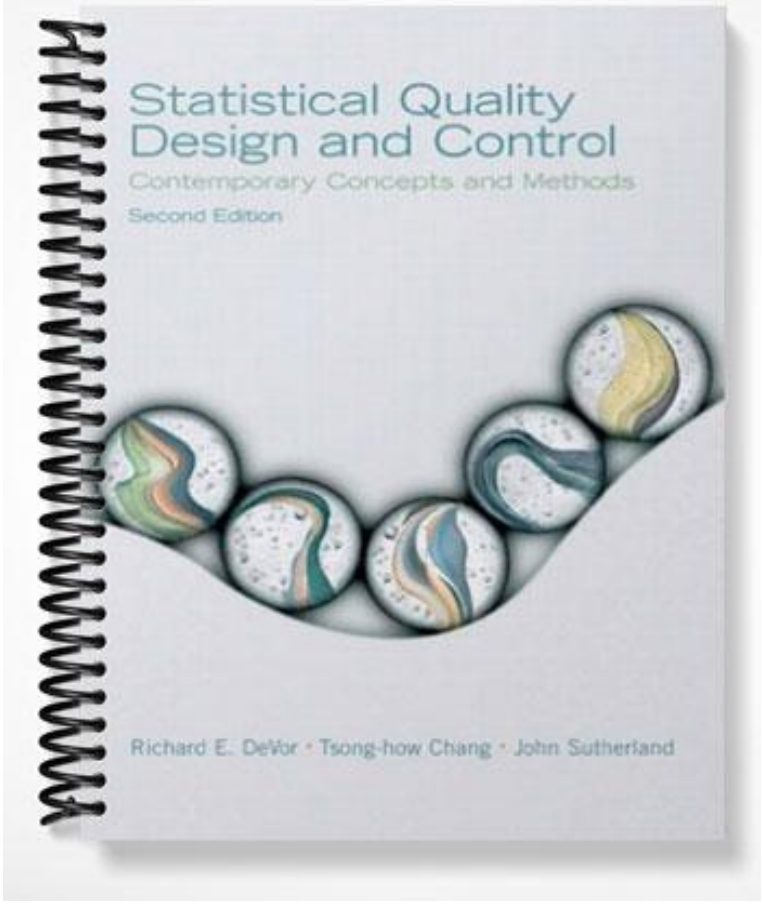
**SOLUTIONS MANUAL**



# Solutions to Chapter 2 Exercises

2.1 *What is the purpose of Deming's Fourteen Points? That is, why did Dr. Deming feel the need to develop and teach these tenets?*

Deming developed his 14 points to help companies realize their potential for better competitive position through continuous improvement. Deming saw the fires of quality improvement burn strongly for a short period of time in the 1940's, but because quality and productivity improvement was not put on an institutional basis within the organization it was always perceived of as someone else's job. Deming, through his 14 points, attempts to provide a clear roadmap for management so they might come to understand what needs to be done and who is responsible for making it happen. Deming learned through his disappointing experiences in the US during and immediately after WWII that without upper level management involvement and leadership it would not be possible to put the concept of never ending improvement in place in a way that would have a lasting impact on competitive position.

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2.2 *What is the most fundamental point of departure of the philosophies of Product Control and Process Control?*

The fundamental point of departure involves the view of quality inherent in each philosophy.

The product control view:
- measures quality of a product in terms of its acceptability as measured by conformance to engineering specifications.
- emphasizes detection and containment of defective material through inspection/screening, therefore making quality and productivity opposing rather than supportive forces.

The process control view:
- emphasizes the prevention of defective material from being made in the first place by seeking the root cause of the problem and eliminating it altogether.
- makes quality and productivity enhancement possible simultaneously by continually seeking ways to reduce variation, thereby eliminating waste and inefficiency in the process and variation in performance of the product.

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2.3 *How did Deming feel customer-supplier relations ought to be approached?*

In regards to customer-supplier relations, Deming felt that:
- single-sourcing ought to be practiced to enhance the trust and teamwork in the relationship. Companies should develop long term partnerships with suppliers that promote close working relationships, continually seeking ways jointly to improve product designs and the manufacturing processes for those products.
- pitting multiple suppliers against each other to reduce price will lead to poorer quality as suppliers look in the short term for ways to cut costs. Contracts should not be awarded based on price tag alone with no evidence that the supplier is practicing the concepts of never-ending improvement.

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2.4 *Explain the term: "hold the gain" in reference to improvement.*

"Holding the gains" refers to the ability to make improvement actions that have a lasting impact on the organization. It is one thing to identify an action that will improve quality and productivity and demonstrate the validity of the action by experiment, but it is something else to make that action become an economic and lasting part of the total system so that the potential gains can be realized for the long term. This means that we must identify any inhibitors that might exist that stand in the way of the long term implementation of the improvement action and remove those inhibitors. We must make sure, for example, that everyone involved knows the reasons for the improvement actions and will not be penalized in some way by the system for the implementation of the actions.

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2.5 *What sort of leadership did Deming feel is necessary in the realm of manufacturing?*

According to Deming, a leader should be:

- a person that shows the way by example and continually motivates people and provides them with the tools and understanding to do their best without threats of reprisal if they do not.
- a coach and teacher who promotes cooperation among employees, e.g., the team approach to the solution of problems and the pursuit of opportunities.
- one who catches employees doing something right, instead of a watch guard in search of errors and otherwise poor performance.

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2.6 *Define quality.*

Quality can be best defined as the "loss imparted to society during product use as a result of functional variation and harmful effect." The key here is that quality is measured by the customer during field use through the variation that is inherent in the use of the product. It is important to employ a definition of quality that can be made operational throughout the organization, not as a shipping criterion, but more as a design and manufacturing criterion.

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2.7 *There are many definitions of the word "quality" that have been used in the past. What are some of the reasons why many of them do not serve us well?*

Many definitions of quality fail because:

- they are attribute-based and are unable to quantify quality and make it an operational criterion for design and manufacturing.
- they are manufacturing-based (i.e., conformance to specification) rather than design-based (i.e., function in field use).
- they focus on the product not the process, that is they are more detection and containment rather that prevention oriented.
- they focus on the producer rather than the consumer.
- they confuse customer preferences with customer needs in terms of product function.

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2.8 *What is the problem with the use of engineering specifications as a definition of quality?*

Engineering specifications poorly define quality because:

- they promote improvement only up to a certain level after which further reductions in variation seem to be of no value unless variation relative to the specifications is evaluated via the loss function idea.
- they focus on the detection and containment of bad product rather than directing attention on prevention and continuing improvement.
- they are often employed on a go/no go basis, thereby failing to distinguish between degrees of goodness of the product. As a result the importance of being on the nominal is not emphasized sufficiently.

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*2.9 How does the loss function concept differ from the classical definition of the engineering specification?*

The loss function differs from the classical engineering specification in that it provides a variable measure of goodness (and badness) without regard to the design specifications. In fact, no design specification is necessary. The loss function simply measures in a quantitative way the quality loss incurred as a result of deviation from the nominal/target. Further, the loss function concept places emphasis on product performance in the field - use environment - and is therefore very customer oriented.

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2.10 *What is wrong with the "loaf-shaped" distribution that is characteristic of the output of processes for so many US manufacturers?*

The characteristic loaf-shaped distribution may signal:

- the presence of the product control approach to quality control which attempts to "inspect" quality into the product. Product initially outside of the specifications is often reworked or otherwise adjusted to make it conform to the specifications.
- an unnatural pattern of product variability, reflecting the presence of causes of variation that are robbing us of productivity and perhaps giving rise to significant scrap or rework of bad product.
- a process under poor statistical control that has a changing mean or variance over time, often as a result of inefficiencies such as overcontrol of the process, poor maintenance policies, etc.
- a process that has been allowed to drift from one end of the specifications to another to exploit a wide set of limits. Such a policy misinterprets the meaning of the specification which must be viewed statistically and must be viewed with an eye toward being on the target/nominal, not just within the specifications.

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2.11 *When does the pursuit of quality and productivity improvement become economically inadvisable? Explain your answer.*

The pursuit of quality and productivity improvement will almost never become economically inadvisable in a practical situation. The real costs involved with not having quality, such as the pursuit of competitive position, are difficult to measure and rarely considered when deciding to discontinue improvement efforts. Also, see answers to 2.12 and 2.19

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2.12 *What is the real "cost of quality" issue?*

The real cost of quality issue is the loss incurred but often unobserved by the organization as a result of failing to pursue improvement/seek reduction in variation never-ending basis. The cost of not having quality is the cost of adhering to a product control mentality for quality control which, for example, promotes the misinterpretation and enhances the misuse of tolerances to the detriment of quality and productivity improvement. The real costs of not having quality include:

- loss of competitive position in the marketplace because of an inability to reduce costs.
- lost opportunity in the form of lower efficiency/productivity resulting from a failure to continue to seek and remove further sources of process variability.
- lost opportunity in the form of all the benefits which are gained from a predictable, consistent, high-quality process, e.g., improved production management, including scheduling, inventory control, MRP, and increased flexibility/adaptability, enhanced environment for breakthrough resulting from lower variability, more positive and participative employee attitudes.

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2.13 *Deming states that it is one of management's responsibilities to provide their workers with the proper tools for the job. What do you think he was referring to here? Can you provide a couple of examples, either real or contrived?*

Too often workers are simply asked to do better, work hard, make fewer mistakes, improve quality, etc., without being given direction and guidance as to how all these things can be made to happen.
The proper tools for the job refers to:

- proper training for employees to perform their jobs effectively (including training for SPC).
- knowledge of the latest available technologies and methods.
- constructive feedback for a better understanding of one's job.
- a commitment to providing capital needed to implement new ideas for quality or productivity improvements.

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2.14 *The elimination of work standards has been one of the more difficult of Dr. Deming's points to be accepted by management. Why do you think that is? How would the elimination of work standards positively affect productivity? quality?*

Work standards have not been eliminated easily because:
- they have become institutionalized within the organization as a measure of productivity.
- they appear to provide some evaluation, in terms of comparison, of the workers, the machines and systems of manufacture.
- eliminating standards would relinquish some control that management has over workers.
- they are used in some situations as part of wage incentive plans, which urge workers to work faster and reward them for production speed, not quality production.

Productivity would increase without work standards since all in the system would be more directed toward the continual pursuit of improvement opportunities. Work standards tend to place a cap on further improvement opportunities if the standard is being met, why try to do better? Rewards should be given for solving quality problems and finding more efficient methods of production, not for meeting or exceeding the numbers. Quality would certainly increase since the production department would begin to take more responsibility for quality.

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2.15 *Deming's 10th point states that work slogans and targets for the workforce should be eliminated. Why? And how will doing so affect quality and productivity?*

Deming feels that slogans and targets should be eliminated because too often they are empty words which substitute for a lack of proper training. To do better, workers must be given the tools and concepts to make improvements. Emphasis on targets and slogans tends to promote the management of things/numbers, not people. Eliminating them will force management to look at more substantive and lasting ways of actually helping workers improve both.

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2.16 *Which of Deming's 14 points show the detrimental effect that weekly performance reports have on overall quality? Explain why these inhibit improvement.*

Points 1 (Create constancy of purpose for the improvement of product or service) and 10 (Eliminate slogans, exhortations, and targets for the workforce that ask for zero defects and new levels of productivity) explain how weekly reports:
- place the focus on short-term gains and a quick-fix approach to improvement, often to the harm of ideas meant to benefit the company in the long run.
- tend to focus on getting the numbers out, not improving quality.
- tend to promote the management of things/numbers, not people, which can lead to overreaction, i.e. making hasty changes which may be the result of normal/common-cause variation.

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2.17 *How will staying with single suppliers benefit a company in the long run? When multiple suppliers are used, where does the emphasis tend to be placed? How can a company be sure that its single-source suppliers won't fail to meet demand?*

Single suppliers lead to long-term benefits such as:
- less buffer stock in inventory due to increased trust and confidence between supplier and customer and a closer working relationship, helping each other plan efficient manufacturing systems and schedules.
- better quality due to more consistent incoming products which will likely mean less trouble in using the supplier's product and a better customer end product.
- closer, stronger relationship that is built more on trust and mutual understanding than suspicion and mistrust.

With multiple suppliers the emphasis is often on who has the lowest price, or who has the fastest delivery. Quality assurance is generally administered through fear of reprisals, e. g., de-sourcing.
To be sure that single-source suppliers will meet demand, a company can:
- continue to reward or provide incentives such as long-term contracts for timely delivery of quality products at a competitive price.
- work closely with the supplier to address quality and productivity problems and encourage the use of available methods (i.e. SPC) to ensure a quality product.

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2.18 *Which of Deming's 14 points addresses the problems associated with the practice of "over-the-wall" design that was discussed in chapter 1? Explain.*

Point 9 (Break down barriers between departments). People in all activities within the organization must work as a team on the implementation of the Deming cycle. This point promotes the notion of knowing your customers within the organization and better understanding the problems, the needs and expectations of those customers. Design and manufacturing is a classic example of this need.

Point 9 addresses the over-the-wall design and manufacturing problem and recommends:

- that the barriers between design and manufacturing be eliminated, allowing them to work together towards a common goal.
- communication lines between departments be cleared, which will lead to a better product which is easier to manufacture and better meets the customer expectations.

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2.19 *What is the major limitation of the loss-function concept in terms of encouraging the continual pursuit of improvements in quality?*

The major limitation inherent in the loss function concept is that it appears to provide an economic basis for stopping the pursuit of improvement, while not considering many of the real (but often hidden) costs of not having quality. If misused, it can suggest an optimal quality level very much like the old "acceptable quality level" concept of product control. Because it represents a closed-form mathematical solution to determining quality loss, it is difficult to include in the formulation all of those aspects of the manufacturing system that will benefit from the never-ending pursuit of variation reduction, viz.,

- improved production management, e. g., scheduling/Inventory control/MRP
- increased flexibility / adaptability
- enhanced environment for breakthrough
- more positive employee attitudes

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2.20 *How can a customer benefit from improved quality in a supplier's product? How will this improved situation affect inventory management for the customer?*

If the improved quality is based on a process control continuous improvement-based quality program on the supplier's part, then the customers will benefit from a supplier's improved quality in many ways:

- suppliers will have fewer quality problems of their own due to a more consistent product/process.
- the customer will no longer need to waste time/resources in quality assurance from a product control perspective, working at arms length among multiple suppliers. Added confidence and the improved working relationship will enable the supplier and the customer to share more information and be more helpful to each other.
- customer inventory levels can be greatly reduced as the need to cover supplier problems with buffer inventories disappears.
- being able to move closer to a just-in-time inventory philosophy and improved production management due to a more reliable/predictable customer manufacturing pattern and fewer quality problems.

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2.21 *Discuss briefly each of the Seven Deadly Diseases of Management as articulated by Deming in his teachings.*

The "seven deadly sins", articulated by Deming in his teachings are explained as follows

**1. Lack of Constancy of Purpose:**
Short-term planning may result in companies adopting strategies insensitive to consumer demands. These strategies are the result of reactive thinking to events such as short-term financial figures, management fads, and perceived

changes in market. Such strategies result in overcontrol of the system thereby increasing variation, waste and inefficiency of the organization. Other examples of "overcontrol" of the system include continual "reorganization" within the system, frequent re-assignment of managers, and special "programs" aimed at reducing defectives, increasing the numbers, etc.

**2. Emphasis on Short-Term Profits:**
Short-Term profit indicators such as "quarterly report" and stock market prices can be often be misleading. Developing strategies based on such figures can give short term benefits, but damage the company in long term. For example, company may decrease expenditures on research programs to improve short term profits, suspend or terminate continuing education programs, and/or eliminate clerical positions.

**3. Evaluation of Performance, Merit Rating, and Annual Reviews of Performance:**
Use of merit ratings and annual reviews for evaluation of performance destroys teamwork and encourages personal rivalry in organization. Performance of individuals is affected by factors beyond the control of individuals. Evaluation of performance under such conditions can result in decrease in motivation and further erode their performance. Performance evaluation by such methods lacks rational basis for assessing the efforts of individual. We can think of the performance of individuals in terms of the Gaussian distribution. There are a small number of people with very poor performance, primarily driven by their own shortcomings, inabilities, and/or poor attitude/motivation (lower tail of the performance distribution). Similarly, there are a very few truly outstanding performers, again driven by their own talents and motivations (upper tail of the performance distribution. The remaining 90-95% of the people are simply above or below average and their position as such under the curve is primarily driven by the forces inherent in the system. Whether they do somewhat better or worse in the future is for the most part out of their control so any effort to rank their performance is meaningless.

**4. Mobility of Top Management:**
This is one of the commonly encountered deadly diseases in an organization. Movement of managers in and out of the organization may result in lack of constancy of purpose. This results in lack of commitment of developing long term strategies and causes interruption in continuous improvement strategies of organization. This can cause waste of time and resources invested in planning of strategies. As a consequence of this deadly disease, managers tend to spend more time thinking about what their next job will be and how best to get it than they do carrying out the duties and responsibilities of their present job.

**5. Running a Company on Visible Figures Alone:**
Management by outcomes or results, that is, taking immediate action based on visible figures, such as number of defects, customer complaints, and poor sales figures for a given quarter can lead to more trouble in the long run than it can ever avoid in the short run. Deming preached that the most important factors governing the long-term success of an organization are often unknown and unknowable. Such tampering is another form of overcontrol and can only increase the variation - waste and inefficiency - of the system.

**6. Excessive Medical Costs:**
The medical costs in the auto industry have reached extremely high levels, as a percent of overall expenditure. The medical expenditure has steadily increased from 1980s. The excessive medical cost have imposed high economic burden on several companies and U.S. economy as a whole. Insurance packages within an organization have become a major factor in selecting a job and in keeping that job. People often change jobs simply to get better health insurance. The exponentially-increasing cost of medical services has become a major cost factor in the legacy (retirement benefit) costs of an organization.

**7. Excessive Legal Damage Awards Swelled by Lawyers Working on Contingency Fees:**
United States had more lawyers per capita than any other country in the world. Certain lawyers, for example, make their living by filing class-action suits on behalf of large groups of consumers. This has become a major socio-economic issue plaguing the United States today. Excessive legal damages has driven up the cost of liability insurance in certain occupational sectors (e.g., physicians) as well as consumer prices in other sections (aircraft, prescription drugs).

2.22 *Six Sigma may be thought of as a quality program that embraces both the Deming cycle and Taguchi's loss function idea, two of the distinctive quality concepts that emerged in the quality movement during the early 1980s. Elaborate on which part or parts of Six Sigma embrace the Deming cycle and which embrace the loss function.*

The methodologies adopted in Six Sigma, viz. DMAIC (Define-Measure-Analyze-Improve-Control) and DMADV (Define-Measure-Analyze-Design-Verify) are structurally similar to the closed loop Deming's cycle (Plan-Do-Check-Act).

Application of Six Sigma methodologies involves defining process goals to meets consumer demand. The performance of the process is measured and the results are analyzed to identify the root cause of the problem. Based on the type of situation encountered DMAIC and DMADV methodology can be adopted. DMAIC methodology is use to improve the process which is already in existence, so as to meet the consumer specification and improve the process performance. DMADV methodology is designed to respond to the company needs to design a new process. This methodology is also adopted when the process performance is optimized and still does not meet the consumer specification. The results of the newly designed process are verified to meet the required consumer demands.

The goal of the Six Sigma effort is to reduction and elimination of defects to improve consumer satisfaction and profitability. This concept is similar to Taguchi's loss function, which argues that deviation from the nominal of any quality characteristic leads to deterioration of product performance and increase in loss to consumer. Increased loss generally translates to increased consumer dissatisfaction.

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2.23 *Think of one point that could be added to Deming's 14 points, particularly in view of the high-tech environment and global economy of the 21st century.*

Sustainability. Deming's philosophy of 14 points is a comprehensive management tool. In view of high-tech environment and global economy there is a need to incorporate principles of sustainability in management policies. It can be stated as follows:

"Develop sustainability management policies to ensure global outreach of an organization."
Sustainable policies by definition should ensure economic, social and environmental development of human society. For any organization to be successful globally must ensure that its policies should be beneficial in all the three sectors. Adopting policies that ensure only economic development of organization, but are harmful to environment and society will not be acceptable to foreign organizations.

Research and Development. In today's world, many of the more successful companies are those that invest significantly in research and development. Product life-cycles are becoming shorter and shorter and global competition in many sectors is becoming fierce. Investment in R&D will continue to increase in importance to the long-term viability of an organization.

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2.24 *Do you find that any of the Deming's 14 points need to be rephrased or eliminated for the 21st century?*

Because of the major strides taken over the past 20-25 years by many organizations, many of the 14 points have become an integral part of the fabric of many organizations. They have also been successfully integrated into company-specific certification programs and the ISO standards related to quality. But none of the original 14 points seem to have become unnecessary or irrelevant. Perhaps, the emphasis today at this stage of our quality and productivity evolution ought to fall more on attacking directly the Seven Deadly Diseases of management!

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2.25 *"Quality" is a word that generally carries a positive connotation. Why does Taguchi treat it as a loss or cost that generally carries a negative connotation?*

Taguchi defines quality as "loss imparted to society during product use as a result of functional variation and harmful effects". The loss function concept quantifies quality as loss due to functional variation. When the product

is performing at the nominal level the loss to the society is minimal. As the product performance deviates from the nominal level the loss starts to increase. Taguchi advocates that products must be designed and manufactured to perform with least variation and such occurs when the proper nominal level is chosen for the critical quality characteristics and when these nominals are adhered to by manufacturing. The loss function emphasizes the need of consistent performance.

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2.26 *Provide a concrete example to illustrate each of Deming's Seven Deadly Diseases of Management.*

**1. Lack of constancy of purpose**
Lack of constancy of purpose may results in absence of long term strategy to maintain equipment and improve process performance. Failure of heavy operating machinery such as boilers may take long time. The effects of such failures are disastrous. Regular maintenance policy would ensure prevention of such failures. The authors recall working at an automotive plant in the mid-1980's when regular maintenance schedules were suspended in an effort to keep machines running a higher percent of the time. This resulted in an increased defect rate.

**2. Emphasis on short-term profits**
Emphasis on short-term profits by reducing investment in quality control program can lead to long term losses. A company may reduce the frequency of data collection for process to reduce cost. In absence of adequate monitoring of process the deterioration in process performance will go unnoticed and would result in increased losses due to product rejection. Suspending or eliminating job-related training programs or reducing or eliminating R&D budgets would be other examples of placing too much emphasis on short-term profits.

**3. Evaluation by performance, merit rating, or annual review of performance**
Effects of evaluation of performance by using merit ratings can be devastating. In one municipality, 32 police officers were rated as "outstanding", "exceeds requirements", " meets requirement" , "below requirements" or "unsatisfactory," based on the number of traffic tickets issued by them. As a result of this policy, motorists who would normally be just warned were issued tickets. This also distracted policemen from their other duties.

**4. Mobility of management**
Movement of managers in and out of organization can result in lack of constancy of purpose. This phenomenon can be commonly encountered in case of software professionals. There is high demand for software professionals in industry. Frequent switching of jobs by project managers for better salaries affects the overall progress of the project. One graduate of the University of Illinois who the authors are familiar with changed companies four times in seven years to improve his position as an IT manager. Frequent changes in managers within an organization in an effort to "shake things up" generally leads to waste and inefficiency because this is simply another form of tampering or overcontrol.

**5. Running a company on visible figures alone**
Developing of newer technology and process involves expenditure in millions of dollars in research and experimentation. Often the technological achievements of the projects are ignored in the company balance sheets. The new technological expertise developed by these efforts should be measured in analyzing the overall benefits and cost figures.

**6. Excessive medical costs.**
The medical cost for auto industry has steadily increased since 1980. According to the manager of Pontiac Motor Division, the cost of medical care per automobile in 1983 was $400. This was more than the cost of steel required per car. Recent comparisons between Toyota and General Motors and Ford in terms of automobile component costs show costs associated with medical benefits constitute one of the highest costs.

**7. Excessive Legal Damage Awards Swelled by Lawyers Working on Contingency Fees**
The United States has more lawyers per capita than any other country in the world. Many of these lawyers make their living by finding people to sue. This has become a major socio-economic issue plaguing the United States today. The implications of this focus on litigation may be that many professionals are defensive about performing their duties. For example, a medical professional may hesitate to perform his/her duty in an emergency due to the fear of liability costs.

2.27 *Discuss a situation in your own life where a misunderstanding has arisen due to a lack of an appropriate operational definition. Knowing what you know now, describe a good operational definition for that situation.*

Recommended for class discussion

2.28 *The chapter discusses a number of learning disabilities that have been identified by Senge. Discuss each of these briefly and provide a concrete example for each.*

Senge has discussed learning disabilities which stand as significant inhibitors to the growth of the organization's ability to learn and expand its capacity to do its work more effectively. Some of them are as follows:

**1. "I am my job"**
In many situations people working in various positions in an organization do not interact. People consider themselves small part of a large system and they do not believe that they can control their personal progress or progress of their organization. This situation is seen in a company which has several departments which do not interact. For example, a company experiences a high rate of rejection of their products from the consumers because of poor design. This may be because the manufacturing department is not in communication with the design department.

**2. "The enemy is out there"**
In many cases it is observed that people in an organization believe that the reasons for its failure are beyond their control. They consider outside influences such as foreign competition, government regulations, and labor unions as obstacles to their success. Such feelings of helplessness lead to lack of proactive decision making in an organization.

**3. Fixation of events**
Organization tends to develop strategies which can be termed as 'fire fighting.' Such strategies tend to provide short-term solutions. The root cause of the problems is not identified. The process of developing strategies should be gradually evolving, so that root cause of the problems is eradicated. For example, a company may encounter drop in their sales. To counter this it may tend to reduce its cost at the expense of quality of the product, without identifying the reasons behind drop in sales. A weekly scrap report showing a precipitous increase in defective parts; the granting of quality certification by a large customer; are other examples of events that organizations often tend to focus on, while gradual trend go completely unnoticed.

**4. "The parable of Boiled Frog"**
The people in the organization tend to recognize situation which are sudden and abrupt in nature. The gradually occurring trends go recognized due to lack of training. For example, effects of climate change and global warming are not evidently visible. Inability of organizations to recognize the slow but steady increase in medical costs is an example of the parable of the boiled frog. Inability to recognize gradual shifts in consumer preferences is another.

**5. "Delusion of learning from Experience"**
The notion of learning from experience causes people to take decision that are not based on a situation which might be similar to one they had encountered and not on the basis of the current problem. Rational decision-making is not practiced. This may result in adoption of inappropriate strategies. For example, consider a situation where an 'automobile manufacturing company' experiences drop in sales of a particular model of car. The organization might have encountered similar situation in the past for a different model. Developing a strategy to address drop in the current sale of cars based on a past situation may not give the desired results. Deming was a strong proponent of the fallacies of learning from experience. He repeatedly emphasized the importance of applying knowledge based on proven theories to solve problems.