Reference Questions TQM

1. Define the meaning of customer satisfaction. Explain the internal and external customer.

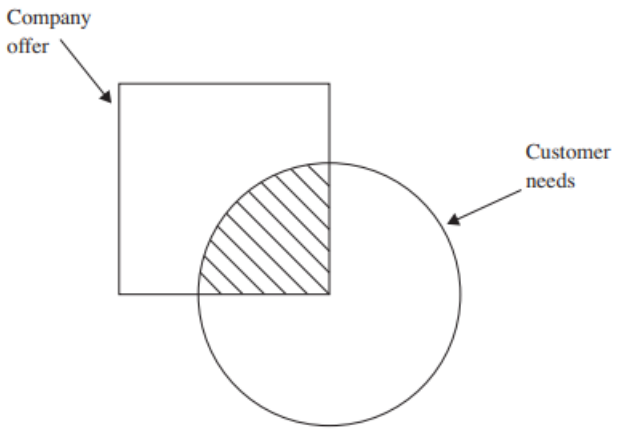
The most important asset of any organization is its customers. An organization's success depends on how many customers it has, how much they buy, and how often they buy. Customers that are satisfied will increase in number, buy more, and buy more frequently. Satisfied customers also pay their bills promptly, which greatly improves cash flow—the lifeblood of any organization. Increasingly, manufacturing and service organizations are using customer satisfaction as the measure of quality.

A simplistic definition of customer satisfaction is illustrated by the Teboul model, which is shown in Figure 3-2. The customer's needs are represented by the circle, and the square depicts the product or service offered by the organization. Total satisfaction is achieved when the offer matches the need, or the circle is superimposed on the square. The goal is to cover the expected performance level better than the competitors.

That part of the square that lies within the circle is perceived by the customer as satisfying, and the part of the square outside the circle is perceived as unnecessary. It is important that the organization listen to the "voice of the customer" and ensure that its marketing, design, production, and distribution processes truly meet the expectations of the customer.

Customer satisfaction seems simple enough, and yet it is far from simple. Customer satisfaction is not an objective statistic but more of a feeling or attitude. Although certain statistical patterns can be developed to represent customer satisfaction, it is best to remember that people's opinions and attitudes are subjective by nature.

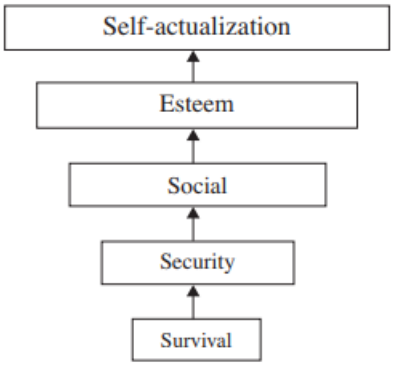
Because customer satisfaction is subjective, it is hard to measure. There are so many facets to a customer's experience with a product or service that need to be measured individually to get an accurate total picture of customer satisfaction. Whether or not a customer is satisfied cannot be classed as a yes or no answer. Using this model, a customer's satisfaction level would be the same if the experience were mediocre in the context of low expectations, or if the experience were superior in the context of high expectations. Customer satisfaction's focus is creating superior experiences, not mediocre experiences.



Customer Satisfaction Model

2. **Explain the following motivational theories for employee involvement: Maslow's Hierarchy of needs, Herzberg's two factor theory.**

Maslow's Hierarchy of Needs



Maslow's Hierarchy of Needs

One of the first and most popular motivational theories was developed by Abraham Maslow. He stated that motivation could best be explained in terms of a hierarchy of needs and that there were five levels. These levels are survival, security, social, esteem, and self-actualization. They are shown in Figure 4-1. Once a given level is satisfied, it can no longer motivate a person.

Relating these needs to motivation, we know that Level 1 (survival) means food, clothing, and shelter, which is usually provided by a job. In the workplace, Level 1 needs include proper lighting, heating/air conditioning, ventilation, phone system, data/voice access, and computer information system.1 Level 2 (security) can mean a safe place to work and job security, which are very important to employees. When the organization demonstrates an interest in the personal well-being of employees, it is a motivating factor. A threat of losing one's job certainly does not enhance motivation. Level 2 is not limited to job security. It also includes having privacy on the job such as being able to lock one's office door or having lockable storage for personal items, as well as having a safe work environment that may include ergonomic adjustable furniture.2

Because we are social animals, Level 3 (social) relates to our need to belong. It has been said that cutting someone out of the group is devastating to that individual. Isolation is an effective punishment. Conversely, giving an individual the opportunity to be part of the group by feeling important and needed will motivate that person. If possible, employees should be provided with both formal social areas such as a cafeteria and conference rooms and informal areas such as water coolers and bulletin boards.3 Being a member of a team is a good way to bring employees into the group. Level 4 (esteem) relates to pride and self-worth. Everyone, regardless of position or job assignment, wants to be recognized as a person of value to the organization. Where possible, employees should be given offices or personal spaces with aesthetics. Business cards, workspace size, and office protocols also provide employees with a certain level of self-esteem within an organization.4 Seeking advice or input into business or production processes is a good way of telling employees that they are of value. This activity requires giving employees control and freedom of their jobs by providing trust.5 Level 5 (self-actualization) says that individuals must be given the opportunity to go as far as their abilities will take them. Many organizations have a policy of promoting from within. It is true that some employees do not want to move up the corporate ladder, which is understandable. However, those who do want to move up must know that it is possible.

It is important to note that as employees move up the hierarchy, they will immediately revert back to the previous level if they feel threatened. For example, if an employee is satisfied in Level 3, a rumor of downsizing may cause an immediate return to Level 2.6

Herzberg's Two Factor Theory

Frederick Herzberg extended the general work of Maslow by using empirical research to develop his theory on employee motivation. He found that people were motivated by recognition, responsibility, achievement, advancement, and the work itself. These factors were labeled motivators. In addition, his research showed that bad feelings were associated with low salary, minimal fringe benefits, poor working conditions, ill-defined organizational policies, and mediocre technical supervision. These job-related factors were labeled dissatisfiers or hygiene factors, which implies they are preventable. It

is important to realize that dissatisfiers are often extrinsic in nature and motivators are intrinsic. The presence of the extrinsic conditions does not necessarily motivate employees; however, their absence results in dissatisfaction among employees. Absence of motivating factors does not make employees dissatisfied, but when there are motivating factors present, they do provide strong levels of motivation that result in good job performance for the individual and the organization. In general, dissatisfiers must be taken care of before motivators can be actuated. Herzberg's dissatisfiers are roughly equivalent to Maslow's lower levels, and the motivators are similar to the upper levels.7

3. Explain in brief Juran Trilogy

The Juran Trilogy

Process improvement involves planning. One of the best approaches is the one developed by Dr. Joseph Juran. It has three components: planning, control, and improvement, and is referred to as the Juran Trilogy. It is based loosely on financial processes such as bud-geting (planning), expense measurement (control), and cost reduction (improvement).

Planning

The planning component begins with external customers. Once quality goals are established, marketing determines the external customers, and all organizational personnel (managers, members of multifunctional teams, or work groups) determine the internal customers. External customers may be quite numerous, as is the case of a bank supply organization, where they include tellers, financial planners, loan officers, auditors, managers, and the bank's customers. Where there are numerous customers, a Pareto diagram (see Chapter 15) might be useful to determine the vital few.

Once the customers are determined, their needs are discovered. This activity requires the customers to state needs in their own words and from their own viewpoint; however, real needs may differ from stated needs. For example, a stated need may be an automobile, whereas the real need is transportation or a status symbol. In addition, internal customers may not wish to voice real needs out of fear of the consequences. One might discover these needs by (1) being a user of the product or service, (2) communicating with customers through product or service satisfaction and dissatisfaction information, or (3) simulation in the laboratory. Because customer needs are stated from their viewpoint, they should be translated to requirements that are understandable to the organization and its suppliers.

The next step in the planning process is to develop product and/or service features that respond to customer needs, meet the needs of the organization and its suppliers, are competitive, and optimize the costs of all stakeholders. This step typically is performed by a multifunctional team. Quality function deployment (Chapter 10), Taguchi's quality engineering (Chapter 16), and quality by design (Chapter 11) are some of the approaches that can be used. It is important that the design team, rather than a single department, approve the final design and that the team be composed of all functional areas within an organization as well as customers and suppliers.

The fourth step is to develop the processes able to produce the product and/or ser-vice features. Some of this planning would have occurred during the previous step. This step is also performed by a multifunctional team with a liaison to the design team. Activities include determining the necessary facilities, training, and operation, control, and maintenance of the facilities. Of particular concern will be the "scaling up" from the laboratory or prototype environment to the real process environment. Additional activities include process capability evaluation and process control type and location.

Transferring plans to operations is the final step of the planning process. Once again, a multifunctional team with a liaison to the other teams is used. When training is necessary, it should be performed by members of the process planning team. Process validation is necessary to ensure, with a high degree of assurance, that a process will consistently produce a product or service meeting requirements. Positrol and process certification, discussed later in the chapter, are excellent techniques to use to help validate the
process.

Control

Control is used by operating forces to help meet the product, process, and service requirements. It uses the feedback loop and consists of the following steps:

1. Determine items/subjects to be controlled and their units of measure.
2. Set goals for the controls and determine what sensors need to be put in place to measure the product, process, or service.
3. Measure actual performance.
4. Compare actual performance to goals.
5. Act on the difference.

Statistical process control (see Chapter 15) is the primary technique for achieving control. The basic statistical process control (SPC) tools are Pareto diagrams, flow diagrams, cause-and-effect diagrams, check sheets, histograms, control charts, and scatter diagrams. In addition, process capability information such as Cp and Cpk are used to determine if the process is capable and is centered.

Improvement

The third part of the trilogy aims to attain levels of performance that are significantly higher than current levels. Process improvements begin with the establishment of an effective infrastructure such as the quality council (see Chapter 2). Two of the duties of the council are to identify the improvement projects and establish the project teams with a project owner. In addition, the quality council needs to provide the teams with the resources to determine the causes, create solutions, and establish controls to hold the gains (see Chapter 4). The problem solving method described in a later section may be applied to improve the process, while the quality council is the driver that ensures that improvement is continuous and neverending. Process improvement can be incremental or breakthrough.

Figure 5-2 provides an example of how the three continuous improvement processes interrelate.3 In the figure, Juran provides a distinction between sporadic waste and chronic waste. The sporadic waste can be identified and corrected through quality control. The chronic waste requires an improvement process. As a solution is found through the improvement process, lessons learned are brought back to the quality planning process so that new goals for the organization may be established.

4. **Define and explain the following**
    - **Performance**
    - **Reward**
    - **Recognition**
    - **Empowerment**
    - **Gainsharing**

Performance involves “fitness for use”—a phrase that indicates that the product and ser-vice is ready for the customer’s use at the time of sale. Other considerations are (1) availability, which is the probability that a product will operate when needed; (2) reliability, which is freedom from failure over time; and (3) maintainability, which is the ease of keeping the product operable.

Recognition is a form of employee motivation in which the organization publicly acknowledges the positive contributions an individual or team has made to the success of the organization. This acknowledgment is delivered using verbal and written praise and may include symbolic items such as certificates and plaques.

Reward is something tangible such as theater tickets, dinner for two, or a cash award to promote desirable behavior. Recognition and reward go together to form a system for letting people know they are valuable members of the organization.

Empowerment is an environment in which people have the ability, the confidence, and the commitment to take the responsibility and ownership to improve the process and initiate the necessary steps to satisfy customer requirements within well-defined boundaries in order to achieve organizational values and goals.

Gainsharing is a financial reward and recognition system that results from improved organizational performance. It is different than profitsharing, in which the stockholders share a portion of the year-end profits with salaried and occasionally hourly employees. Gainsharing is based on the philosophy that people and teamwork are the keys to success. Because organizational success is dependent on team effort, the team shares in the rewards of success. Thus, gainsharing is a measurement of organizational productivity and a method to share productivity gains.

5. Explain the basic concepts to achieve the motivated workforce

The building of a motivated work force is for the most part an indirect process. Managers at all levels cannot cause an employee to become motivated; they must create the environment for individuals to motivate themselves. Concepts to achieve a motivated work force are as follows:

a. **Know thyself**. Managers must understand their own motivations, strengths, and weaknesses. This understanding can best be obtained by having peers and employees anonymously appraise the manager's performance. Some organizations like Cummins India Ltd. have implemented 360 degree feedback system for the managers. Motivating managers know that the most valuable resource is people and that their success largely depends on employees achieving their goals.
b. **Know your employees**. Most people like to talk about themselves; therefore, the motivating manager will ask questions and listen to answers. With a knowledge of the employees' interests, the manager can help achieve them within the business context. As the manager learns more about the employee, he/she can assist the employee in directing their efforts toward satisfying their goals and well-being. This knowledge will also enable the manager to utilize their strengths.
c. **Establish a positive attitude**. A positive action-oriented attitude permeates the work unit. Managers are responsible for generating attitudes that lead to positive actions. Feedback should, for the most part (say, 87%), be positive and constructive. Respect and sensitivity toward others is essential to the development of positive attitudes. Asking employees for their opinions concerning job-related problems is an effective way to build a cooperative atmosphere. Managers should treat ideas and suggestions as price-less treasures and implement them immediately whenever possible.
d. **Share the goals**. A motivated work force needs well-defined goals that address both individual and organizational needs.
e. **Monitor progress**. The process of goal-setting should include a road map detailing the journey with periodic milestones and individual assignments. Managers should periodically review performance.
f. **Develop interesting work**. Managers should consider altering the employees' assignments by means of job rotation, job enlargement, and job enrichment.
g. **Communicate effectively**. Effective communication provides employees with knowledge about their work unit and the organization rather than "grapevine" information.
h. **Celebrate success**. Recognizing employee achievements is the most powerful tool in the manager's toolbox.

What Employees Want

Factor	*Employee Rating*	*Manager Rating*
Interesting work	1	5
Appreciation	2	8
Involvement	3	10
Job security	4	2
Good pay	5	1
Promotion/growth	6	3
Good working conditions	7	4
Loyalty to employees	8	7
Help with personal problems	9	9
Tactful discipline	10	6

6. Explain in brief Categories of Quality Costs

INTERNAL FAILURE COSTS

These are costs which are associated with the defects or non-conforming situations that are found prior to shipment of the product to customer. These costs can be reduced to zero if no defect existed prior to shipment. Whenever quality appraisals are carried out, there exists a possibility of discovering nonconforming situations. Such situations are salvaged by either rework, complete replacement or scrapping. The total cost of carrying out re-inspection/re-tests, failure analysis, evaluation, disposition and subsequent actions are included in the internal failure cost. In summary, this includes all material, labor, energy and overhead expenses that are wasted on account of non-conforming or defective product or service. Examples of internal failure costs are:

- Rework, fixing of bugs detected in internal testing of software
- Premium freight due to late delivery
- Internal scrap
- Engineering and drawing changes to correct errors
- Energy cost for remelting of rejected castings

EXTERNAL FAILURE COSTS

Often the defects are found only after the product reaches the dealer or customer. Such costs are included in the external failure costs. This component of quality cost also disappears if there are no defects. Some examples of external failure cost are:

- **Complaints**: Complaints from customer are analyzed, resolved and communication is sent to customer. Sometimes it may also involve field service or adjustments.
- **Warranty claims**: Recall of vehicles for defects, costs involved in repairs or replacement of product during warranty period, the cost associated with receipt, evaluation and replacement of defective product from field.
- **Retrofit and recall costs**: It is often required to modify or update the product in order to incorporate new design changes in order to overcome design deficiencies. There are several cases in recent past, where automobiles were recalled due to failure investigation reports on the steel used in the manufacturing.
- **Liabilities and penalties**: Insurance claims and contractual obligatory claims are included in such types of costs.
- **Allowances and customer goodwill**: The cost of concessions offered to the customer due to substandard product, poor quality or costs incurred because the customer is not completely satisfied with the quality because his expectations were higher than those delivered to him by the product.
- **External failure** costs will also include lost sales and loss of goodwill although these are difficult to measure

APPRAISAL COSTS

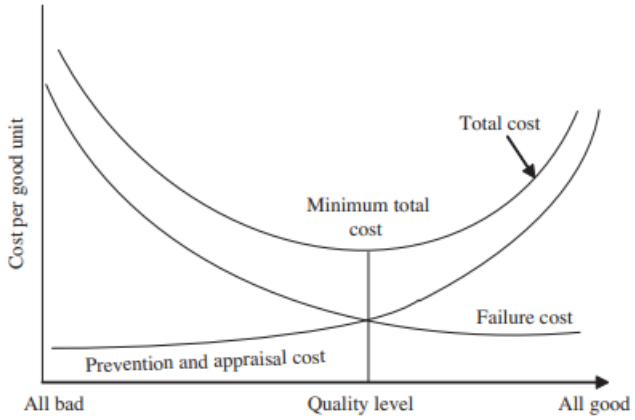
These are the costs incurred while conducting inspection, tests, and several other planned evaluations with the purpose of determining whether the product (or service) confirms to its stated requirements. Appraisal cost also includes various activities related to quality system audit, cost of legal compliance, supplier surveillance, product quality audits, costs for calibration of testing equipment, etc. Thus, cost of maintaining the inspection and test equipment is a part of appraisal cost. Examples include:

- Design reviews
- Software testing
- Set-up inspection
- Performance testing by customer
- Calibration of gauges
- Calibration of testing facility
- Receiving inspection of purchased parts

PREVENTION COSTS

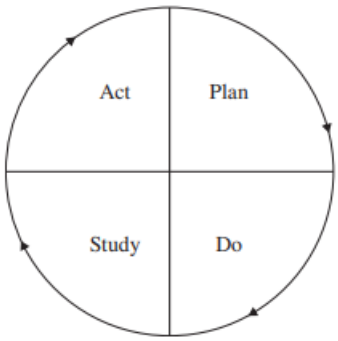
These are the costs of all such activities undertaken to prevent defects in design, development, purchase, labor and other aspects of creation of the product/service. Prevention costs lower the other costs (failure cost and appraisal cost). Prevention is achieved by examining previous failure data and developing action plans for incorporating into the basic system so that the same failures/ defects do not occur again. Examples of prevention costs include:

- Staff training
- Product Quality Planning
- Design and Process FMEA
- Tolerance analysis before design release
- Computer aided design and analysis
- Process capability study for process qualification
- Part selection for better reliability
- Designed experiment for optimum settings of the product



Relation Between Prevention + Appraisal and Failure Costs

7. Explain PDSA cycle with neat block diagram



The PDSA Cycle

8. Describe the criteria and strategy for performance measurement.

Criteria

1. **Simple**: Measures should be understandable by those who will use them.
2. **Few in number**: The important measures must be distinguished from the unimportant ones so that users can concentrate on just a few. Two or three measures should be sufficient for any work group, with the number increasing for departments, functional areas, plants, and corporations. Quality councils may wish to use composite measures such as a customer satisfaction index. It is composed of several weighted metrics such as on-time delivery, cost, product or service quality, and complaints.
3. **Developed by users**: In order to ensure ownership of the measures, they must be developed by the user. Measures dictated by a higher authority will usually not receive support from downstream units. However, in some cases, measures are mandated by the customer.
4. **Relevance to customer**: Measures must be relevant to the needs of internal or external customers. Control over important changes should be vested in the people who are held responsible for the performance measure. They also decide what measures to use and set target goals.
5. **Improvement**: Although correcting nonconformances and making current decisions are important, the focus should be on improvement, prevention, and strategic long-term planning and goal setting. Measures are used to promote improvement, not to identify poor performance and penalize the low performers. They should be sensitive to the improvements made.
6. **Cost**: Of course, the bottom line is that cost and profit must reflect an improved financial picture, as shown by the cost of poor quality system and other financial data. In addition, the cost of measurement should be considered.
7. **Visible**: Facility-wide measures should be posted in a central location, such as the lunch or break room, where everyone can see them. Likewise, unit measures should be posted at the machine or work center.
8. **Timely**: Financial and accounting data are often presented too late to be actionable. This may require that measurements are taken hourly, daily, or weekly rather than monthly or quarterly as in traditional accounting systems. A significant portion of measurements need to be operational rather than financial. Data needs to be measured, analyzed, and evaluated with respect to the desired goals so that the information can be used effectively in decision making.
9. **Aligned**: A comprehensive set of measures and indicators tied to customer and organizational performance requirements provides a way to align all activities with organizational goals.
10. **Results**: Key result measures need to be guided and balanced by the interests of all stakeholders— customers, employees, stockholders, suppliers, the public, and the community.

Strategy

The quality council has the overall responsibility for the performance measures. It ensures that all the measures are integrated into a total system of measures. To develop the system, the quality council will obtain appropriate information from all of the stake-holders. They will utilize the core values, goals, mission, and vision statements (see Chapter 2) as well as the objectives and criteria given above. With this information, the strategic measurement system is created. An example of a system that emphasizes percent improvement might contain the functions and metrics as given below:

Quality

- Percent reduction in cost of poor quality
- Percent reduction in nonconformities
- Percent of certified suppliers
- Percent reduction in supplier base
- Percent reduction in corrective action cycle time

Cost

- Percent increase in inventory turnover
- Percent reduction in data transactions
- Percent increase in materials shipped direct to work-in-process by the supplier
- Percent increase in output dollars per employee
- Percent reduction in floor space utilization

Flexibility

- Percent reduction in cycle time
- Percent reduction in setup time
- Percent reduction in lot/batch size
- Percent increase in number of jobs mastered per employee
- Percent increase in common materials used per product

Reliability

- Percent of processes capable of Cp = 2.0
- Percent reduction in down time
- Percent reduction in warranty costs
- Percent reduction in design changes
- Percent increase in on-time delivery

Innovation

- Percent reduction in new product introduction time
- Percent increase in new product sales revenue as a percent of total sales revenue
- Percent increase in new patents granted
- Customer perception as a leader in innovation
- Percent of management time spent on or leading innovation

9. Illustrate the performance measure presentation with different measurement techniques.

There are six basic techniques for presenting performance measures. The simplest and most common is the time series graph shown in Figure 6-1. Time as measured by days, weeks, months, and so forth, is shown on the horizontal axis, and the performance measure is shown on the vertical axis. This type of graph benchmarks the process and shows favorable and unfavorable trends in the measure.

A second form of presentation is the control chart (see Chapter 15). A control chart for percent nonconforming is shown in Figure 6-2.

A third presentation technique is the capability index, which is the ratio of the tolerance to the capability. There are two measures: one indicates the ability of the process to meet specifications, and the other indicates the centering of the process on the target (see Chapter 15).

Another way of measuring quality is Taguchi's loss function. This technique combines target, cost, and specifications into one measurement. Figure 6-3 illustrates the concept (see Chapter 16).

The fifth method of presenting performance measures is the cost of poor quality. Money attracts the attention of senior management; quality costs are described in the next section of this chapter.

The last method includes the performance measurement based on the criteria of national/international quality awards such as Malcolm Baldrige National Quality Award (U.S.), Deming Prize (Japan) or Rajiv Gandhi National Quality Award (India). The criteria for such awards quite effectively measure the performance of TQM effort, on an annual basis. The details are described in the last section of this chapter.

Another approach adopted by many modern organizations is the Balanced Score Card (BSC), which is aimed at the assessment of an organization's financial performance in "balance" with the other business aspects. This approach is also described in the last section.

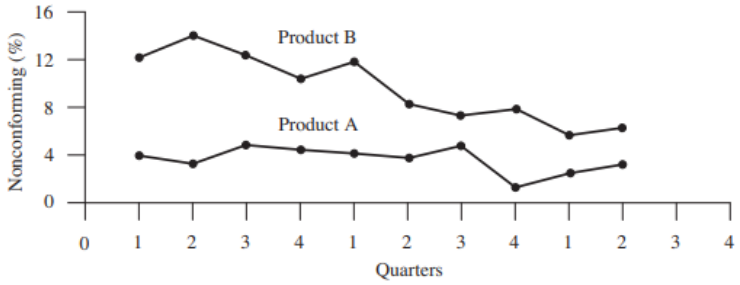


Figure 6-1 Time Series Graph for Percent Nonconforming

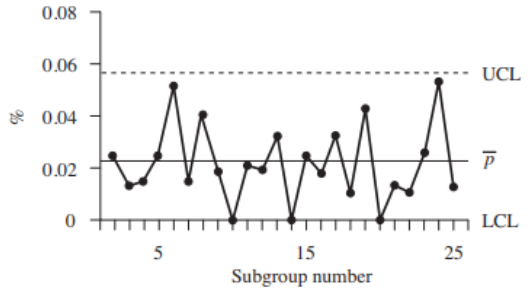


Figure 6-2 Control Chart for Percent Nonconforming

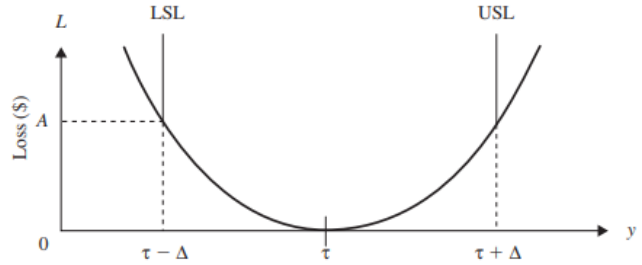


Figure 6-3 Taguchi's Quadratic Loss Function for Nominal-the-Best

10. Explain the different improvement strategies under continuous process improvement

There are four primary improvement strategies—repair, refinement, renovation, and reinvention. Choosing the right strategy for the right situation is critical. It is also true that proper integration of the strategies will produce never-ending improvement.

Repair

This strategy is simple—anything broken must be fixed so that it functions as designed. There are two levels to this strategy. If a customer receives a damaged product, a quick fix is required. This level is a temporary or short-term measure. Although short-term measures shore up the problem, they should not become permanent.

The second level occurs when an individual or team identifies and eliminates the root cause(s) of the problem and effects a permanent solution. It is important to note that the repair strategy does not make the process better than the original design.

Refinement

This strategy involves activities that continually improve a process that is not broken. Improvements to processes, products, and services are accomplished on an incremental basis. Refinement improves efficiency and effectiveness. It should become an integral part of every employee's job. Both individuals and teams can use this strategy. Typically it relies on doing things just a bit quicker, better, easier, or with less waste. This is the concept behind Kaizen to be discussed later in the chapter. The change may be so gradual that there is no appearance of change. The primary benefit of gradual change is that it produces little resistance from employees. However, because the change is so gradual, management may not recognize and reward the affected employees. Also, minor changes may not be documented or properly communicated.

Organizational programs—such as process improvement teams, suggestion systems, and empowerment— are combinations of repair and refinement. They provide the mechanisms for activities aimed at making these two strategies a part of the daily work life.

Renovation

This strategy results in major or breakthrough improvements. Although the resulting product, service, process, or activity might often appear to be different from the original, it is basically the same. Innovation and technological advancements are key factors in this approach. For example, the process of drilling a hole was originally done by hand with a cranking mechanism; however, with the advent of the electric motor, the electric drill was born. The electric drill has been continually refined by improved bits, chucks, and materials. More recently, another renovation occurred that was brought about by the development of rechargeable batteries. The rechargeable electric drill is basically the same as the old hand drill. Renovation is more costly than the previous strategies and is usually undertaken by teams rather than individuals.

Reinvention

Reinvention is the most demanding improvement strategy. It is preceded by the feeling that the current approach will never satisfy customer requirements. A new product, ser-vice, process, or activity is developed using teams based on a complete understanding of the customer's requirements and expectations. Reinvention or reengineering begins by imagining that the previous condition does not exist—in other words, a clean sheet of paper. Then the team uses in-depth knowledge of the customer's requirements and expectations and invents a new product, service, process, or activity. For example, the process of drilling holes using lasers or water jets was a reinvention.

Reinvention might also be desirable to maintain organization vitality or competitive advantage. An organization should use this strategy sparingly because of resistance to change and the fact that any new product, service, process, or activity will probably need to have the "bugs" removed by repair, refinement, and renovation.

11.Define TQM. Explain the basic approach of TQM

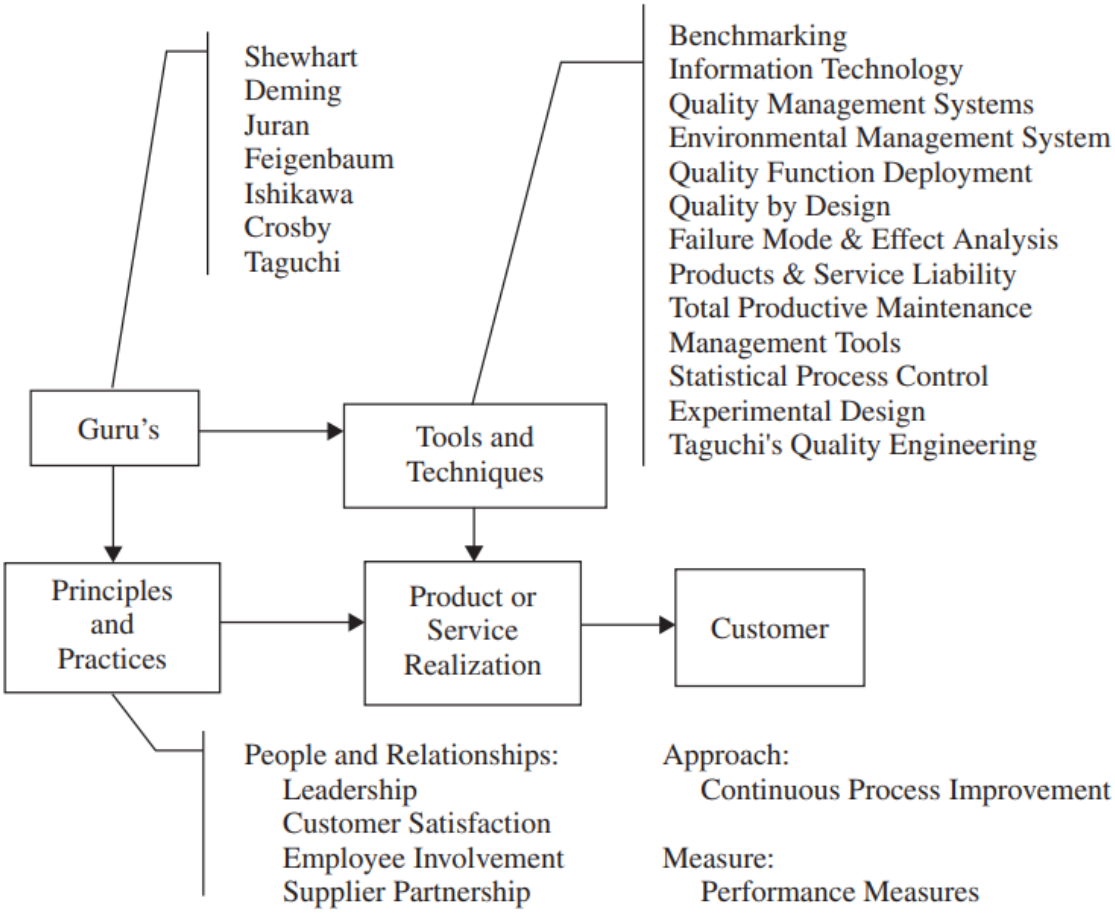
Total Quality Management (TQM) is an enhancement to the traditional way of doing business. It is a proven technique to guarantee survival in world-class competition. Only by changing the actions of management will the culture and actions of an entire organization be transformed. TQM is for the most part common sense.

Basic Approach TQM requires six basic concepts:

1. A committed and involved management to provide long-term top-to-bottom organizational support.
2. An unwavering focus on the customer, both internally and externally.
3. Effective involvement and utilization of the entire work force.
4. Continuous improvement of the business and production process.
5. Treating suppliers as partners.
6. Establish performance measures for the processes.

1. Management must participate in the quality program. A quality council must be established to develop a clear vision, set long-term goals, and direct the program. Quality goals are included in the business plan. An annual quality improvement program is established and involves input from the entire work force. Managers participate on quality improvement teams and also act as coaches to other teams. TQM is a continual activity that must be entrenched in the culture—it is not just a one-shot program. TQM must be communicated to all people.
2. The key to an effective TQM program is its focus on the customer. An excellent place to start is by satisfying internal customers. We must listen to the "voice of the customer" and emphasize design quality and defect prevention. Do it right the first time and every time, for customer satisfaction is the most important consideration.
3. TQM is an organization-wide challenge that is everyone's responsibility. All personnel must be trained in TQM, statistical process control (SPC), and other appropriate quality improvement skills so they can effectively participate on project teams. Including internal customers and, for that matter, internal suppliers on project teams is an excellent approach. Those affected by the plan must be involved in its development and implementation. They understand the process better than anyone else. Changing behavior is the goal. People must come to work not only to do their jobs, but also to think about how to improve their jobs. People must be empowered at the lowest possible level to perform processes in an optimum manner.
4. There must be a continual striving to improve all business and production processes. Quality improvement projects, such as on-time delivery, order entry efficiency, billing error rate, customer satisfaction, cycle time, scrap reduction, and supplier management, are good places to begin. Technical techniques such as SPC, benchmarking, quality function deployment, ISO 9000, and designed experiments are excellent for problem solving.
5. On the average 40% of the sales dollar is purchased product or service; therefore, the supplier quality must be outstanding. A partnering relationship rather than an adversarial one must be developed. Both parties have as much to gain or lose based on the success or failure of the product or service. The focus should be on quality and life-cycle costs rather than price. Suppliers should be few in number so that true partnering can occur.
6. Performance measures such as uptime, percent nonconforming, absenteeism, and customer satisfaction should be determined for each functional area. These measures should be posted for everyone to see. Quantitative data are necessary to measure the continuous quality improvement activity.

12.Explain the TQM framework



13. Define quality. Elaborate the different dimensions of quality

When the expression “quality” is used, we usually think in terms of an excellent product or service that fulfills or exceeds our expectations. These expectations are based on the intended use and the selling price. For example, a customer expects a different performance from a plain steel washer than from a chrome-plated steel washer because they are a different grade. When a product surpasses our expectations we consider that quality. Thus, it is somewhat of an intangible based on perception. Quality can be quantified as follows:

Q = P / E where Q = quality P = performance E = expectations

The Dimensions of Quality

Dimension	*Meaning and Example*
Performance	Primary product characteristics, such as the brightness of the picture
Features	Secondary characteristics, added features, such as remote control
Conformance	Meeting specifications or industry standards, workmanship
Reliability	Consistency of performance over time, average time for the unit to fail
Durability	Useful life, includes repair
Service	Resolution of problems and complaints, ease of repair
Response	Human-to-human interface, such as the courtesy of the dealer
Aesthetics	Sensory characteristics, such as exterior finish
Reputation	Past performance and other intangibles, such as being ranked first

14. Illustrate the obstacles and benefits of TQM

Lack of Management Commitment
Inability to Change Organizational Culture
Improper Planning
Lack of Continuous Training and Education
Incompatible Organizational Structure and Isolated Individuals and Departments
Ineffective Measurement Techniques and Lack of Access to Data and Results
Paying Inadequate Attention to Internal and External Customers
Inadequate Use of Empowerment and Teamwork
Failure to Continually Improve

Lack of Management Commitment

In order for any organizational effort to succeed, there must be a substantial management commitment of management time and organizational resources. The purpose must be clearly and continuously communicated to all personnel. Management must consistently apply the principles of TQM. Robert Galvin of Motorola said that only the CEO can ensure, even in times of great pressure, that quality and customer satisfaction are preserved. In a survey of 188 quality professionals, 66% reported that management's compensation is not linked to quality goals such as failure costs, customer complaints, and cycle time reduction.

Inability to Change Organizational Culture

Changing an organization's culture is difficult and will require as much as five years. Individuals resist change—they become accustomed to doing a particular process and it becomes the preferred way. Management must understand and utilize the basic concepts of change. They are:

1. People change when they want to and to meet their own needs.
2. Never expect anyone to engage in behavior that serves the organization's values unless adequate reason (why) has been given.
3. For change to be accepted, people must be moved from a state of fear to trust.

It is difficult for individuals to change their way of doing things; it is much more difficult for an organization to make a cultural change. Management by exhortation and inspiration will fail. Speeches, slogans, and campaigns that are supposed to motivate people are only effective for a short period of time. Impediments to a cultural change are the lack of effective communication and emphasis on short-term results. Organizations that spend more time planning for the cultural aspects of implementing a TQM program will improve their chances of success.

Improper Planning

All constituents of the organization must be involved in the development of the implementation plan and any modifications that occur as the plan evolves. Of particular importance is the two-way communication of ideas by all personnel during the development of the plan and its implementation. Customer satisfaction should be the goal rather than financial or sales goals. Peterson Products, a metal stamping firm near Chicago, improved on-time delivery, which resulted in a 25% increase in sales. Focus on quality and the other goals will follow.

Lack of Continuous Training and Education

Training and education is an ongoing process for everyone in the organization. Needs must be determined and a plan developed to achieve those needs. Training and education are most effective when senior management conducts the training on the principles of TQM. Informal training occurs by communicating the TQM effort to all personnel on a continual basis

Incompatible Organizational Structure and Isolated Individuals and Departments

Differences between departments and individuals can create implementation problems. The use of multi-functional teams will help to break down long-standing barriers. Restructuring to make the organization more responsive to customer needs may be needed. Individuals who do not embrace the new philosophy can be required to leave the organization. Adherence to the six basic concepts will minimize the problems over time. At Spartan Light Metal Products, Inc. in Sparta, IL, product support teams composed of three members from design, quality, and production are assigned to each customer segment.

Ineffective Measurement Techniques and Lack of Access to Data and Results

Key characteristics of the organization should be measured so that effective decisions can be made. In order to improve a process, you need to measure the effect of improvement ideas. Access to data and quick retrieval is necessary for effective processes. Peoples Bank of Bridgeport, CT found that extra inspection, training, and management encouragement did not help a high error rate. Finally, the bank investigated the root causes of the problem and corrected them, which virtually eliminated the problem.

Paying Inadequate Attention to Internal and External Customers

Organizations need to understand the changing needs and expectations of their customers. Effective feedback mechanisms that provide data for decision making are necessary for this understanding. One way to overcome this obstacle is to give the right people direct access to the customers. Maruti Suzuki, the leading car manufacturing company in India, takes significant efforts in training their service technicians and dealers' sales staff in order to ensure that their actions and interactions are in synchronization with the changes in customer profiles and expectations.6 When an organization fails to empower individuals and teams, it cannot hold them responsible for producing results.

Inadequate Use of Empowerment and Teamwork

Teams need to have the proper training and, at least in the beginning, a facilitator. Whenever possible, the team's recommendations should be followed. Individuals should be empowered to make decisions that affect the efficiency of their process or the satisfaction of their customers. Solar Turbines, Inc. flattened its organization by restructuring into work teams and delegating authority to the point of customer contact or to the work performed.

Failure to Continually Improve

It is tempting to sit back and rest on your laurels. However, a lack of continuous improvement of the processes, product, and/or service will even leave the leader of the pack in the dust.

Benefits of TQM

According to a survey of manufacturing firms in Georgia, the benefits of TQM are improved quality, employee participation, teamwork, working relationships, customer satisfaction, employee satisfaction, productivity, communication, profitability, and market share.8 TQM is a good investment as shown by a ten-year study by Hendricks and Singhai. They showed that there is a strong link between TQM and financial performance. The researchers selected a group of 600 publicly traded organizations that had won awards for effectively implementing TQM. They then selected a control group similar in size and industry to the award winners. Performance of both groups was compared during the five years prior to the award and five years after winning the award. No difference was shown between the two groups prior to the award. However, as shown below the award group far outstripped the control group during the five-year period after the award.

15. Define Leadership. Explain the characteristics of quality leaders

A leader as one who instills purposes, not one who controls by brute force. A leader strengthens and inspires the followers to accomplish shared goals. Leaders shape the organization's values, promote the organization's values, protect the organization's values and exemplify the organization's values.

There are 12 behaviors or characteristics that successful quality leaders demonstrate.

1. They give priority attention to external and internal customers and their needs. Leaders place themselves in the customers' shoes and service their needs from that perspective. They continually evaluate the customers' changing requirements.
2. They empower, rather than control, subordinates. Leaders have trust and confidence in the performance of their subordinates. They provide the resources, training, and work environment to help subordinates do their jobs. However, the decision to accept responsibility lies with the individual.
3. They emphasize improvement rather than maintenance. Leaders use the phrase "If it isn't perfect, improve it" rather than "If it ain't broke, don't fix it." There is always room for improvement, even if the improvement is small. Major breakthroughs sometimes happen, but it's the little ones that keep the continuous process improvement on a positive track.
4. They emphasize prevention. "An ounce of prevention is worth a pound of cure" is certainly true. It is also, true that perfection can be the enemy of creativity. We can't always wait until we have created the perfect process or product. There must be a balance between preventing problems and developing better, but not perfect, processes.
5. They encourage collaboration rather than competition. When functional areas, departments, or work groups are in competition; they may find subtle ways of working against each other or withholding information. Instead, there must be collaboration among and within units.
6. They train and coach, rather than direct and supervise. Leaders know that the development of the human resource is a necessity. As coaches, they help their subordinates learn to do a better job.
7. They learn from problems. When a problem exists, it is treated as an opportunity rather than something to be minimized or covered up. "What caused it?" and "How can we prevent it in the future?" are the questions quality leaders ask.
8. They continually try to improve communications. Leaders continually disseminate information about the TQM effort. They make it evident that TQM is not just a slogan. Communication is two way—ideas will be generated by people when leaders encourage them and act upon them. For example, on the eve of Desert Storm, General Colin Powell solicited enlisted men and women for advice on winning the war. Communication is the glue that holds a TQM organization together.
9. They continually demonstrate their commitment to quality. Leaders walk their talk—their actions, rather than their words, communicate their level of commitment. They let the quality statements be their decision-making guide.
10. They choose suppliers on the basis of quality, not price. Suppliers are encouraged to participate on project teams and become involved. Leaders know that quality begins with quality materials and the true measure is the life-cycle cost.
11. They establish organizational systems to support the quality effort. At the senior management level a quality council is provided, and at the first-line supervisor level, work groups and project teams are organized to improve the process
12. They encourage and recognize team effort. They encourage, provide recognition, and reward individuals and teams. Leaders know that people like to know that their contributions are appreciated and important. This action is one of the leader's most powerful tools

16. Explain the Deming's philosophy through 14 principles

1. **Create a constant purpose toward improvement.**
    - Plan for quality in the long term.
    - Resist reacting with short-term solutions.
    - Don't just do the same things better – find better things to do.
    - Predict and prepare for future challenges, and always have the goal of getting better.
2. **Adopt the new philosophy.**
    - Embrace quality throughout the organization.
    - Put your customers' needs first, rather than react to competitive pressure – and design products and services to meet those needs.
    - Be prepared for a major change in the way business is done. It's about leading, not simply managing.
    - Create your quality vision, and implement it.
3. **Stop depending on inspections.**
    - Inspections are costly and unreliable – and they don't improve quality, they merely find a lack of quality.
    - Build quality into the process from start to finish.
    - Don't just find what you did wrong – eliminate the "wrongs" altogether.
    - Use statistical control methods – not physical inspections alone – to prove that the process is working.
4. **Use a single supplier for any one item.**
    - Quality relies on consistency – the less variation you have in the input, the less variation you'll have in the output.
    - Look at suppliers as your partners in quality. Encourage them to spend time improving their own quality – they shouldn't compete for your business based on price alone.
    - Analyze the total cost to you, not just the initial cost of the product.
    - Use quality statistics to ensure that suppliers meet your quality standards.
5. **Improve constantly and forever.**
    - Continuously improve your systems and processes. Deming promoted the Plan-Do-Check-Act approach to process analysis and improvement.
    - Emphasize training and education so everyone can do their jobs better.
    - Use kaizen as a model to reduce waste and to improve productivity, effectiveness, and safety.
6. **Use training on the job.**
    - Train for consistency to help reduce variation.
    - Build a foundation of common knowledge.
    - Allow workers to understand their roles in the "big picture."
    - Encourage staff to learn from one another, and provide a culture and environment for effective teamwork.
7. **Implement leadership.**
    - Expect your supervisors and managers to understand their workers and the processes they use.
    - Don't simply supervise – provide support and resources so that each staff member can do his or her best. Be a coach instead of a policeman.
    - Figure out what each person actually needs to do his or her best.
    - Emphasize the importance of participative management and transformational leadership.
    - Find ways to reach full potential, and don't just focus on meeting targets and quotas.
8. **Eliminate fear.**
    - Allow people to perform at their best by ensuring that they're not afraid to express ideas or concerns.
    - Let everyone know that the goal is to achieve high quality by doing more things right – and that you're not interested in blaming people when mistakes happen.
    - Make workers feel valued, and encourage them to look for better ways to do things.
    - Ensure that your leaders are approachable and that they work with teams to act in the company's best interests.
    - Use open and honest communication to remove fear from the organization.
9. **Break down barriers between departments.**
    - Build the "internal customer" concept – recognize that each department or function serves other departments that use their output.

- Build a shared vision.
- Use cross-functional teamwork to build understanding and reduce adversarial relationships.
- Focus on collaboration and consensus instead of compromise.

10. **Get rid of unclear slogans.**
    - Let people know exactly what you want – don't make them guess. "Excellence in service" is short and memorable, but what does it mean? How is it achieved? The message is clearer in a slogan like "You can do better if you try."
    - Don't let words and nice-sounding phrases replace effective leadership. Outline your expectations, and then praise people face-to-face for doing good work.
11. **Eliminate management by objectives.**
    - Look at how the process is carried out, not just numerical targets. Deming said that production targets encourage high output and low quality.
    - Provide support and resources so that production levels and quality are high and achievable.
    - Measure the process rather than the people behind the process.
12. **Remove barriers to pride of workmanship.**
    - Allow everyone to take pride in their work without being rated or compared.
    - Treat workers the same, and don't make them compete with other workers for monetary or other rewards. Over time, the quality system will naturally raise the level of everyone's work to an equally high level.
13. **Implement education and self-improvement.**
    - Improve the current skills of workers.
    - Encourage people to learn new skills to prepare for future changes and challenges.
    - Build skills to make your workforce more adaptable to change, and better able to find and achieve improvements.
14. **Make "transformation" everyone's job.**
    - Improve your overall organization by having each person take a step toward quality.
    - Analyze each small step, and understand how it fits into the larger picture.
    - Use effective change management principles to introduce the new philosophy and ideas in Deming's 14 points.

17. Define customer satisfaction. Explain the internal and external customers

External customer

An external customer can be defined in many ways, such as the one who uses the product or service, the one who purchases the product or service, or the one who influences the sale of the product or service. For instance, McDonald's determined the customer to be the child when they introduced their Happy Meals. The child never paid for the meals but the child influenced the sale. Oftentimes, parents purchase mobile phones and yet the teenage children use the mobile phones. The identity of the external customer is not always easy to determine.

An external customer exists outside the organization and generally falls into three categories: current, prospective, and lost customers. Each category provides valuable customer satisfaction information for the organization. Every employee in the organization must know how their job enhances the total satisfaction of the external customer. Performance must be continually improved in order to retain existing customers and to gain new ones.

Internal customer

An internal customer is just as important. Every function, whether it be engineering, order processing, or production, has an internal customer—each receives a product or service and, in exchange, provides a product or service. Every person in a process is considered a customer of the preceding operation. Each worker's goal is to make sure that the quality meets the expectations of the next person.

18. Explain the customer perception of quality

1. Performance
2. Features
3. Service
4. Warranty
5. Price
6. Reputation

Performance

Performance involves “fitness for use”—a phrase that indicates that the product and ser-vice is ready for the customer’s use at the time of sale. Other considerations are (1) availability, which is the probability that a product will operate when needed; (2) reliability, which is freedom from failure over time; and (3) maintainability, which is the ease of keeping the product operable.

Features

Identifiable features or attributes of a product or service are psychological, time-oriented, contractual, ethical, and technological. Features are secondary characteristics of the product or service. For example, the primary function of an automobile is transportation, whereas a car stereo system is a feature of an automobile.

Service

An emphasis on customer service is emerging as a method for organizations to give the customer-added value. However, customer service is an intangible—it is made up of many small things, all geared to changing the customer’s perception. Intangible characteristics are those traits that are not quantifiable, yet contribute greatly to customer satisfaction. Providing excellent customer service is different from and more difficult to achieve than excellent product quality. Organizations that emphasize service never stop looking for and finding ways to serve their customers better, even if their customers are not complaining. For instance, at Baptist Hospital in Pensacola, FL, janitors, after cleaning a room, ask if there is anything they can do for the patient. Often patients will have a request for a window shade to be drawn or a door closed.5

Warranty

The product warranty represents an organization’s public promise of a quality product backed up by a guarantee of customer satisfaction. Ideally, it also represents a public commitment to guarantee a level of service sufficient to satisfy the customer

Price

Today’s customer is willing to pay a higher price to obtain value. Customers are constantly evaluating one organization’s products and services against those of its competitors to determine who provides the greatest value. However, in our highly-competitive environment, each customer’s concept of value is continually changing. Ongoing efforts must be made by everyone having contact with customers to identify, verify, and update each customer’s perception of value in relation to each product and service.

Reputation

Most of us find ourselves rating organizations by our overall experience with them. Total customer satisfaction is based on the entire experience with the organization, not just the product. Good experiences are repeated to six people and bad experiences are repeated to 15 people; therefore, it is more difficult to create a favorable reputation.

Customers are willing to pay a premium for a known or trusted brand name and often become customers for life. Because it costs five times as much to win a new customer as it does to keep an existing one, customer retention is an important economic strategy for any organization. Although it is difficult for an organization to quantify improved customer satisfaction, it is very easy to quantify an increase in customer retention. Investment in customer retention can be a more effective bottom-line approach than concentrating on lowering operational costs. An effective marketing retention strategy is achieved through using feedback from information collecting tools.

19. Explain the feedback and customer complaints under customer satisfaction

Customer feedback must be continually solicited and monitored. Customers continu-ally change. They change their minds, their expectations, and their suppliers. Customer feedback is not a one-time effort; it is an ongoing and active probing of the customers' mind. Feedback enables the organization to:

Discover customer dissatisfaction.

Discover relative priorities of quality.

Compare performance with the competition.

Identify customers' needs.

Determine opportunities for improvement.

Even in service industries, such as insurance and banking, customer feedback has become so important that it drives new product development. There are programs to identify and analyze errors, take corrective action, and make ongoing enhancements. All these efforts are justified when the consumers' expectation levels are very high. Effective organizations take the time to listen to the voice of the customer and feed that information back to the idea stage. For instance, listening to the voice of the customer changed how the Internal Revenue Service does business. Previously, the IRS thought that good customer service was mailing tax forms out right after New Year's Day. Then, the IRS asked its customers what good customer service was. The IRS found out that the customers wanted fast refunds and very little contact with the IRS. Now, about 20 million taxpayers can forget using the 1040EZ form and file on their touch-tone phone. There is no contact with the IRS, it takes about six minutes, and the phone system does the math. Refunds are received within 21 days.6 Listening to the voice of the customer can be accomplished by numerous information-collecting tools. The principal ones are comment cards, questionnaires, focus groups, toll-free telephone lines, customer visits, report cards, the Internet, employee feedback, mass customization and the American Customer Satisfaction Index

1. **Define QFD. Benefits of QFD**

-Quality function deployment (QFD) is a method to transform qualitative user demands into quantitative parameters, to deploy the functions forming quality, and to deploy methods for achieving the design quality into subsystems and component parts, and ultimately to specific elements of the manufacturing process.

Benefits-

Improves Customer Satisfaction-

Quality function deployment looks past the usual customer response and attempts to define the requirements in a set of basic needs, which are compared to all competitive information.

Reduces Implementation Time-

Fewer engineering changes are needed when using QFD, and, when used properly, all conflicting design requirements can be identified and addressed prior to production. This results in a reduction in retooling, operator training, and changes in traditional quality control measures.

Promotes Teamwork-

Quality function deployment forces a horizontal deployment of communication channels. Inputs are required from all facets of an organization, from marketing to production to sales, thus ensuring that the voice of the customer is being heard and that each department knows what the other is doing.

Provides Documentation-

A database for future design or process improvements is created. Data that are historically scattered within operations, frequently lost and often referenced out of context, are now saved in an orderly manner to serve future needs.

2. Explain the Stages of FMEA

-Failure Mode and Effect Analysis

The four stages of FMEA are given below:

1. Specifying Possibilities

a. Functions
b. Possible Failure Modes
c. Root Causes
d. Effects
e. Detection/Prevention

2. Quantifying Risk

a. Probability of Cause
b. Severity of Effect
c. Effectiveness of Control to Prevent Cause
d. Risk Priority Number

3. Correcting High Risk Causes

a. Prioritizing Work
b. Detailing Action
c. Assigning Action Responsibility
d. Check Points on Completion

4. Re-evaluation of Risk

a. Recalculation of Risk Priority Number

3. Explain the concept and reasons for benchmarking

Concept-

-Benchmarking is the systematic search for best practices, innovative ideas, and highly effective operating procedures. Benchmarking considers the experience of others and uses it.

-it is the common-sense proposition to learn from others what they do right and then imitate it to avoid reinventing the wheel.

-Implicit in the definition of benchmarking are two key elements. First, measuring performance requires some sort of units of measure. These are called metrics and are usually expressed numerically. The numbers achieved by the best-in-class benchmark are the target. An organization seeking improvement then plots its own performance against the target.

- Second, benchmarking requires that managers understand why their performance differs. Benchmarks must develop a thorough and in-depth knowledge of both their own processes
and the processes of the best-in-class organization

Reasons-

-Benchmarking is a tool to achieve business and competitive objectives. It is powerful and extremely effective when used for the right reasons and aligned with organization strategy.

-Organizations must still decide which markets to serve and determine the strengths that will enable them to gain competitive advantage. Benchmarking is one tool to help
organizations develop those strengths and reduce weaknesses.

-Benchmarking can notify the organization if it has fallen behind the competition or failed to take advantage of important operating improvements developed elsewhere.

-In contrast to the traditional method of extrapolating next year's goal from last year's performance, benchmarking allows goals to be set objectively, based on external information.

24. Discuss the sector specific standards under ISO 9000 system

Sector specific standards-

AS9100-

-This aerospace industry quality system was officially released by the Society of Automotive Engineers in May 1997.

- Its development and release represent the first attempt to unify the requirements of NASA, DOD, and FAA, while satisfying the aerospace industry's business needs.

- In March 2001, the International Aerospace Quality Group (IAQG) aligned AS9100 with ISO 9001:2000. Industry-specific interpretations and methodologies are identified in italics and bold type.

ISO/TS 16949-

- This standard is entitled Quality Systems Automotive Suppliers–Particular Requirements for the Application of ISO 9001.

- It harmonizes the supplier quality requirements of the U.S. big three as provided in QS 9000 Third Edition with the French, German and Italian automakers.

-The standard has been approved by Asian automakers. The goal of this technical specification is the development of fundamental quality systems that provide for continuous improvement, emphasizing defect prevention, and the reduction of variation and waste in the supply chain.

TL 9000-

-The Quality Excellence for Suppliers of Telecommunications Forum (Quest) wrote TL 9000 to consolidate the various quality system requirements within the telecommunications industry.

- This forum was created to develop the standard wherein suppliers such as Motorola and Lucent, and telecom service providers such as Verizon, Southwestern Bell, and AT&T would have an equal vote in developing the new strategy.

- It is a specific set of requirements based on ISO 9001 that defines the design, development, production, delivery, installation, and maintenance of telecommunications products and services.

25. Explain the requirements of ISO14000series of standards

26. Define QFD. Explain the benefits of QFD

Same as Q 21.

27. Explain Rationale for implementation of Quality by design

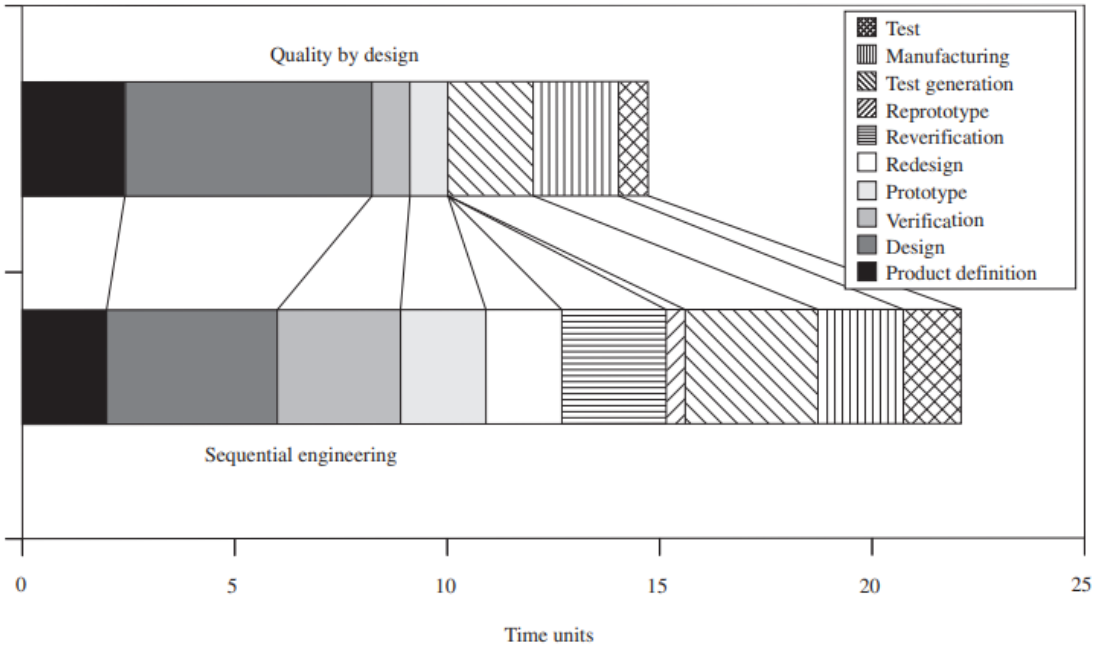


Figure 11-3 Hypothetical Product Development Time Line

- Quality by design helps control design changes by shifting all the design to the beginning of the project rather than throughout its whole life cycle, as shown in Figure 11-3.

- The shifting of all design to the beginning of the project increases the time required for initial design; however, the future benefits outweigh this increase. For example, a change made during the design stage could cost up to ten times as much as one made during the testing stage. Spending ten times as much to change features that could have been designed into the product at the beginning justifies the purchase of high-powered product development software.

- The amount of time required in the quality by design model for product definition and specifications can be significantly greater than that required in the sequential engineering model. However, the increased time is warranted because the brainstorming sessions among specialists result in a more complete final product definition.

- Fewer design changes and shorter product lead times both equate to a quicker response to customer needs; however, there are even better reasons for using quality by design. Lower reject and scrap rates on the shop floor quickly improve profits.

28. Describe the Design FMEA document with an example

29. Illustrate the intent of FMEA. Discuss the stages of FMEA

Intent of FMEA-

-One of the most powerful methods available for measuring the reliability of the process or product is FMEA. As previously stated, FMEA is an analytical technique that combines the technology and experience of people in identifying foreseeable failure modes of a product or process and planning for its elimination. This method can be implemented in both the design and the process areas and basically involves the identification of the potential failure modes and the effect of those on both the internal and the external customer.

- FMEA attempts to detect the potential product-related failure modes. The technique is used to anticipate causes of failure and prevent them from happening. FMEA uses occurrence and detection probability criteria in conjunction with severity criteria to develop risk prioritization numbers for prioritization of corrective action considerations.

- This method is an important step in debugging and preventing problems that may occur
in the manufacturing process. It should be noted that for FMEA to be successful, it is extremely important to treat the FMEA as a living document, continually changing as new problems are found and being updated to ensure that the most critical problems are identified and addressed quickly.

- The FMEA evaluation should be conducted immediately following the design phase of product production and, definitely in most cases, before purchasing and setting up any machinery.

-**STAGES SAME AS 22 Q**

30. Explain the control charts for Variables and Attributes

TABLE 15-5

Different Control Charts for Variables

Type	*Central Line*	*Central Limits*	*Comments*
$\overline{X}$ and s	$\overline{\overline{X}}$	$LCL_{\bar{x}} = \overline{\overline{X}} - A_3\bar{s}$ $LCL_{\bar{x}} = \overline{X} - A_3 s$	Use when more sensitivity is desired than R; when $n > 10$; and when data are collected automatically
	$\bar{s}$	$UCL_s = B_4 s$ $LC L_s = B_3\bar{s}$	
Moving average, M $\overline{X}$ and moving range, MR	$\overline{\overline{X}}$	$UCL_{\bar{x}} = \overline{\overline{X}} + A_2\overline{R}$	Use when only one observation is possible at a time. Data needn't be normal.
	$\overline{R}$	$LCL_{\bar{x}} = \overline{\overline{X}} - A_2\overline{R}$ $UCL_R = D_4\overline{R}$ $LCL_R = D_3\overline{R}$	
X and moving R	$\overline{X}$	$UCL_x = \overline{X} + 2.660\overline{R}$	Use when only one observation is possible at a time and the data are normal. Equation are based on a moving range of two.
	$\overline{R}$	$LCL_x = \overline{X} - 2.660\overline{R}$ $UCL_R = 3.276\overline{R}$ $LCL_R = (0)\overline{R}$	
Median and Range	Md_{md}	$UCL_{Md} = Md_{Md} + A_5 R_{Md}$ $LCL_{Md} = Md_{Md} - A_5 R_{Md}$	Use when process is in a maintenance mode. Benefits are less arithmetic and simplicity.
	R_{md}	$UCL_R = D_6 R_{Md}$ $LCL_R = D_5 R_{Md}$	

DO ATTRIBUTES ON YOUR OWN.