to adopt quality management principles. Further airlines seem to have concluded that they must compete on the basis of price and not quality, especially in the customer service areas.

2-41. The obvious reason that companies outsource their customer service activities is labor cost; it's cheaper. This is the same reason that manufacturing and retail companies have outsourced their supply to places like China and Mexico. Many quality-conscious companies like P&G and Wal-Mart seek to incorporate their overseas suppliers into their own quality management systems, whereas some companies have not.

2-42. Apple's overall product quality, customer service and technical innovations create demand that overcomes potential "glitches" in its initial product designs.

2-43. Companies can insure quality across its supply chain by requiring its suppliers to adopt its own quality management system, and by closely monitoring its effectiveness. Companies that have failed in their attempts to insure quality among their overseas suppliers in countries like China, have allowed quality to be monitored locally or by a third-party firm, while successful companies have used their own offices and employees to monitor quality overseas, i.e., a physical presence is generally required combined with the willingness to change suppliers if quality is not forthcoming.

2-44. In the workplace, labor, materials, manufacturing processes, sourcing and transportation.

2-45. Common characteristics include a commitment to product and process innovation, emulating "best practices" of quality leaders, and supply chain efficiency. These companies are typically involved in ISO certification processes, employ Six Sigma, and often adopt Baldrige Award criteria.

2-46. There are several companies identified in the chapter that use Six Sigma, and the student can also search "Six Sigma" on the Internet.

2-47. Categories of quality problems for flight delays could relate to employees (not enough to check in, problems with the check-in process, deplaning problems, insufficient maintenance personnel to accomplish plane turn-around, etc.), mechanical problems, luggage problems, maintenance problems, weather, flight controller problems, over booking, over scheduling, etc.

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2-48. This depends on the business the student selects. If for example, they selected a restaurant they eat at frequently they would need to identify the categories of quality problems which might include employees, food quality, restaurant environment, waiting time, price, service, menu, etc.

2-49. It should be obvious to the student that the most important defects are the engine problems and faulty brakes. The priority of the quality problems is almost the reverse of the frequencies; faulty brakes are clearly the most significant category of defects. This points out that when applying Pareto analysis the degree of importance must be the same for all defect categories. If not then the categories should be weighted according to their importance in order to adjust the chart.

2-50. *Marketing* has direct contact with the customer. Marketing is typically responsible for the consumer research that determines the quality characteristics that customers want and need, and the price they are willing to pay for it. Marketing also informs the consumer about the quality characteristics of a product through advertising and promotion. Sales provides feedback information through its interaction with the customer, which is a determinant of product design. Research and development will explore new ideas for products and be actively involved in product innovation.

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

*Purchasing* must make sure that the parts and materials required by the product design are of high quality. Quality of the final product will be only as good as the quality of the materials used to make it. Purchasing must select vendors who share the company's commitment to quality and who maintain their own quality management program for providing high-quality service, materials, and parts.

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

*Distribution* makes sure that high-quality products are delivered on-time and undamaged to the customer. Packaging methods and materials, storage facilities and procedures, and shipping modes must ensure that final products are protected and that customers receive them on time.

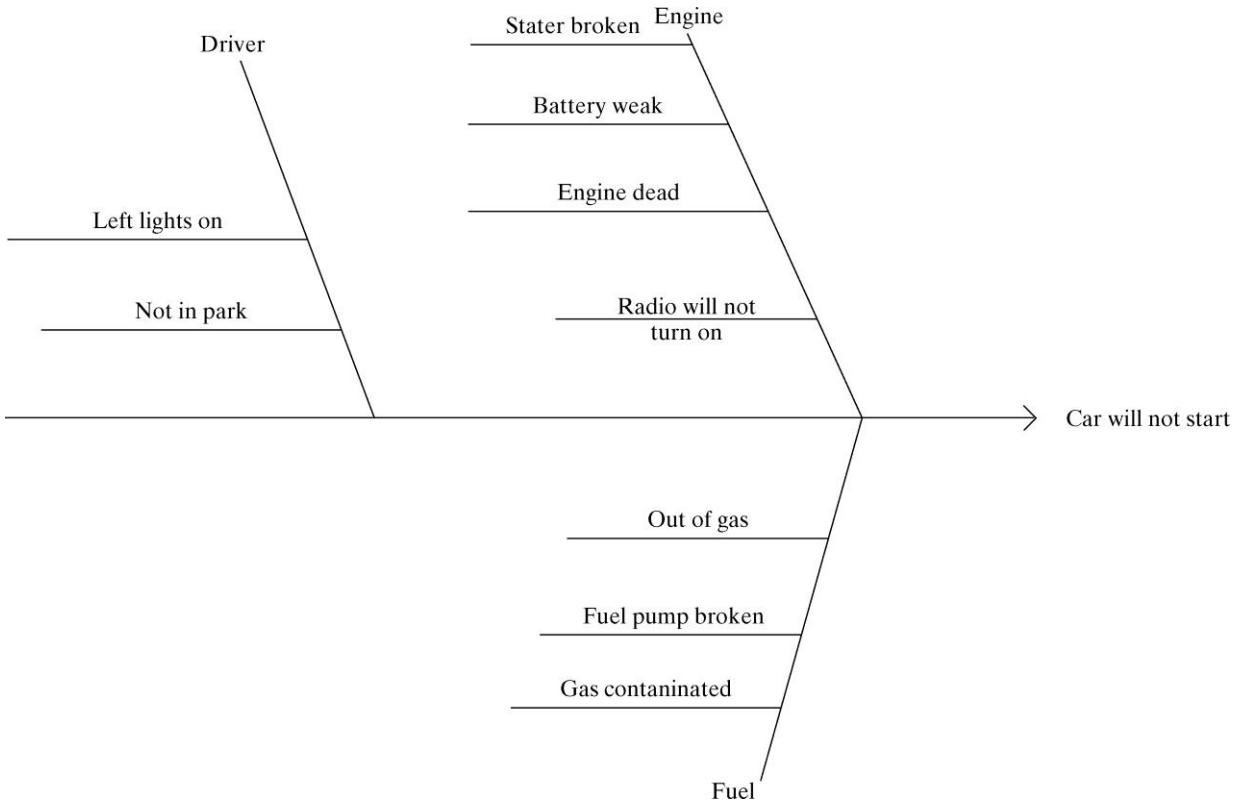
2-51. This answer depends on the award the student selects.

2-52. This answer depends on the company the student selects.

2-53. This answer depends on the article and company the student selects.

2-54. This question was adapted from: L. Fredendall, J. Patterson, C. Lenhartz and B. Mitchell," What Should Be Changed?", *Quality Progress* 35 (1; January 2002): p. 50–59. This is an excellent article about the use of cause and effect diagrams students can be referred to.

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2-55. *Black Belt*—the leader of a quality improvement project, which is a full-time position

*Green Belt*—a project team member, which is a part-time position

*Master Black Belt*—a teacher and mentor for Black Belts which, is also a full-time position. A Black Belt would have to have led several successful projects before being certified as a Master Black belt.

2-56. Breakthrough Strategy:

1. *Define* the process including who the customers are and what their problems are.
2. *Measure* the process and collect data.
3. *Analyze* the data in order to develop information that provides insight into the process, including causes of defects.
4. *Improve* the process by making changes and measuring the results.
5. *Control* the improved process by monitoring it and making sure the desired performance level is sustained.

2-57. This answer depends on the project the student selects.

2-58. In general, the ACSI model is a set of causal equations that link customer expectations, perceived quality, and perceived value to customer satisfaction (ACSI). In turn, satisfaction is linked to consequences as defined by customer complaints and customer loyalty—measured by price tolerance and customer retention. There are two menu items on the ACSI website that describe, in general terms, how the ACSI is determined—"What it measures," and "Methodology." The student should refer to these descriptions. As an example, the student could select two fast food restaurant

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chains in the fast food industry and compare the company with the highest score with the lowest scoring company and explain the reasons for the difference in scores.

2-59. Answer depends on the personal health improvement project the student selects.

2-60. Answer depends on the personal improvement project the student selects.

2-61. Answer depends on the infirmary process the student selects.

2-62. Answer depends on the registration process at the student's university.

2-63. In general, the Japanese recognized that even though high quality might cost more in the "short run," in the long run it would help them gain market share, which would increase long term profits. This is something American companies did not recognize. The Japanese economic climate and business and management culture was also more conducive to quality management programs than American companies.

2-64. The student should go to the ISO website at www.iso.org to determine these steps.

2-65. Answer depends on the store the student selects.

2-66. 5S described in Table 16.1 is a process for identifying defects, establishing goals for improvement, and then eliminating or correcting defects to achieve the goals, must like Deming's PDCA cycle, or the Six Sigma Breakthrough Strategy DMAIC 5 step improvement process.

2-67. The student should refer to the ISO website at www.iso.org and the Baldrige Award website at www.nist.gov to answer this question.

2-68. The answer should include references to some form of customer feedback, such as a "voice of the customer (VoC)" process and surveys. Since assessing customer satisfaction is a critical part of the Baldrige Award criteria, the summaries of Baldrige Award winning companies at www.nist.gov are a good source for students to learn how companies and organizations assess customer satisfaction.

2-69. In general, this will be a subjective answer on the part of the student. A good source for this question is an article by David Goldhill titled "How American Health Care Killed My Father," that appeared in the September 2009 online edition of The Atlantic magazine (www.theatlantic.com).

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## Solutions to Problems

2-1. a. Failure costs as percentage of quality costs:

2015: 157.7 / 187.2 = 0.8424, or 84.24%

2016: $\frac{161.8}{201.7} = 0.8022,$ or 80.22%

2017: $\frac{153.6}{212.5} = 0.7288,$ or 72.88%

2018: $\frac{127.2}{193.9} = 0.6560,$ or 65.6%

2019: $\frac{97.3}{166.9} = 0.5830,$ or 58.3%

The failure costs decrease as a percentage of total quality costs. This may be attributed to an increase in product monitoring and inspection. Fewer defective products are reaching the consumer, as evidenced by the sharp decline in external failure costs.

b.

| | Prevention costs as % of quality costs: | Appraisal costs as % of quality costs: |
|---|---|---|
| 2015: | $\frac{3.2}{187.2} = 0.0171,$ or 1.71%; | |
| 2016: | $\frac{10.7}{201.7} = 0.0530,$ or 5.3%; | |
| 2017: | $\frac{28.3}{212.5} = 0.1332,$ or 13.32%; | |
| 2018: | $\frac{42.6}{193.9} = 0.2197,$ or 21.97%; | |
| 2019: | $\frac{50}{166.9} = 0.2996,$ or 29.96%; | |

The increase in prevention costs as a percentage of total quality costs indicates that Backwoods American is placing more emphasis on prevention of defects rather than correction of them. Perhaps they are spending more in the areas of quality planning, product design, process, training, and information. This is contributing to a decline in the need for inspection and testing, equipment testing, and operators to test quality; thus appraisal costs decline, both absolutely and as a percentage of total costs. Prevention also contributes to the decline in external and internal failures, because fewer defective products are produced to begin with. Increases in prevention expenditures will result in a decrease in all other quality costs.

c.

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| | Quality Sales Index | Quality-Cost Index |
|---|---|---|
| 2015 | 6.93 | 44.48 |
| 2016 | 7.50 | 47.64 |
| 2017 | 7.85 | 50.04 |
| 2018 | 6.90 | 44.46 |
| 2019 | 5.79 | 38.32 |

These index values do not provide much information regarding the effectiveness of the quality assurance program. They are, however, useful in making comparisons from one period to the next and in showing trends in product quality over time.

d. Examples of quality-related costs:

- *Prevention:* Market research, that is, producing what consumers want; purchasing only high-quality down and other materials, designing an efficient and effective manufacturing process; training employees in making quality products.
- *Appraisal:* Inspection of raw materials, work-in-process, and finished product; equipment testing (pattern cutter, sewing machines, etc.), inspection.
- *Internal failure:* Wasted materials and labor, defective products discovered during inspection, use of inefficient processes, equipment downtime, poorly trained employees.
- *External failure:* Defective products, customer complaints, warranty costs, lost sales, loss of good will.

2-2. a. Product yield

2015: 20,000 (0.83) + 20,000 (1-0.83) (0.20) = 16,600 + 680
= 17,280 parkas

2016: 20,000 (0.85) + 20,000 (0.15) (0.20) = 17,000 + 600
= 17,600 parkas

2017: 20,000 (0.87) + 20,000 (0.13) (0.20) = 17,400 + 520
= 17,920 parkas

2018: 20,000 (0.89) + 20,000 (0.11) (0.20) = 17,800 + 440
= 18,240 parkas

2019: 20,000 (0.91) + 20,000 (0.09) (0.20) = 18,200 + 360
= 18,560 parkas

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b. Manufacturing cost per good parka:

$$2015: \frac{420{,}900 + 12(680)}{17{,}280} = \frac{429{,}060}{17{,}280} = \$24.83$$
$$2016: \frac{423{,}400 + 12(600)}{17{,}600} = \frac{430{,}600}{17{,}600} = \$24.47$$
$$2017: \frac{424{,}700 + 12(520)}{17{,}920} = \frac{430{,}940}{17{,}920} = \$24.05$$
$$2018: \frac{436{,}100 + 12(440)}{18{,}240} = \frac{441{,}380}{18{,}240} = \$24.20$$
$$2019: \frac{435{,}500 + 12(360)}{18{,}560} = \frac{439{,}820}{18{,}560} = \$23.70$$

$$2009: \frac{436{,}100+12(440)}{18{,}240} = \frac{441{,}380}{18{,}240} = \$24.20$$
$$2010: \frac{435{,}500+12(360)}{18{,}560} = \frac{439{,}820}{18{,}560} = \$23.70$$

Improving the quality assurance program has resulted in fewer defective parkas, lower rework costs, and greater productivity. This has lowered the per-unit manufacturing costs without additional capital investment.

2-3. a. $y = (I)(\%G) + (I)(1-\%G)(\%R)$

= (150)(0.83) + (150)(1-0.83)(.60) = 139.8 file cabinets

b. 145 = (150) (%G) +(150)(1-%G)(0.60)
145 = 150G + (150-150G)(0.60)
145 = 150g + 90 – 90G
55 = 60 G
G = 55 / 60 = 0.916 = 91.6%

2-4. Cost with 83% quality = [27(150) + 8(15)] / 139 = $30 per cabinet
*Note: if don't round until the end, $29.85 instead of $30*

Cost with 90% quality = [27(150) + 8(9)] / 144 = $28.63 per cabinet

2-5. Manufacturing cost per good product:

2017: Yield = 32,000 (0.78) + 32,000 (0.22) (0.25) = 26,720
Product Cost = (278,000 + 3520) ÷ 26,720 = $10.54
In this case, total direct manufacturing cost = $278,000
and total direct rework = 32,000(0.22) (0.25) = $3250

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2018: Yield = 34,600 (0.83) + 34,600 (0.17) (0.25) = 30,188.50
Product Cost = (291,000 + 2,941) ÷ 30,188.50 = $9.74

2019: Yield = 35,500 (0.9) + 35,500 (0.1) (0.25) = 32,837.50
Product Cost = (305,000 + 1,775) ÷ 32,837.50 = $9.34

Percentage change: 2017 - 2018: (9.74 – 10.54) / 10.54 = -7.60%
2018 - 2019: (9.34 – 9.74) / 9.74 = - 4.10%

2-6. a. $\text{Product yield} = 300(0.87)(0.91)(0.94)(0.93)(0.93)(0.96)$
$= 185$ cabinets

roduct yield = 300(0 87)(0 91)(0 94)(0 93)(0 93)(0 96)

b. For a yield of 300, input would have to be
$I(0.87)(0.91)(0.94)(0.93)(0.93)(0.96) = 300$
$I(0.6179) = 300$
$I = 486$ cabinets

2-7. a. Alt. 1: $300(0.93)(0.91)(0.94)(0.93)(0.93)(0.96) = 198$
Alt. 2: $300(0.87)(0.96)(0.94)(0.97)(0.93)(0.96) = 204$ **Greatest yield**
Alt. 3: $300(0.87)(0.91)(0.94)(0.93)(0.97)(0.98) = 197$
Alt. 4: $300(0.87)(0.97)(0.94)(0.93)(0.93)(0.96) = 198$

b. Alternative 2 will result in the highest yield and will be the most effective.

2-8. $320(1-0.12)(1-0.08)(1-0.04) = 320(0.88)(0.92)(0.96)$
$= 248$ errorless orders

2-9. a. $\text{QPR} = \dfrac{(585+16)(100)}{650(18)+16(3.75)} = 5.11$

b. $\text{QPR} = \dfrac{(720+20)(100)}{800(18)+20(3.75)} = 5.11$

c. $\text{QPR} = \dfrac{(585+16)(100)}{650(16.50)+16(3.20)} = 5.58$

d. $\text{QPR} = \dfrac{(604+11)(100)}{650(18)+11(3.75)} = 5.24$

2-10. a. $\text{QPR} = \dfrac{250(100)}{250(47)+33(16)} = 2.04$

b. $\text{QPR} = \dfrac{320(100)}{320(42)+19.2(12)} = 2.34$

2-11. a. $\text{Product cost} = \dfrac{(K_d)(I)+(K_r)(R)}{Y}$

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$$= \frac{(\$6.15)(680)+(1.75)(2.72)}{655.52}$$

$$= \frac{4186.76}{655.52} = \$6.39$$

b. $\text{Product cost} = \dfrac{(\$6.20)(680)+(1.75)(0.68)}{673.88}$

$$= \frac{4217.19}{673.88} = \$6.26$$

$\text{Cost savings} = \$0.13/\text{order}$

$\text{Annual savings} = \$0.13/\text{order} \times 680 \text{ orders/day} \times 365 \text{ days/year} = \$32,266$

c. It is likely that some customers who receive defective orders will not return, thus, fewer defective orders will retain more customers and also increase the number of orders.

2-12. a. $\text{QPR} = \dfrac{655.52}{(680)(6.15)+(2.72)(1.75)}(100) = 15.66$

b. $\text{QPR} = \dfrac{673.88}{(680)(6.20)+(0.68)(1.75)}(100) = 15.98$

2-13.

With defects:

$$v = \frac{c_f}{p - c_v}$$

$$= \frac{\$350,000}{1,000 - 600}$$

$= 875$ units or \$875,000 in sales

Without defects (Six Sigma):

$$v = \frac{\$350,000}{1,000 - 540.05}$$

$= 760.952$ or \$760,952 in sales

The slope of the line is steeper with a reduced break-even point; the company can make more money without selling additional units.

2-14. With 8% defect rate:

| | |
|---|---|
| Sales | \$151,200 |
| Variable costs | 61,200 |
| Fixed costs | 31,000 |
| Profit | \$59,000 |

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With zero defects:

| | |
|---|---|
| Sales | $151,200 |
| Variable costs | 56,305 |
| Fixed costs | 31,000 |
| Profit | 63,895 |

Six Sigma results in an 8% reduction in variable costs and a corresponding 8% increase in profit. The return on the Six Sigma investment would be:

$$\text{Return} = \frac{100(4,200 - 695)}{25,000}$$
$$= 14\%$$

2-15.

A possible version of the cause and effect matrix:

| | | | Key Output (Y) Variables (*CTQC's*) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | | |
| | | | Clothes clean | Clothes not damaged | Colors fine | Lint free | Stains removed | Smell fresh/ no odors | | |
| | **Key Input (X) Variables** | **Customer rank** | 1 | 3 | 2 | 5 | 6 | 4 | | **Rank of X Variables/ Importance to Customer** |
| | | **Weight** | *10* | *9* | *9* | *7* | *7* | *8* | **Score** | |
| 1 | Sort laundry | | 5 | 6 | 10 | 8 | | 5 | 290 | 1 |
| 2 | Cycle | | 7 | | 8 | | | | 142 | 8 |
| 3 | Wash temperature | | 8 | | 10 | | 7 | | 219 | 5 |
| 4 | Rinse temperature | | 4 | | 9 | | | | 121 | 9 |
| 5 | Stain treatment | | | | 5 | | 10 | | 115 | 10 |
| 6 | Load size | | 9 | 10 | 6 | | | 6 | 282 | 2 |
| 7 | Fabric softener | | 3 | 5 | | 4 | | 9 | 175 | 7 |
| 8 | Detergent | | 10 | | 7 | | 5 | 10 | 278 | 3 |
| 9 | Bleach | | 7 | | 9 | | 6 | 4 | 225 | 4 |
| 10 | Type of washer | | 8 | 9 | | 5 | | | 196 | 6 |

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2-16. Weekly revenue = (18,400 orders) ($47/order)
= $864,000
Weekly variable costs = - 365,000
Weekly fixed costs = - 85,000
Total profit = $414,800

Orders returned = (18,400)(.12) = 2,208
Cost of refilling orders = (2,208)(.30)($8) = $5,299
Cost of lost sales = (2,208)(.70)($47)= $72,643
Cost of lost future sales = (2,208)(.70)(.5)(15) = $11,592
Total cost of defects = $5,299 + 72, 643 + 11,592 = $89,534

**With quality improvements:**

Orders returned = (18,400)(.02) = 368
Cost of refilling orders = (368)(.30)($8) = $883
Cost of lost sales = (368)(.70)($47) = $12,107
Cost of lost future sales = (368)(.70)(.50)(15) = $1,932
Total cost of defects = $883 + 12,107 + 1,932 = $14,922

Savings with quality improvements = $89,534 – 14,922 = $74,612 per week
Annual savings = ($74,612)(52) = $3,879,824

Invest in program.

Processes likely to be improved include computer ordering system, suppliers, handling, etc.

Zero defects are unlikely because some orders will be returned because customers simply change their minds.

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## CASE 2.1: Designing a Quality Management Program for the Internet at D4Q

This can be an instructive, hands-on case project. The students should first search the Internet for different web sites at which retail items can be ordered. They should next develop a list of quality characteristics or dimensions to focus on. These might include the visual appearance of the web site, the friendliness of the language used, the accuracy of instructions, the availability of e-mail or telephone support, etc. An attractive web site should probably include photos of the catalog items, for example book jackets, CD covers and video jackets, instead of just item titles. Instructions for ordering should be detailed and accurate with help icons located at every step. Customer support should be easy to access with e-mail or by telephone. Responses to requests for support should be quick. Service measurement is difficult in this type of operation. If an order center is used, then the company can count the number of customers who enter the center then abort as the result of poor instructions. Follow up surveys of customers who place orders or request hard copy catalogs is a good way to evaluate service. From the server end, the server responses to customer inquiries can be monitored for accuracy, completeness and timeliness. These are just a few of the possible quality initiatives you might suggest to develop a high quality web site ordering system.

## CASE 2.2: Quality Management at State University

In general, the student should respond to this case by attempting to go through the chapter and to discuss each major topic in terms of a university environment. This will require that they first identify the product and the process, obviously the student and the educational process. However, in a university environment, is the product also the customer? This is an interesting question to begin with.

An initial step should be to develop a customer definition of quality—that is, what are the dimensions of quality in an education that parents, students, and legislators expect? This step can be accomplished by surveying alumni, potential employers, parents, students, and legislators. It would also be beneficial to see what the competition (other colleges and universities) does.

The various support functions in the university should be identified in terms of a production process. For example, the admissions office is analogous to the purchasing department. A key problem here in a QM approach is that the university has little, if any, control over suppliers (high schools). As a result, admissions must institute inspection and process control procedures to ensure high-quality raw material (i.e., students) is admitted.

The product-design function, or curriculum design, is typically decentralized in a university among various colleges and departments. In some cases, the university administration will design a core curriculum for the first two years and college and departments will design the curriculum for the last two.

The production process is the movement of students through the curriculum to graduation. Discussion should focus on how to institute process control in order to avoid final product “defects.” This obviously requires a definition as to what a defective item is—a student who enters but fails to graduate, a student who graduates but does not gain employment, or a graduate who indicates disappointment with his or her education five years from now. An area on which to focus is the degree to which quality control tools such as brainstorming, quality circles, histograms, check sheets, and fishbone diagrams can be used to evaluate the process.

Customer service would seem to be an integral part of a QM approach in the university. This service would focus on support services such as dining, recreation, housing, advising, counseling, extracurricular activities, entertainment, placement, alumni services, etc.

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Depending on the time designated to spend on this case, students might interview various administrators at their own university to determine where QM can be applied in the university and obstacles to a TQM approach.

## CASE 2.3: Quality Problems at the Tech Bookstore

a. Mr. Watson's organization of the customer survey categorized the two bookstores and types of customer, i.e., students and non-students. He differentiated between the two stores because they carried different products, and it also was likely that a different population of customers visited the two stores since they were in different locations. Also, the two stores had different managers, staff and employees; in effect they were separate entities. He differentiated between the two customer groups because he knew they likely had different characteristics and different service expectations. Also, it was probable that they shopped for different items. Student would be primarily interested in textbooks, school supplies, computer items and apparel, whereas non-students would have not been as interested in textbooks and school supplies, and they would have had a higher interest in trade books.

   A customer survey was probably the best way to start in order to see if there was a quality problem and its extent. He might also analyze different processes in the store, such as employee floor service, checkout, etc. He could have probably gotten the help of an OM class on campus to help him analyze various service processes in the store. He could also benchmark other "successful" college bookstores.

b. It is possible to develop 9 different Pareto charts—a chart each for students and non-students at the campus store, and a chart each for students and non-students at the off-campus store; a combined chart for students at both stores and a combined chart for non-students at both stores; a chart for each store combining the two customer groups at each one; and a summary chart combining all the data for both stores and both customer categories. Following is a summary of the survey data.

c. Using a fitness for use definition, quality should be prompt, knowledgeable and courteous customer service; a pleasant shopping environment with prompt and courteous customer checkout; and quality products at a competitive (or lower) price.

d. The most pronounced problem is the discrepancy between the student and non-student groups in their perception of service. This is likely due to the different expectations of the two groups. Non-students are likely to be older and less patient. The student employees' attitude and demeanor is probably more familiar to other students, i.e., what they are used to, and they are probably more patient with the student employees than the non-student group. Also it is less likely that students will ask questions than the non-student group so the problem of not being helpful or knowledgeable does not come up as much with students as with non-students. It also may be that students visit the bookstores more often and know where to find items, and they may also be more familiar with bookstore policies. Many of the non-student customers could be visitors.

   However, this discrepancy does not hide two other potential quality problems—that the off campus store has poorer quality service across all categories than the on-campus store, and there seems to be a significant problem with employee training at both stores. The relatively low percentage of customers who think employees are knowledgeable and helpful, reinforced by the graduate student evaluators and the complaint incidents to the Board, clearly indicates that the student employees are not adequately prepared to do their job. They are probably in need of more training, however it is likely the bookstore has been hesitant to provide additional training because of the high turnover rate, i.e., the return on training investment might be perceived by management to be low when student employees leave after a semester or two. The off campus store may have poorer quality service, in general, because of the

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management staff, and the fact that the Executive Director resides at the on campus store.

The much lower percentage of students who think that the cost of purchases at the bookstores is reasonable is probably due to the fact that students purchase textbooks, which are expensive. The bookstore probably does not do a very good job of publicizing the fact that it has a very low mark up on textbooks. This is something that could be highlighted on the store web site, which the students access more than non-students.

e. Since this is a service, several of the costs of poor quality that relate to manufactured products such as scrap, product rework, returned products, etc., do not apply. Thus, the two primary costs of poor quality are lost sales and customer complaint costs. The costs the bookstore is incurring to conduct the customer survey, hire the graduate student evaluators, and analyze the results are all costs of poor quality. From the limited information provided it is difficult to address the question of lost sales. However, it is noted that that the town and university have been growing while sales have remained steady. Given the ideal location of the on campus store in particular, and the fact that the football team is very successful should mean much higher sales of licensed apparel. It could be that the quality problems are having a very negative impact on sales.

f. While the bookstores would benefit from a complete QM program, the most immediate need is for a more extensive employee training program. The bookstore needs to establish a plan for improving its quality that includes employee training as a top priority. The plan needs tangible objectives. For example, every customer question should be answered as promptly as possible. Some form of reward system for employees might be beneficial. They likely would benefit from a set of guidelines for employees for addressing customer questions. Having a resource person available that has intimate knowledge of all aspects of store policies, and knows where all items are in the store, that the student employees could contact at any time would be a good personnel investment. In addition, management needs to establish a process for monitoring employee performance on a routine, daily basis. Benchmarking other college bookstores could provide insight into ways to solve quality problems. A process for measuring customer *and* employee satisfaction on a regular basis needs to be put into effect, and performance measures could be tied to these surveys.

g. Because the bookstores are quasi non-profit, government-type entities, the revenue pressures that a business might feel are not present. Thus, the motivation for improved quality is primarily the store's reputation. Another factor is the university-invoked policy of hiring students on a part-time basis. This means that to solve the quality problems associated with part time students, bookstore management must look to other solutions besides hiring more-experienced, full-time employees. The fact that students will be serving adults is a situation that cannot be changed.

h. The most probable benefit would be an increase in sales and revenue. However, employee satisfaction would also likely increase as a result of a quality management program. Also, the Board of Directors would likely receive fewer complaints.

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| | Campus Store | | | | Off Campus Store | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Student** | | **Non-student** | | **Student** | | **Non-student** | | **Total** | |
| | **Yes** | **No** | **Yes** | **No** | **Yes** | **No** | **Yes** | **No** | **Yes** | **No** |
| | *%* | *%* | *%* | *%* | *%* | *%* | *%* | *%* | *%* | *%* |
| Were employees courteous and friendly? | 86 | 14 | 67 | 33 | 75 | 25 | 52 | 48 | 73 | 27 |
| Were employees knowledgeable and helpful? | 79 | 21 | 52 | 48 | 77 | 23 | 41 | 59 | 65 | 35 |
| Was the overall service good? | 86 | 14 | 63 | 37 | 71 | 29 | 55 | 45 | 71 | 29 |
| Did you have to wait long for service? | 11 | 89 | 45 | 55 | 11 | 89 | 46 | 54 | 25 | 75 |
| Did you have to wait long to checkout? | 12 | 88 | 46 | 54 | 16 | 84 | 45 | 55 | 27 | 73 |
| Was the item you wanted available? | 92 | 8 | 84 | 16 | 90 | 10 | 90 | 10 | 89 | 11 |
| Was the cost of your purchase(s) reasonable? | 58 | 42 | 90 | 10 | 60 | 40 | 92 | 8 | 72 | 28 |
| Have you visited the store web site? | 50 | 50 | 12 | 88 | 58 | 42 | 5 | 95 | 41 | 59 |
| | 42 | 5 | 95 | 41 | 59 | | | | | |

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# CASE SOLUTION 2.4 - Product Yield at Continental Luggage Company

*Average Weekly Yield*

$$\text{Stage 1 yield: } Y_1 = I(\%G) + I(1 - \%G)(\%R)$$
$$= 500(0.94) + 500(0.06)(0.23)$$
$$= 470 + 6.9$$
$$Y_1 = 476.9$$

$$\text{Stage 2 yield: } Y_2 = (476.9)(0.98) + 476.9(0.02)(0.91)$$
$$= 467.4 + 8.7$$
$$Y_2 = 475.2$$

$$\text{Stage 3 yield: } Y_3 = 475.2(0.98) + (475.2)(0.02)(0.67)$$
$$= 465.7 + 1.8$$
$$= 467.6$$

$$\text{Stage 4 yield: } Y_4 = 467.6(0.98) + (467.6)(0.02)(0.89)$$
$$= 458.2 + 8.3$$
$$= 466.1$$

$$\text{Stage 5 yield: } Y_5 = 466.1(0.98) + 466.1(0.02)(0.72)$$
$$= 456.8 + 6.7$$
$$= 463.5$$

*Increasing Good Quality Yield by 1% at Each Stage*

$$\text{Stage 1 yield: } Y_1 = 500(0.95) + 500(0.05)(0.23)$$
$$Y_1 = 480.75$$

$$\text{Stage 2 yield: } Y_2 = 480.75(0.97) + 480.75(0.03)(0.91)$$
$$Y_2 = 479.45$$

$$\text{Stage 3 yield: } Y_3 = 479.45(0.96) + 479.45(0.04)(0.67)$$
$$Y_3 = 473.12$$

$$\text{Stage 4 yield: } Y_4 = 473.11(0.98) + 473.11(0.02)(0.89)$$
$$Y_4 = 472.07$$

$$\text{Stage 5 yield: } Y_5 = 472.07(0.99) + 472.07(0.01)(0.72)$$
$$Y_5 = 470.75$$

$$\text{Difference in yields} = 470.75 - 463.5 = 7.25 \text{ units}$$

$$\text{Percentage increase} = \frac{7.25}{463.2} = 1.56\%$$

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Chapter

# 2 Quality Management

This chapter introduces one of the most critical processes for effective operations, quality management. Chapter 2 discusses the evolution of quality management, tools for solving quality problems, six sigma, cost of quality and quality awards and certifications. The next chapter goes into the details of statistical quality control. The material can be covered in two or three 75 minute classes (depending on the number of interactive exercises used).

We present quality early in the text not only because of its importance to industry, but also for its relevance to students. Every student has experienced both good and bad quality and can articulate how that experience has shaped their buying behavior.

Listed below are learning objectives, a lecture outline, teaching notes, pause and reflect questions, and suggested videos. Web links, Internet Exercises, Virtual Tours, PowerPoint files, online practice quizzes, and other resources can be found on the text Web site at www.wiley.com/college/russell.

## OVERALL LEARNING OBJECTIVES

- To appreciate, and be able to articulate, the importance of good quality and the cost of poor quality
- To understand how quality management systems have evolved and be able to assess the stage of Q evolution a particular company exhibits.
- To learn how to use quality tools and the DMAIC methodology in problem solving
- To understand the magnitude of six sigma quality
- To recognize quality awards and ISO certifications

## LECTURE OUTLINE *(suggested activities in italics)*

Day 1 – *What is Q, Q Management Systems, Q Tools, Customer Focus, Employee Involvement, Q in Services*
Day 2 – *Six Sigma, Cost of Q, Q & Productivity, Q Awards and Certifications*

A. *Quality and Value in Athletic Shoes*
B. What is Quality? *Student examples of good and bad Q; match with dimensions of Q*
   1. Quality from the Consumer's Perspective – *Defining Quality*
      a. Dimensions of Quality for Manufactured Products
      b. Dimensions of Quality for Services
      c. Quality from the Producer's Perspective
      d. A Final Perspective on Quality
C. Quality Management System - *Quality vs. Value in Denim Jeans*
   1. The Evolution of Quality Management
      a. W. Edwards Deming - *Show video clip of Deming or conduct Red bead experiment*
      b. Deming's Fourteen Points (Table 2.2)
      c. Plan-Do-Study-Act Cycle (Figure 2.2)
   2. TQM and QMS
D. Quality Tools (Figure 2.3) *Apply tools in a short case*
   1. Process Flowcharts - *Applying Deming's PDCA Cycle in Education*
   2. Cause-and-Effect Diagrams
   3. Check Sheets and Histograms
   4 Pareto Analysis (Figure 2.6)



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5. Scatter Diagrams
6. Process Control Charts and Statistical Quality Control

E. Customers and Employees in Quality Management (Figure 2.7)
1. Quality Management in the Supply Chain - *Achieving Quality in Target's Supply Chain*
2. Measuring Customer Satisfaction - *Customer Feedback and Voice of the Customer at JetBlue* and *Quality and value in Smartphones*
3. The Role of Employees in Quality Improvement
4. Kaizen and Continuous Improvement
5. Quality Circles
6. Process Improvement - *What needs to be improved at your university? Create charter for an improvement team.*

F. Quality in Services
1. Quality Attributes in Services -*Discuss how you measure Q in services*
2. *Two-Time Baldrige National Quality Award Winner, Ritz-Carlton Hotels*

G. Six Sigma "*Who Wants to be a Millionaire" questions for different levels of 6-sigma training*
1. The Six Sigma Goal – 3.4 DPMO *Give examples of 99.99% good quality*
*Motorola's Six Sigma Quality*
2. The Six Sigma Process (Figure 2.9)
3. Improvement Projects
4. The Breakthrough Strategy: DMAIC - *Six Sigma Highlights*
5. Black Belts and Green Belts (Figure 2.10)
6. Design for Six Sigma - *North Shore University Hospital*
7. Lean Six Sigma - *Six Sigma Success at Telefonica Group*
8. The Bottom Line - Profitability

H. Quality Costs and Productivity
1. The Cost of Achieving Good Quality
   a. Prevention Costs
   b. Appraisal Costs
2. The Cost of Poor Quality - - *Discuss high profile recalls and their ultimate cost*
   a. Internal Failure Costs
   b. External Failure Costs
3. Measuring and Reporting Quality Costs
4. The Quality-Cost relationship
5. Productivity
6. Measuring Product Yield and Productivity
7. The Quality-Productivity Ratio

I. Quality Awards (Table 2.3) *Who are the latest Baldrige award winners? Show video clips*
1. The Malcolm Baldrige Award
*K&N Management, Baldrige National Quality Award Winner in Small Business*
2. Other Awards for Quality
*Baldrige National Quality Award Winners in Healthcare: What It Takes*

J. ISO 9000 - *Which companies in your area are ISO 9000 certified?*
1. Standards *What kinds of standards and certifications make a difference to you?*
2. Certification
3. Implications of ISO 9000 for U.S. Companies
*ISO Certifications for Sustainability and Social Responsibility*
4. ISO Registrars



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## MAPPING OF SPECIFIC LEARNING OBJECTIVES TO ASSIGNMENTS

| # | H1 Heading | Terminal Learning Objective | Questions | Problems | Other |
|---|---|---|---|---|---|
| 2.1 | WHAT IS QUALITY | ***Discuss the meaning of quality of goods and services from both the producer's and consumer's perspectives*** | 1, 2, 3, 7, 10, 18, 20, 21, 22, 27, 28, 29, 31, 63 | | case 1, 2, 3 |
| 2.2 | QUALTIY MANAGEMENT SYSTEM | ***Discuss the evolution of quality management into a quality management system; including key figures and their contributions*** | 14, 20, 21, 23, 26, 48, 61, 51 | | case 1, 2, 3 |
| 2.3 | QUALITY TOOLS | ***Utilize several common quality control tools*** | 21, 30, 45, 46, 47, 52, 58, 60 | 15 | case 1, 2, 3 |
| 2.4 | TQM AND QMS | ***Compare and contrast total quality management and a quality management system*** | 16, 17, 21, 34, 51 | | case 1, 2, 3 |
| 2.5 | THE FOCUS OF QUALITY MANAGEMENT – CUSTOMERS | ***Explain how and why customer satisfaction can be measured and provide several strategies for ensuring quality from suppliers*** | 11, 21, 32, 33, 34, 36, 38, 42, 43, 44, 56, 65, 66, | | case 1, 2, 3 |
| 2.6 | THE ROLE OF EMPLOYEES IN QUALITY IMPROVEMENT | ***Describe several approaches used for involving employees in the quality improvement process*** | 7, 21 | | case 1, 2, 3 |
| 2.7 | QUALITY IN SERVICES | ***Describe how quality management is applied to services*** | 19, 18, 21, 27, 28, 29, 32, 34, 36, 37, 38, 40, 41, 63 | | case problems 1, 2, 3 |
| 2.8 | SIX SIGMA | ***Explain the philosophy and magnitude of six sigma quality.*** | 21, 53, 54, 55, 57, 58, | 13, 14 16 | case problems 1, 2, 3 |
| 2.9 | THE COST OF QUALITY | ***Classify quality related costs and calculate and interpret quality measurement indices*** | 4, 5, 6, 7, 9, 11, 12,13, 21, 63, 66 | 1 16* | case problems 1, 2, 3 |
| 2.10 | THE EFFECT OF QUALITY MANAGEMENT ON PRODUCTIVITY | ***Utilize several quality measures that reflect productivity*** | 8, 11 20, 21, 63 | 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 16 | solved problems 1, 2 case problems 1, 2, 3, 4 |
| 2.11 | QUALITY AWARDS | ***Recognize quality awards and ISO certifications*** | 15, 21, 25, 35, 38, 45, 52, 53, 59, 68 | | case problems 1, 2, 3 |
| 2.12 | ISO 9000 | | 24, 49, 51^ 21*, 67 | | case problems 1^, 2^, 3* |

* Secondary problems or questions that are listed with another section as the primary problem or question.



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^ Listed with another section also (equally important; not secondary).

## SUGGESTED VIDEOS

There are numerous videos available on the Internet on quality management, ISO 9000, six sigma and more. NIST has a channel on YouTube that describes the Baldrige National Quality Winners. These are good resources for either chapter 2 or 3.

**Baldrige Award** winners are available on the NIST channel, http://www.youtube.com/user/usnistgov.

**The Mayo Clinic** has a series of quality related videos on its YouTube channel. Links to several are given in the Experential Exercises section below. The first video in the series is shown here: http://www.youtube.com/watch?v=f-FbIA3ezBw

**The Deming Institute** has a number of good videos showing Deming explaining quality concepts (WARNING: he speaks slowly and is sometimes hard to understand). https://deming.org/

**ASQ** has a number of short videos available to show from its website. One of them is shown below. They also have a YouTube channel with a number of good videos on the state of quality improvement today. http://www.youtube.com/user/ASQhq

***Cost of Poor Quality***
http://asq.org/audit/109163/web.html?shl=109163

## EXPERIENTIAL EXERCISES

### The Red Bead Experiment (Chapter 2 or 3)

***Description***
*http://www.redbead.com/what/*

***Online simulator (free trial) of the experiment***
***http://www.symphonytech.com/redbeadexp.htm***

***Video of Deming performing the experiment***
http://www.youtube.com/watch?v=R3ewHrpqclA

***Video of Mayo Clinic performing the experiment***
http://www.youtube.com/watch?v=JeWTD-0BRS4

### The Funnel Experiment

You can use an actual funnel from the kitchen or a child's marble race toy to perform this experiment.

***Video of Mayo Clinic performing the experiment***
http://www.youtube.com/watch?v=2VogtYRc9dA



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# TEACHING NOTES

## Teaching Note 1—Quality was not always a high priority

After World War II, American manufacturers put quality low on their objectives. Pent-up consumer demand, combined with industries still converting from military use, and combined with the absence of meaningful international competition, led to a situation where manufacturers could sell almost anything they could produce. It was unfortunate and ironic that this happened while the infrastructure for quality control and management was being put in place in other countries.

## Teaching Note 2—The Japanese learned quality from Deming after WWII

After World War II, the Japanese found their reputation for poor quality to be a major obstacle in their ability to compete in world markets. This created an eager atmosphere of acceptance for the ideas and philosophies about quality provided by such individuals as W. E. Deming when he visited Japan as a consultant after the war.

## Teaching Note 3—Quality issues pervade this textbook

The impact of quality management on some of the operational functions discussed in these sections of the text is addressed in greater detail in other chapters of this text. For example, the relationship between quality management and product design is discussed in greater detail in Chapters 4 (Product Design) 5 (Service Design). The relationship of quality to job design and employees is considered in Chapter 8 (Human Resources). Quality and statistical process control is discussed in greater depth in Chapter 3 (Statistical Quality Control) and its Supplement (Acceptance Sampling). Quality is also an issue in shipping, materials management, and logistics, which are addressed in Chapters 10 (Supply Chain Strategy and Design) and 11 (Global Sourcing and Logistics).

## Teaching Note 4—Quality Management and Design Teams

A recent trend in QM is to use design teams for product design. Design teams include members from various functions and operations in the organization that can affect product quality such as engineering, quality, purchasing, manufacturing and marketing. For example, members from purchasing can provide input or supplier capabilities, and frequently representatives from the actual suppliers are members of the team. Other members might include marketing representatives to indicate consumer preferences and the quality features most likely to appeal to consumer tastes and demands. In some cases, important consumers are informal members of the design team. The use of design teams is discussed in greater detail in Chapters 4 and 5.

## Teaching Note 5—Templates and software for Quality Tools

Templates are available for most of the tools of quality management. Microsoft's Visio has a library of templates for business use; this includes a cause-and-effect diagram. Excel makes easy work of Pareto analysis problems, histograms, and scatter diagrams and in chapter Excel is used for statistical process control and process capability.

## Teaching Note 6—Deming Brings Statistical Process Control to the Masses

During the mid-1930s, W. E. Deming took a one-year leave of absence from the U. S. Department of Agriculture to study statistical theory under noted statistician, Ronald A. Fisher. After he returned to the USDA he organized a series of evening lectures on statistical theory for the USDA's graduate school of continuing education. Deming invited a number of prominent international scholars to lecture, and it was in this forum that Deming promoted Walter Shewhart's work on statistical process control. Shewhart delivered a four-part lecture which Deming helped compile into the book that for many years was the bible of statistical quality control, *Statistical Method from the Viewpoint of Quality Control*. Through this lecture series Deming became well-known to many prominent individuals who attended the lectures, including Milton Friedman.

*Source:* Gabor, A., "Deming Demystifies the Black Art of Statistics," *Quality Progress,* December 1991, pp. 26-28.



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## Teaching Note 7- Joseph Juran

Joseph Juran worked as an engineer at the Hawthorne Works at Western Electric Company, the manufacturing arm of the Bell Telephone System in the 1920s. He worked in close association with some of the pioneers in quality at Bell Laboratories including Walter Shewhart, Harold Dodge, and George Edwards. During World War II he worked as assistant lend-lease administrator and assistant foreign economic administrator.

## Teaching Note 8—Military Quality Initiatives Play a Role in ISO 9000 Development

Following World War II, the Air Force, in reviewing their military performance during the war, came to the conclusion that their reliance on inspection to insure quality was not entirely effective. As a result the Air Force embarked on a new approach by establishing a plan for quality assurance and making sure contractors conformed to the plan via close surveillance. The Department of Defense later adopted this same concept in its standard MIL-Q-9858, which subsequently, in revised form, was embodied in the ISO 9000 series of standards.

## Teaching Note 9 - Baldrige Awards

Several of the "Along the Supply Chain" boxes in this chapter describe companies that have won the Baldrige Awards. They make the best examples of how companies and organizations can improve quality since they have done it and it has been documented. A detailed presentation of each Baldrige Award winning company can be accessed at the Baldrige Award site. You can also generate class discussion by asking students to nominate their own "best quality" products or services.



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