QUESTION BANK

SUBJECT: TOTAL QUALITY MANAGEMENT SEMESTER: VIII

SUB CODE: GE6757

UNIT-I

1. Define Quality**. (MAY/JUNE 2014)**
A. 1. Fitness for intended use. (Joseph Juran). 2. Conformance to specifications. (Philip Crosby). 3. The totality of features of a product or service that bears on its ability to satisfy a stated or implied need. (American Society of Quality).

2. Define Total Quality Management.
A. 1. The art of managing the total organization to achieve excellence in all spheres of activity.(Besterfield). 2. The integration of all functions and processes within an organization in order to achieve the continuous improvement of the quality of goods and services. (Omachonu).

3. Mention the basic features of TQM**. (NOV/DEC 2012)**
A. 1. Management commitment, 2. Focus on customer (both external and internal), 3. Employee involvement, empowerment, 4. Continuous improvement, 5. Treating suppliers as partners, and 6. Establish performance measures for processes.

4. What are the major benefits of TQM? **(NOV/DEC 2011)**
A. Improved quality, higher productivity, employee participation, teamwork, working relationships, customer satisfaction, employee satisfaction, communication, profitability, market share, and stock price performance.

5. What are some major obstacles to TQM implementation? **(MAY/JUNE 2012)**
A. Lack of management commitment, Inability to change organizational culture, Improper planning, Lack of continuous training and education, Paying inadequate attention to internal and external customers, Inadequate use of empowerment and teamwork, Lack of employee involvement, Emphasis on short-term results, etc.

6. What are the various quality statements?
A. The quality statements include the vision statement, mission statement, and quality policy statement.

7. What is a Vision statement?
A. A short declaration of what an organization aspires to be in the future. It is an ideal state that an organization continually strives to achieve. It is timeless, inspirational, and becomes deeply shared within the organization.

8. What is a Mission statement?
A. The mission statement answers the following questions: who we are, who are our customers, what we do, and how we do it. The mission provides the guide map, milestones for achieving the vision.
9. What is the importance of customer focus for an organization?
A. Customers are the most important asset of an organization. An organization's success depends on how many customers it has, how much they buy, how often they buy, and how long they are retained (loyalty).

10. Distinguish between 'internal customer' and 'external customer'.
A. An *external customer* exists outside the organization and can be defined in many ways – user, buyer, influencer. He generally falls into one of three categories: current, prospective, or lost customer. Every function within the organization – engineering, production, order processing, etc. – has an *internal customer*. Every person in a process is considered a customer of the preceding operation. For example, Manufacturing is a customer for Purchasing, and Dispatching is a customer for Packaging.

11. What are the three levels of quality in the Kano model of customer satisfaction?
A. (i) Basic quality, (ii) Performance quality, and (iii) Excitement quality. The products corresponding to these three quality levels were termed as 'Dissatisfiers', 'Satisfiers' and 'Delighters/Exciters' respectively in the Kano model.

12. What is importance of customer retention?
A. It costs a company six times more to sell a product to a new customer than it does to sell to an existing one. Loyal customers generate more revenue, and are also cheaper to maintain. Customer loyalty facilitates cross-selling/up-selling of a company's other products/services, and also acts as an effective barrier to the entry of competition.

13. What are the major dimensions of product quality?
A. Performance, features, usability, conformance to standards/specifications, reliability, durability, maintainability, etc.

14. What are the major dimensions of service quality?
A. Service duration, timeliness, completeness, consistency, convenience, accuracy, courtesy, etc.

15. What is meant by 'Cost of quality'?
A. Quality costs are defined as costs associated with non-achievement of product/service quality. In simple terms, quality cost is the cost of poor products/services. All costs associated with poor quality and its correction are integrated into one system to enhance the quality management function.

16. What are the four categories of quality costs?
A. 1. Prevention costs, 2. Appraisal costs, 3. Internal failure costs, and 4. External failure costs.

17. What are internal failure costs?
A. These are costs required to identify, repair, replace, or dispose off defective products/services prior to delivery to the customer.

18. Mention the names of some major contributors to the quality movement.
A. Edwards Deming, Joseph M. Juran, Philip Crosby, Feigenbaum, Ishikawa, Taguchi, Shingo, Walter Shewhart, etc.

19. What is Deming Cycle?
A. P-D-S-A (Plan-Do-Study-Act) cycle of continuous improvement.

20. What is Deming's "System of Profound Knowledge"?
A. Deming summarized his philosophy in what he called "A System of Profound Knowledge". It comprised of 4 parts: (1) appreciation for a system, (2) some knowledge of the theory of variation, (3) theory of knowledge, and (4) psychology. Deming recognized the synergy among these diverse subjects and developed them into a theory of management.

PART-B

1. Explain the Dimensions of product quality.(NOV/DEC 2013)

Dimensions of quality

Quality has different dimensions. These dimensions are somewhat independent and therefore, a product can be excellent in one dimension and average or poor in another.

Dimensions of product quality:

1. Performance: primary product characteristics, e.g. picture brightness in TV.
2. Features: secondary characteristics, added features, e.g. remote control, picture-in-picture.
3. Usability: ease of use with minimum training.
4. Conformance: meeting specifications, industry standards,. (E.g. ISI specs., emission norms).
5. Reliability: consistency of performance over a specified time period under specified conditions.
6. Durability: extent of useful life, sturdiness.
7. Maintainability/Serviceability: ease of attending to maintenance, repairs.
8. Efficiency: ratio of output to input. E.g. mileage, braking distance, processing time.
9. Aesthetics: sensory characteristics, e.g. appearance, exterior finish, texture, color, shape, etc.
10. Reputation: subjective assessment based of past performance, brand image, industry ranking.
11. Safety: in items like pressure cookers, electrical items, toys, cranes, etc.

2. Explain the Dimensions of service quality. [Nov/Dec'11 ,Nov /Dec'12 , May /June '13]

Dimensions of service quality:

1. Time: how much time a customer must wait / undergo service.
2. Timeliness: whether service will be performed when promised.
3. Completeness: whether all items in the order are included.
4. Consistency: consistent service every time, and for every customer. Reliability of service.
5. Accessibility/Convenience: ease of obtaining the service.
6. Accuracy: absence of mistakes.
7.Responsiveness: quick response, resolution of unexpected problems.
8. Courtesy: cheerful, friendly service.
9. Competency/Expertise: In professions like doctors, lawyers, mechanics, etc.

3. Explain the evolution of TQM.

HISTORICAL REVIEW OF TQM:

* Ancient Egypt, 1400 B.C. – Pyramids, wall paintings show evidence of measurement, inspection, accuracy.

* Middle Ages – Age of craftsmanship. The skilled craftsperson served as both manufacturer and inspector. Pride in workmanship. Spread of skills through apprentice training.

* 1798 – Concept of interchangeable parts. U.S. Government awarded Eli Whitney a two-year contract to supply 2,000 muskets to the armed forces. Due to myriad problems in accurate making and matching of parts, it took more than 10 years to complete the project. It was the precursor to the Industrial Revolution in the early 19th century.

* Early 1900s – Taylor's Scientific Management era. Separation of planning and execution functions. Inclusion of product inspection as a stage in manufacturing. Segmentation of a job into specific work tasks, with focus on efficiency. Quality assurance fell into the hands of inspectors. Inspection became the primary means of quality control during the first half of the 20th century.

* 1920s – Bell Telephone Labs in USA was the leader in industrial quality assurance. Early pioneers of quality control – Walter Shewhart, Dodge, Edwards Deming – belonged to this company. Shewhart introduced control charts, Statistical Quality Control. Dodge and Romig

introduced Acceptance Sampling. Quality became a separate discipline handled by experts, and workers, managers stopped bothering about quality.
* World War II (1940s) – Large-scale use of Quality Control in industry. American Society for Quality (ASQ) set up.
* Post-World War II (late 1940s, early 1950s) – Two US consultants, Deming and Joseph Juran, visited Japan and introduced SQC techniques to the Japanese to help them rebuild their war-shattered economy and industry. The two focused on top management rather than on quality specialists. Juran began his 'Cost of Quality' approach.
* 1951 – The Union of Japanese Scientists & Engineers (JUSE) instituted the Deming Prize to reward companies which excelled in quality.
* Mid-1950s – Feigenbaum (USA) introduced the concept of Total Quality Control (TQC) to expand the quality focus beyond manufacturing to include design, procurement, and other supporting functions.
* 1960s – Philip Crosby (USA) introduced the concept of 'Zero Defects'.
* 1970s – Japanese overtook the Western manufacturers in quality. Invasion and capture of US, European markets by Japanese products.
* Late 1970s – Crisis response in the US to the Japanese domination. Dramatic shift from quality assurance to a strategic approach to quality. Shift from a reactive to a pro-active approach of prevention rather than finding and correcting defects. Also an era of increased consumer awareness, assertiveness, government safety regulations, product liability judgments in courts. Quality became the key to survival, global competitiveness.
* 1980 – Start of a quality revolution in USA. Origin: Deming's TV program on NBS titled "If Japan Can, Why Can't We?" which became highly popular. Top companies like Ford, GM, P&G sought Deming's help to revolutionize their approach to quality. Launch of TQM movement.
* 1987 – US government established the Malcolm Baldrige National Quality Award. ISO 9000 standards came into existence, mainly through efforts in Europe. Quality practices were extended to service sector to include schools, hospitals, transportation, etc.
* Current scenario – TQM principles are recognized as the basis for high performance and competitive success. Quality principles have got integrated so tightly with daily work activities that quality is no longer viewed as something special.

4. Write basic concepts of TQM?

BASIC CONCEPTS/PRINCIPLES OF TQM:

1. Management commitment
2. Focus on customer (both external and internal)
3. Employee involvement, empowerment
4. Continuous improvement
5. Treating suppliers as partners
6. Establish performance measures for processes
7. Designing products for quality
8. Quality at source
9. Defect prevention
10. Root cause corrective action
11. Benchmarking
12. Training
13. Positive motivation
14. Team work
15. Management by fact and
16. Quick response.

5. Explain the contributions of Deming to TQM. [Nov /Dec '11 ,May /June '12 , Nov/ Dec'12 , Nov/Dec '13,Nov/Dec '14, May/June '15]

Deming's 14 points for Management:

1. Create and publicize to all employees the aims and purposes of the organization.

2. Adopt the new philosophy (of customer satisfaction, continuous improvement, defect prevention, management-labour cooperation, etc.).

3. Stop dependence on inspection to achieve quality. (Managers must understand how variation affects their processes and take steps to reduce the causes of variation. Workers must take responsibility for their own work).

4. End the practice of awarding business on the basis of price tag alone. (Costs due to inferior materials/components increase costs in the later stages of production. Suppliers themselves are part of the whole system and hence should be treated as long-term partners).

5. Improve constantly and forever the system of production and service .(Aim for small, incremental, continuous improvements – not merely in the area of production but also covering transportation, maintenance, sales, service, administration, etc. – all areas of the organization).

6. Institute training. (Employees need the proper tools and knowledge to do a good job, and it is management's responsibility to provide these. Training not only improves quality and productivity, but also enhances workers' morale).

7. Adopt modern methods of supervision and leadership. (Managers, Supervisors should act as coaches, facilitators and not as policemen).

8. Drive out fear. (Fear in work manifests as fear of reprisal, fear of failure, fear of change, fear of the unknown. Fear encourages short-term, selfish thinking, not long-term improvement for the benefit of all).

9. Break down barriers between departments and individuals. (Promote teamwork).

10. Eliminate the use of slogans and exhortations. (Workers cannot improve solely through motivational methods when the system in which they work constrains their performance. On the contrary, they will become frustrated, and their performance will decrease further).

11. Eliminate work standards, numerical quotas, and MBO. (Numerical quotas reflect short-term perspectives and do not encourage long-term improvement. Workers may shortcut quality to reach the goal. The typical MBO system focuses on results, not processes, and encourages short-term behavior).

12. Remove barriers to pride in workmanship. (Treating workers as commodities; giving them monotonous jobs, inferior tools; performance appraisals, management assuming it is smarter than workers and not using the workers' knowledge and experience to the fullest extent).

13. Encourage education and self-improvement for everyone.

14. Take action to achieve the transformation. (The TQ philosophy is a major cultural change,and many firms find it difficult. Top management must take the initiative and include everyone in it).

6. Explain the contributions of Juran to TQM. [May /June '12, May '13, May '14]

Biographical:

+ Joseph M. Juran, Ph.D. (1904-). Born in Romania. His parents migrated to the USA.

+ Worked at Western Electric Co.from 1924 to 1941. There he got exposed to the concepts of Shewhart.

Contributions:

+ In 1951, he published 'Quality Control Handbook' which is still a standard reference for quality control departments in organizations.

+ Traveled to Japan in 1954 to teach quality management to the Japanese at the invitation of the Japanese Union of Scientists and Engineers (JUSE). Juran and Deming introduced the concept of SQC to the Japanese. Helped the Japanese to improve quality to unprecedented levels.

+ Developed, published in 1986, the **Juran Trilogy (Quality Trilogy)** of three inter-related processes – quality planning, quality control, and quality improvement – for managing quality.

+ He popularized the concept of **Fitness for Quality –** comprising of Quality of Design, Quality of Conformance, Availability (reliability), Safety and Field Service.
+ Along with Deming, he introduced the concept of 'Quality Assurance'.
+ He formulated a **Quality Planning Roadmap.** [1. Identify your customers, 2. Find out their needs, 3. Translate them into technical requirements, 4. Develop the product, 5. Develop and validate the process, and 6. Translate the resulting plan to the operating personnel.]
+ He advocated the accounting and analysis of quality costs to focus attention on quality problems.
+ He emphasized that upper management in particular needed training and experience in managing for quality. At the operational level, his focus was on increasing conformance to specifications through the elimination of defects, supported by statistical analysis.
+ Founded Juran Institute in 1979 to provide training, consulting services for improving business performance and attaining quality leadership.
+ His book *'Managerial Breakthrough'* (1964) presented the concept of '**Universal Breakthrough Sequence (or Breakthrough improvement),** which has now evolved into Six Sigma, the basis for quality initiatives worldwide.
+ Juran described quality from the customer perspective as having two aspects: (i) Higher quality means a greater number of features that meet customers' needs. (ii) 'Freedom from trouble' – higher quality consists of fewer defects.
+ Juran is recognized as the person who added the human dimension to quality – broadening it from its statistical origins, and thus helping develop the concept of TQM.

7. Explain the contributions of Crossby to TQM. [Nov/Dec'11 ,Nov/Dec '12,Nov/Dec'13]

Biographical:

* Philip B. Crosby (1926-2001)
* Was Corporate Vice President for Quality at International Telephones & Telegraph (AT&T) for 14 years after working his way up from line inspector.
* After leaving AT&T, he established Philip Crosby Associates in 1979 to develop and offer training programs. Guided GM, Chrysler, Xerox, Motorola, etc. in quality management.
* He wrote 13 books on quality, many of which were translated into 17 languages, sold millions of copies, and changed the way management looked at quality. Two of his most popular books are: *'Quality is Free'(1979)* and *'Quality Without Tears' (1984).*

Contributions:

* He developed the concept of **Zero Defects.**
***** He stated that "doing it right the first time" is less expensive than the costs of detecting and correcting defects.
* The book *'Quality Without Tears'* contains the essence of Crosby's philosophy embodied in two concepts: (i) **Absolutes of Quality Management,** and (ii) **Basic Elements of Improvement.**

+ (i) Absolutes of Quality Management:
(1) Quality means conformance to requirements, not elegance.
(2) Quality is achieved by prevention, not appraisal.
(3) The performance standard is zero defects, not acceptable quality levels. Quality is free.
(4) Quality is measured by the price of non-conformance, not indexes.

+ **(ii) Basic Elements of Improvement**
(1) Determination: Top management must be serious about quality improvement.
(2) Education: Through education, the Absolutes must be made understandable to everyone.
(3) Implementation: Every manager must understand the implementation process.

* He enumerated **14 steps for quality improvement** *{[1] Establish management commitment, [2] Form quality improvement team, [3] Establish quality measures, [4] Evaluate the cost of quality, [5] Establish quality awareness, [6] Instigate corrective action, [7] Carry out Zero Defect planning, [8] Undertake employee training, [9] Hold a Zero-Defect Day, [10] Employee goal setting, [11] Error cause removal, [12] Establish recognition, [13] Establish Quality Councils, and [14] Do it all over again.}*
* He developed **'Quality Vaccine'.** Crosby advocated the concept of Quality Vaccine for successful implementation of TQM. Its three major components are:
(1) Integrity – towards customers, employees, and suppliers.
(2) Communication - both internal and external.
(3) Systems and Operations.

8. Explain the TQM framework.
*** Basic concepts/principles of TQM:**
1. Management commitment, 2. Focus on customer (both external and internal), 3. Employee involvement, empowerment, 4. Continuous improvement, 5. Treating suppliers as partners, 6. Establish performance measures for processes, 7. Designing products for quality, 8. Quality at source, 9. Defect prevention, 10. Root cause corrective action, 11. Benchmarking, 12. Training, 13. Positive motivation, 14. Team work, 15. Management by fact, and 16. Quick response.

*** Cause-and-effect cycle of TQM:**
TQM → High quality product/service → High productivity, lower cost → Lower price → More competitive position → High profit, growth → Job security → Satisfying place to work.

*** Stages in the evolution of quality:**
Inspection → Quality Control (QC) → Quality Assurance (QA) → Quality Mgmt. (QM) → TQM

*** Benefits of quality systems:**
Increase in – system efficiency, worker morale, customer satisfaction.
Decrease in – complaints, costs, production time.

9. State and explain the barriers to TQM implementation in an organization.

* Many organizations, especially small ones with niche products, are comfortable with their current state. They are satisfied with their current level of performance and profits. Organizations with this culture will see little need for TQM until they begin to lose market share.

Awareness comes about when (a) the organization loses market share or (b) TQM is mandated by the customer, or (c) management realizes that TQM is a better way to run a business and compete in domestic and world markets.

Once an organization embarks on TQM, the following are some of the major obstacles encountered in implementation:
1. Lack of management commitment: Management does not allocate sufficient time and resources for TQM implementation. The purpose is not clearly, consistently communicated to all personnel. Management's compensation is not linked to quality goals such as failure costs, customer complaints, and cycle time reduction.
2. Inability to change organizational culture: Even individuals resist change; changing an organization's culture is much more difficult and may require as much as 5 years or more. Exhortations, speeches, slogans are effective only in the short run.
3. Improper planning: Absence of two-way communication of ideas during the development of the plan and its implementation.
4. Lack of continuous training and education.

5. Incompatible organizational structure and differences between individuals/departments.
6. Ineffective measurement techniques for key characteristics of the organization. Lack of access to data and results.
7. Paying inadequate attention to internal and external customers. Inability to understand the changing needs and expectations of customers. Absence of effective feedback mechanisms.
8. Inadequate use of empowerment and teamwork.
9. Lack of employee involvement.
10. Non-cooperation of first-line managers and middle management.
11. Lack of clarity in vision.
12. Emphasis on short-term results.
13. Setting of unmanageable, unrealistic goals.
14. Bureaucratic system.
15. TQM is considered as a quick-fix solution to current problems.
16. Treating suppliers as adversaries to be manipulated, taken advantage of.
17. Adversarial relationship between workers/unions and management.
18. Motivating employees through fear of punishment.
19. Failure to continually improve. Tendency to sit back and rest on one's laurels. Rigidly sticking to one 'success formula'.

UNIT-II

21. Why should suppliers be treated as partners?
A. Costs due to inferior materials/components from suppliers increase costs in the later stages of production. Suppliers themselves are part of the whole system and hence should be treated as long-term partners.

22. What is the 'Juran Trilogy' ('Quality Trilogy')? **(Dec 2011)**
A The **Juran Trilogy (Quality Trilogy)** consists of three inter-related processes – quality planning, quality control, and quality improvement – for managing quality.

23. What are Crosby's Four Absolutes of Quality Management?
A. (1) Quality means conformance to requirements, not elegance. (2) Quality is achieved by prevention, not appraisal. (3) The performance standard is zero defects, not acceptable quality levels. Quality is free. (4) Quality is measured by the price of non-conformance, not indexes.

24. Mention the major contribution of Feigenbaum to quality.
A. He was the originator of the concept of **Total Quality Control (TQC).** His concept of *Total Quality Control* was used as the foundation by the Japanese for their practice called *'Company-Wide Quality Control' [CWQC]* which began in the 1960s and later evolved into TQM.

25. What are Quality Circles (QC)?
A. QC is a small team of people (around 8 to 10) coming from the same work area/department who voluntarily meet on a regular basis (about an hour every week) to identify, investigate, analyze and solve work-related problems. QC can be viewed from three angles: (i) as a form of participative management, (ii) as a HRD technique, and (iii) as a problem-solving technique.

26. What are the roles assigned to people in Quality Circles?
A. The QC organization has a four-tier structure consisting of *Members, Leaders, Facilitators, and Steering Committee.*

27. What are the steps in implementing Quality Circle projects?
A. (1) Select the problem, (2) Study the problem, (3) Plan the improvement, (4) Carry out the improvement, (5) Check the results, (6) Form conclusions, (7) Present to management, (8) Obtain approval, and (9) Implement on regular basis.

28. Mention some tools used by Quality Circles for solving problems.
A. Data collection, Brainstorming, Check sheets, Pareto Analysis, Cause & Effect diagrams, Control charts, Presentation techniques, etc. are used by quality circles in solving problems.

29. Mention some major objectives of Quality Circle projects.
A. 1. Improve quality and productivity. 2. Cost reduction. 3. Effective utilization of resources.
4. Avoid unnecessary errors, defects. 5. Solve work-related problems that interfere with production, etc.

30. What are the Japanese 5S principles? **(Dec 2011) [Nov/Dec'13]**
A. The 5S's stand for five Japanese words: **Seiri, Seiton, Seiso, Seiketsu,** and **Shitsuke.** In English, they mean ***Sort, Arrange, Clean up, Systematize,*** and ***Discipline*** respectively.

31. What does **Seiri** mean?
A. Separate out all unnecessary things and remove them, retaining only necessary things.

32. What does **Seiton** mean?
A. Put required things in proper order so that they can be easily accessed for use and quickly put away in their proper locations after use.

33. What does **Seiso** mean?
A. Keep machinery and work environment clean.

34. What does **Seiketsu** mean?
A. Develop routine practices for orderly, systematic working.

35. What does **Shitsuke** mean?
A. Impart systematic training and coaching to ensure discipline in 5S implementation.

36. Mention some benefits of implementing 5S principles.
A. 5S increases productivity, eliminates waste, reduces inventory, creates a pleasant workplace, improves safety, and increases the overall efficiency and effectiveness of people and machines.

37. Explain Kaizen (**Dec 2011) [Nov/Dec '12]**
Kaizen, which is a Japanese word that means gradual and orderly continuous improvement, is a philosophy that covers all business activities and everyone in an organization. In the kaizen philosophy, improvement in all areas of business – cost, meeting delivery schedules, employee safety and skill development, supplier relations, new product development, and productivity – serve to improve the quality of the firm. Thus, any activity directed toward improvement falls under the kaizen umbrella.

38. Explain Supplier Rating.
A supplier rating system (often called a scorecard system) is usually based on quality, delivery, and service; however, some customers have added other categories, such as lead time, product support, technology, etc.

39.Define Empowerment

. Empowerment requires *a sincere belief and trust in people.* It involves employees directly in decision-making processes, giving them the security and confidence to make decisions, and providing them with the necessary tools and training.

40. Distinguish between Reward and Recognition. **(Dec 2010)**

Recognition & reward: Creating incentives for suppliers is one way to ensure that they remain committed to a quality improvement strategy. Incentives may be in the form of a preferred supplier category with its rewards. Recognition may be in the form of publication of outstanding contributions in the customer's newsletter, a letter of commendation, or a plaque.

PART-B

1. Explain the different types of Teams. **(Dec 2011)**

A *team* is defined as a group of people working together to achieve common objectives or goals. *Teamwork* is the cumulative actions of the team in which each member of the team subordinates his individual interests to fulfill the objectives or goals of the group.

Process improvement teams: The members represent each operation of the process. When the targeted process includes many work units or the entire organization, a cross-functional team may be more appropriate with work unit teams operating as sub-teams. The life cycle of this type of team is usually temporary – it is disbanded when the objective has been achieved.

Cross-functional teams: The members represent a number of different functional areas such as engineering, marketing, accounting, production, quality, and human resources. It may also include the customer and/or the supplier. A design review team is a good example of a cross-functional team. This type of team breaks down functional area boundaries.

Problem-solving teams: Members gather to solve a specific problem and then disband.

Project teams: Teams with a specific mission to develop something new or to accomplish a complex task.

Self-directed/self-managed work teams: They are the epitome of the empowered organization – they not only do the work but also manage it. There is wide discretion to organize their work subject to organizational work flow requirements.

2. What are the various steps involved in developing a team.

Effective teams are goal-oriented, independent, open, supportive and empowered. Problem solving drives the team concept. The three basic functions of a team are to *identify, analyze* and *solve* quality and productivity problems. These three basic functions can be expanded into the following nine steps:

Identify: 1. Develop list of problems, 2. Select problem to tackle.
Analyze: 3. Collect data, 4. Focus attention, 5. Find causes.
Solve: 6. Develop solutions, 7. Pick best solution, 8. Develop follow-up plan, and 9. Implement.

3. Explain all the elements in 5'S principle and also the implentation procedure of 5'S in a manufaturingcompany. **(Dec 2011)**

* The 5S's stand for five Japanese words: **Seiri, Seiton, Seiso, Seiketsu,** and **Shitsuke.** The 5S is not only useful to improve the physical environment, but also the thinking processes.

1. Seiri (Sort): Separate out all unnecessary things and remove them, retaining only necessary things. Accumulation, mixing of unnecessary things and wastes with needed items leads to clutter, confusion and mess, thereby reducing the efficiency of working. Seiri also involves keeping the number of things as low as possible and at a convenient location. If the workplace is

clean, there is greater motivation to carry out the job; but if the place is full of unwanted things, it will be difficult to work effectively.

2. Seiton (Arrange): Put required things in proper order so that they can be easily accessed for use and quickly put away in their proper locations after use. It prevents people from wasting their time searching for things. *"A place for everything and everything in its place".*

3. Seiso (Clean up): Keep machinery and work environment clean. Employees should be responsible for cleaning their own workplaces. Workers should clean up the workplace first thing before they commence work and at the end of the day before they leave. They should also see that their workplace remains clean and tidy throughout the day. Any dirt, spillage, etc. should be attended to immediately.

If cleanliness is not maintained, it can be harmful to the personnel [health hazards], machinery [can fail due to dust, dirt, etc.], and materials [due to contamination], thereby causing quality and productivity problems.

4. Seiketsu (Systematize, Standardize): Develop routine practices for orderly, systematic working. If the 5S processes are standardized, it becomes easier to continuously maintain the organization's neatness and cleanliness. An effective means of achieving *Seiketsu* is Visual management – like signboards, marked parking lots, marking of aisles, identification labels, etc. Another important consideration is transparency – tools, files, etc. should be visible so that it is easy to locate them. This will reduce the time for searching.

5. Shitsuke (Discipline): Impart systematic training and coaching to ensure discipline in 5S implementation. Discipline comes through repetition and practice. Self-discipline goes beyond discipline. It is essential for the successful implementation of the 5S principles.

* In a factory, 5S increases productivity, eliminates waste, reduces inventory, creates a pleasant workplace, improves safety, and increases the overall efficiency and effectiveness of people and machines.

* The logic behind the 5S principles is that organization, neatness, cleanliness, standardization, and discipline at the workplace are basic requirements for producing high quality products and services, with high productivity and little or no wastage; hence the importance of combining the 5S principles in TQM.

4. Write about the system of recognition an reward followed in an organisation. **(Dec 2011)**

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. **Reward** is something tangible such as a cash award, plaque, certificate, special dinner, theatre tickets, etc. to promote desirable behavior. *Recognition* and *reward* go together to form a system for letting people know they are valuable members of the organization. They can be monetary or non-monetary, formal or informal, individual or group.

+ The recognition and reward system must have clear recognition criteria. Policies and procedures must be consistently and fairly applied throughout the organization. Recognition should be valid, genuine, and meaningful for the giver and the recipient; it should not be used to manipulate people.

+ In the selection of individuals/teams to be recognized or rewarded, employees should be involved along with the manager(s), and sometimes the customer and supplier too.

+ While the reward may be delayed until an appropriate time, the recognition should be on a timely basis. Rewards should be appropriate to the improvement level – the greater the improvement, the greater the reward. They should also be perceived to be of value.

+ Individual rewards include cash awards, gift certificates, dinner out, event tickets, trips, etc. Group rewards are similar and can also include an outing, group lunch or dinner, allowing the team to make some decisions affecting their work, etc.

+ People like to be recognized, either as a team or individually. A person's feeling of achievement, value to the organization, knowing the organization cares, and having peer recognition may be more important than any reward. In addition to the plaque or certificate given at a formal function, other forms of recognition include name/picture on the bulletin board, articles in newsletters,/journals, letters to families, personal phone calls or notes, increased responsibility, and on-the-spot praise.

5. What are the steps involved in continuous improvement process . **[Nov /Dec'11,May /June '14]**

Continuous improvement is an inherent part of the TQM process. It transforms the drive towards quality into a never-ending journey. This concept allows companies to start with modest beginnings and make small incremental improvements towards excellence.
+ Effective continuous improvement needs the support of performance measurement methods. Performance measurement systems help people to identify and measure, in quantitative terms, the sizes of improvements.

*** Steps in Continuous Improvement Strategy:**

1. Define the current status: This can be addressed from any of several perspectives *viz.* number of defects, cost of defects, customer satisfaction indices, and the like.

2. Define continuous improvement objectives: While the first step asks the question "where are we?" the second step asks the question "where should we be going?". The objectives should be based on a realistic appraisal of what the organization, with its available resources, is capable of achieving. It is better to set modest improvement goals at first to realize a few initial successes, which will help to motivate employees to accept the continuous improvement philosophy.

3. Select continuous improvement projects: These are the specific areas in which the organization desires to seek improvement. Some examples of improvement projects are: [i] frequent product failures during final testing, [ii] delayed payments to suppliers, [iii] delays in attending to machine breakdowns. Each of these projects provide the framework of an action plan for the organization to realize continuous improvement.

4. Assign teams: After selecting the projects, the organization has to assign people to work on these projects and empower them to attain the continuous improvement objectives set. The concepts of *employee involvement, empowerment and teamwork* are extremely important to achieve *continuous improvement* as they allow an organization to achieve significant synergies and fully utilize its human resources.

5. Define the process: Once a team has been assigned a project, the first task of the team is to define the process it is assigned. This is done by preparing a flow chart for the process. Flow charts provide the visibility of the entire process to all those who work on the process. It also reveals various problem areas and inefficiencies. Each step in the process should be critically examined by asking the question: *What happens if this step is eliminated?* If nothing happens, then that particular step should be removed from the process.

6. Define sources of variability: The next step is to identify areas in which variability can creep into the process. Reducing variability is another key concept of TQM, because anything done to reduce variability will result in improved quality. Two sources of variability are *chance causes* and *assignable causes.* Variability reduction focuses on ensuring that the assignable causes (due to human factors) are eliminated from the process. According to Deming, 85% of a company's quality problems are due to variability induced by problems in the process and not workmanship. Eliminating process deficiencies and minimizing process variability will prevent future defects.

7. Implement change: Formulate a pilot program in a small area to test the effectiveness of the suggested improvement project. Based on feedback indicating any glitches and problem areas, make suitable modifications and go in for full-scale implementation. Continue to monitor the process using the same measurement criteria once the upgrade has been fully implemented.

6. Write short notes on :i) customer perception of quality and ii) Customer complaints **(Dec 2010)**

CUSTOMER PERCEPTION OF QUALITY

One of the basic concepts of TQM – continuous improvement – implies that there is no acceptable quality level because customers' needs, values, expectations are constantly changing and becoming more demanding. *[Refer Kano model]*.

An American Society for Quality (ASQ) survey on end user perceptions of important factors that influenced purchases showed the following ranking: 1. Performance, 2. Features, 3. Service, 4. Warranty, 5. Price, and 6. Reputation. The first four factors are part of product/service quality. Hence it is evident that product/service quality is considered more important than price.

Other factors felt important by customers are: Availability, Reliability, Maintainability, Care in handling (of products as well as customers), Response time.

The way to assess customers' perception of quality is by measuring customer satisfaction (by carrying out customer satisfaction surveys).

CUSTOMER COMPLAINTS

+ Although complaints are reactive in nature, they are vital in gearing data on customer perceptions. A dissatisfied customer can easily become a lost customer. Many organizations use customer dissatisfaction as the primary measure to assess their process improvement efforts.

+ A survey by American Society for Quality (ASQ) showed that only about 1% of customers bothered to complain to management, around 20% took the trouble to complain to front-line personnel, and almost 80% did nothing.

+ Frequently, dissatisfied customers switch to a competitor and don't say anything. The average organization takes its customer base for granted, assuming that no complaints is good news. Every single complaint should be accepted, analyzed, and acted upon, for it represents the tip of the iceberg.

+ Another study indicated more than 50% of dissatisfied customers will buy again if their complaint is heard and resolved. Only 20% will buy again if their complaint is heard but not resolved. Less than 10% will be repeat buyers when a complaint is not heard. Such complaints do reach other potential customers, thereby damaging the company's reputation and business prospects.

+ An organization can save both money and customers by training and empowering front-line employees (those who directly deal with customers) to solve problems directly with customers. Customers want problems solved quickly and efficiently. Management should encourage employees to take risks, make decisions, and not be afraid of making a mistake.

+ Studies have shown that the better the service at the point of sale, the fewer the complaints and the greater the sales volume. Unmotivated, dissatisfied employees are as noticeable as dissatisfied customers. It's just as important to focus on employee satisfaction as customer satisfaction.

**** Some actions organizations can take to handle customer complaints:***

1. Investigate customers' experiences by actively seeking feedback, both positive and negative, and act on it promptly.
2. Develop procedures for resolving complaints that include empowering front-line personnel.
3. Analyze complaints to go into their root cause.
4. Identify process and material variations and then eliminate the root cause. "More inspection" is not corrective action.
5. Establish customer measures and constantly monitor them.
6. Communicate complaint information, as well as the results of all investigations and solutions, to all people in the organization.
7. Provide a monthly complaint report to the Quality Council for their evaluation and, if needed, the setting up of process improvement teams.
8. Identify customers' expectations beforehand rather than afterward through complaint analysis.

7. List the five levels in Maslow's Hierarchy of needs and describe in detail each level.

* **Maslow's Hierarchy of Needs:**
+ Maslow's hierarchy consists of physical (survival), security, social, esteem, and self-actualization needs. Once a given level is satisfied, it ceases to be a motivator, and the next higher level need becomes the motivator.
+ Level 1 needs of food, clothing, and shelter are usually provided by a job. Level 1 needs also include a conducive working environment such as proper lighting, ventilation, fan, A/C, etc.
+ Level 2 (security) can mean a safe place to work and job security. It also includes having privacy on the job such as separate cabin, lockable storage for personal items, etc.
+ Level 3 (social) needs involve giving a person the opportunity to be part of a group. Employees should also be provided with both formal social areas such as conference rooms and cafeterias, and informal areas such as water coolers and bulletin boards. Being a member of a team is a good way to meet the social needs of an individual.
+ Level 4 (esteem) needs: Everyone, regardless of position or nature of job, wants to be recognized as a person of value to the organization. Provision of business cards, separate work space, office protocols, etc. provides employees with a certain level of self-esteem.
+ Level 5 (self-actualization) says that individuals must be given the opportunity to go as far as their abilities will take them. In this regard, many organizations have a policy of promoting from within.

8. What are the characteristics of empowered employee? And also discuss the benefits of empowered environment.

Characteristics of empowered employees: [1] They feel responsible for their own task. [2] They are given a free hand in their work. [3] They balance their own goals with those of their organization. [4] They are well trained, equipped, creative, and customer oriented. [5] They are critical, have self-esteem, and are motivated. [6] They monitor and improve their work continuously. [7] They constantly seek new goals and challenges.
+ **Benefits of empowerment:** [1] It builds confidence in workers by showing them that the company has confidence in their ability to make decisions on their own. [2] It generates commitment and pride in employees. [3]It gives employees better experience and an opportunity to advance their careers. [4] It benefits customers by reducing bureaucratic red tape that customers encounter – such as seeking a superior's approval/signature – which makes customer transactions speedier and more pleasant.

9. Explain in detail the concept of Employee involvement. **[Nov/Dec '12 , Nov/Dec '14]**

Employee involvement (EI) refers to any activity by which employees participate in work-related decisions with the aim of tapping the creative energies of all employees and improving their motivation.
+ The various levels of employee involvement is summarized in the following table. As total quality matures in an organization, higher levels of employee involvement become evident.

Level	Action	Primary outcome
1. Information sharing	Managers decide, then inform employees	Conformance
2. Dialogue	Managers get employee input, then decide	Acceptance
3. Special problem solving	Managers assign a one-time problem to selected employees	Contribution
4. Intra-group problem solving	Intact groups meet weekly to solve local problems	Commitment

5. Inter-group problem solving	Cross-functional groups meet to solve mutual problems	Cooperation
6. Focused problem solving	Intact groups extend daily involvement in a specific issue	Concentration
7. Limited self-direction	Team functions with minimum supervision	Accountability
8. Total self-direction	Executives facilitate self-management	Ownership

+ EI is rooted in the psychology of human needs and supported by the motivation models of Maslow, Herzberg, and McGregor. Employees are motivated through exciting work, responsibility, and recognition. EI provides a powerful means of achieving the highest order individual needs of self-realization and fulfillment, thereby improving employee morale and commitment, with resultant improvements in quality and productivity.
+ One of the easiest ways to promote employee involvement is the **suggestion system.** It is a management tool for the submission, evaluation, and implementation of an employee's idea to save cost, increase quality, or improve other elements of work such as safety.
+ Major factors contributing to employee involvement are: motivation, compensation, recognition & reward system, working environment, organization culture and climate, leadership, and empowerment.

10. Write short note on: Supplier partnership, Partnering, supplier selection, supplier rating.

Supplier Partnership.
+ An organization spends a substantial portion of its resources on the purchase of raw materials, components, and services. Therefore, supplier quality can greatly affect the overall cost and quality of a product or service. It is important for the customer to work with suppliers in a partnering atmosphere to achieve high quality levels in its end products and services.
+ Organizations (customers) and their suppliers have the same goal – to satisfy the end user. Since both the customer and the supplier have limited resources, they must work together as partners for their mutual benefit.
+ There have been a number of forces that have changed supplier relations. Prior to the 1980s, purchase decisions were typically based on price, thereby awarding contracts to the lowest bidder. As a result, quality and timely delivery were sacrificed. The advent of the TQM philosophy exemplified by Deming's fourth point *(Stop awarding business based on price alone)* addressed this problem.
Another force changing supplier relations was the introduction of the just-in-time (JIT) concept. It calls for raw materials and components to reach the shop-floor in small quantities when they are needed and not before. As a result, the supplier will have many more process setups, thus becoming a JIT organization itself.
The practice of continuous process improvement has also caused many suppliers to develop partnership with their customers. Suppliers are now taking increased product-development responsibilities. They are becoming involved in product design, formation of specifications, and component testing.
A final force is ISO 9000 which requires suppliers to work towards zero defects, 100% on-time delivery, and a process for continuous improvement.
All these forces have changed adversarial customer-supplier relationships into mutually beneficial partnerships. Joint efforts improve quality, reduce costs, and increase market share for both parties.

PARTNERING

+ Partnering is a long-term commitment between two or more organizations for the purpose of achieving specific business goals. The relationship is based upon trust, dedication to common

goals, and an understanding of each participant's expectations and values. Benefits include improved quality, increased efficiency, and lower cost.

+ There are three key elements to a partnering relationship: *long-term commitment, trust,* and *shared vision.*

1. Long-term commitment: Long-term commitment provides the needed environment for both parties to work toward continuous improvement. Each party contributes its unique strengths to the processes. A supplier might not take risks, such as acquiring new equipment or systems, without a long-term commitment.

2. Trust: Mutual trust forms the basis for a strong working relationship that is non-adversarial. The purchasing function must be subordinate to the overall relationship goals and objectives. Open and frequent communication avoids disputes while strengthening the relationship. The parties should have access to each other's business plans and technical information, such as product and process parameters. In addition, they may share or integrate resources such as training activities, administrative systems, and equipment. Both parties become motivated when "win-win" solutions are sought rather than "win-lose" solutions.

3. Shared vision: Each of the partnering organizations must understand the need to satisfy the final customer. Shared goals ensure a common direction and must be aligned with each party's mission. Employees of both parties should think and act for their common good. Decisions must be formulated and implemented as a team.

SUPPLIER SELECTION

+ Before deciding on suppliers, the organization has to decide whether to produce or outsource a particular item. This decision is a strategic one and must be made after answering the following questions: *How critical is the item to the design of the product or service? Does the organization have the technical knowledge to produce the items internally? Are there suppliers who specialize in producing the item?* These questions must be answered in terms of cost, delivery, quality, safety, and the acquisition of technical knowledge.

+ Once the decision has been made to outsource, then the supplier must be selected. The following are some important criteria for evaluation and selection of suppliers:

- The supplier has the capability to produce the item in quantities needed by the organization.
- The supplier has excellent quality practices and a commitment to quality.
- The supplier maintains high technical standards and has the capability of dealing with future technological innovations.
- The price is right and the delivery dates can be met.
- The supplier is easily accessible in terms of transportation and communication.
- The supplier has a track record of customer satisfaction and organization credibility.
- The supplier has an effective quality system and improvement program such as ISO 9000.
- The supplier understands and appreciates the management philosophy of the organization.

SUPPLIER RATING

* The customer rates suppliers to: [i] obtain an overall rating of supplier performance, [ii] ensure complete communication with suppliers regarding their performance in the areas of quality, service, delivery, and other measures the customer desires, and [iii] provide each supplier a detailed, factual record of problems for corrective action.

* A supplier rating system (often called a scorecard system) is usually based on quality, delivery, and service; however, some customers have added other categories, such as lead time, product support, technology, etc. These categories may also have subcategories.

* These basic categories are weighted, with quality usually given the greatest weight. A score is given to each category by means of a numerical value or a letter grade, which can then be converted to a numerical value.

* Reports are prepared and issued quarterly, and overall grades are provided to each supplier. The basic objective of such supplier rating systems is to have high quality, dependable suppliers in the long run.

UNIT – III

TQM TOOLS & TECHNIQUES I

PART - A

1. List the seven tools of quality. [Nov/Dec'11]

1. Check sheets.
2. Histograms.
3. Cause and effect diagrams.
4. Pareto diagrams.
5. Stratification analysis.
6. Scatter diagrams, and
7. Control charts.

2. What is check sheet?

A check sheet or tally sheet is a form for systematic data gathering and registering to get a clear view of the facts.

3. When do you use the check sheet?

A check sheet is used to indicate the frequency of a certain occurrence.

4. What are the types of check sheets commonly used? [May/June'12]

1. Process distribution check sheet.
2. Defective item check sheet.
3. Defect location check sheet, and
4. Defect factor check sheet.

5. What is histogram?

A histogram is a bar chart / diagram showing a distribution of variable quantities or characteristics. It is graphical display of the frequency distribution of numerical data.

6. When do you use histogram?

A histogram is used to show clearly where the most frequently occurring values are located and the data is distributed.

It enables the analyst to quickly visualize the features of a complete set of data.

7. What are the various types of histogram?

1. Bell-shaped.
2. Double-peaked.
3. Plateau.
4. Comb.
5. Skewed.
6. Truncated.
7. Isolated peak and
8. Edged peak.

8. What is cause and effect diagram?
The cause and effect diagram or Fishbone diagram is a graphical-tabular chart to list and analyze the potential causes of a given problem.

9. Under what situations, one can use cause and effect diagram?
The cause and effect diagram has unlimited application in research manufacturing, marketing, office operations, services, etc.

10. What are the uses of CE diagram?
The cause and effect diagrams are used:
To analyse cause and effect relationships
To facilitate the search for solutions of related problems.
To standardize existing and proposed operations and
To educate and train personnel in decision-making and corrective action activities.

11. What is Pareto diagram?
A pareto diagram is a diagnostic tool commonly used for separating the vital few causes that account for a dominant share of quality loss.

12. State the Pareto principle.
Pareto principle states that a few of the defects accounts for most of the effects.

13. What are the purposes of pareto principle.
Pareto analysis can be used in a wide range of situations, where one need to priorities problems based on its relative importance.

14. What is stratification?
Stratification is a method of analysis of data by grouping it in different ways.

15. What is scatter diagram?
The scatter diagram is a simple graphical device to depict the relationship between two variables.

16. When do you use the scatter diagram?
The purpose of the scatter diagram is to display what happens to one variable when another variable is changed.

17. What is control chart?
A control chart is a graph that displays data taken over time and the variation of this data.

18. What are the types of control charts?
Control charts for variables – for measurable data such as time, length, temperature, weight, pressure, etc.

Control charts for characteristics- for quantifiable data such as number of defects, typing errors in a report, etc.

19. When do you use control chart?
The purpose of control chart is to identify when the process has gone out of statistical control, thus signaling the need for some corrective action to be taken.

20. Define statistics applications of statistical techniques?
Statistics is defined as the science that deals with the collection, tabulation, analysis, interpretation and presentation of quantitative data.

21. What are major functions of statistical analysis? Write down the applications of statistical techniques?
The major functions of statistical analysis are:
Reducing the complexity of the situation,
Making comparisons and drawing conclusions,
Estimating and predicating, and
Decision-making.
Statistical techniques are applicable in all situations where quantification is possible. The statistical analysis has become indispensable to practically every field that exists.

22. What are the types of graphs used in representing frequency distribution?
Histogram,
Frequency polygon and frequency curve, and
Cumulative frequency or the 'Ogive'

23. How do obtain frequency curve?
A frequency curve is obtained by drawing a smooth freehand curve through the points of the frequency polygon. The cumulative frequency curve (also called an Ogive) obtained by plotting upper class limits (or lower class limits) against the 'less than' (or 'more than') cumulative frequencies is known as 'less than' Ogive (or 'more than' Ogive).

24. What do you mean by measure of central tendency? What are the three measures of central tendency?
A measure of central tendency of a distribution is a numerical value that describes the central position of the data.
1. Mean, 2, Median, and 3. Mode.

25. What are the three measures of dispersion?
Measures of dispersion tell us how the individual observations are spread on either side of the centre.
1. Range, 2.Mean deviation, and 3. Standard deviation

26. What is meant by attribute? What is the use of control charts for attributes?
An attribute refers to those quality characteristics that confirm to specifications or do not conform to specifications.
Control charts for attributes monitor the number of defects or fraction defects or fraction defect rate present in the sample.
p chart: The chart for fraction rejected as non-conforming to specification
np chart: The control chart for number of non-conforming items.
c chart: The control chart for number of defects.
u chart: The control chart for number of defects per unit.

27. Define fraction defective (p).
It is defined as the ratio of the number of defective articles found in any inspection to the total number of articles actually inspected.
Mathematically, $p = np/n$
Where P= Fraction defective,

np = Number of defectives, and
n = Number of items inspected in the sub-group

28. When up chart is preferred over p chart? Why a np chart is preferred over p chart?
When subgroup size is constant, the np chart is preferred over p chart.
In np chart, when the subgroup size is variable, the expected number of rejectable items per subgroup will also change. This means that a different central line as well as different control limits for every subgroup on the chart. This makes the chart very confusing and almost not understandable by shop personnel. Therefore when the subgroup size is variable, np chart is not recommended.

29. Write down the difference between a defect and defective.
An item is said to be defective if it fails to conform to the specifications in any of the characteristics. Each characteristics that does not meet the specifications is called defect. For example, if a casting contains undesirable hard sports, below holes, etc., the casting is defective and the hard spots, below holes, etc., are the defects.

30. Differentiate between producer's risk and consumer's risk.
Producer's risk: It is the probability of rejecting a good lot which otherwise would have been accepted.
Consumer's risk: It is the probability of accepting a defective lot which otherwise would have been rejected.

31. What is six sigma? [Nov/Dec '12]
Six sigma is similar to Zero Defects (ZD), is a philosophical benchmark or standard of excellence proposed by Philip Crosby. Six sigma strives for perfection. It allows for only 3.4 defects per million opportunities (or 99.99966 percent accuracy).

32. What are the five phases in six sigma process?
The five phases in six sigma process are:
1. Define, 2. Measure, 3. Analyse, 4. Improve, and 5. Control

33. Brief the scope of six sigma principle.
The six sigma concept is originated from manufacturing field. Now it is applied to non-manufacturing processes also. Today one can apply six sigma to many fields such as services, medical and insurance procedures, call centres, etc.

PART – B

1. Explain briefly about check sheet (or) data collection sheet with an example.
Check sheet (data collection sheet)
i. What is it?

- A check sheet*, also known as tally sheet, is a form for systematic data gathering and registering to get a clear view of the facts.
- It is used to keep track of how often something occurs.
- The form of the check sheet is tailored for each situation / application.

ii. When do we use it?

- A check list is used to indicate the frequency of a certain occurrence.

iii. How do we construct it?

- A checklist may be constructed using the following steps:
- Formulate the objective for collecting data
- Decide which data is necessary.
- Determine who and how data will be analyzed.
- Draw a format to record data.
- Collect and record data problem-wise by putting tally lines.
- Start counting by tallying on the list; |, ||, |||, |||| and |||| represent the numbers 1,2,3,4 and 5 respectively.
- Mark on the list the total number of facts, which were noticed.

iv. Types of check sheets

The widely used different types of check sheets are:

Process distribution check sheet:

This check sheet is used to collect on process variability.

Defective item check sheet:

This check sheet is intended to specify the variety of defects occurring, together with their frequency of occurrence.

Defect location check sheet:

This check sheet is intended to identify where defects occur on the product.

Defect factor check sheet:

This check sheet is used to monitor the input parameters in a process that might affect the incidence of defects.

Illustration

Example Fig illustrates the check sheet of customer complaints by category

Check sheet / Tally sheet of customer complaints

S.No	Problems		Frequency
i)	Delivery	𝍸 ||	7
ii)	Packaging	||	2
iii)	Quality / Performance	𝍸 𝍸 |	11
iv)	Personnel	𝍸 𝍸	10
v)	Invoicing	𝍸 𝍸 𝍸 |||	18

2. Define Histogram. Mention its types. Illustrate with an example. (Nov/Dec'12, May/June'13)

i. What is it?

A histogram is a bar chart / diagram showing a distribution of variable quantities or characteristics.

It is a graphical display of the frequency distribution of the numerical data.

The data are displayed as a series of rectangles of equal width and varying heights.

ii. When do we use it?

A histogram is used to show clearly where the most frequently occurring values are located and the data is distributed.

It is also a tool for determining the maximum process results.

It enables the analyst to quickly visualize the features of a complete set of data.

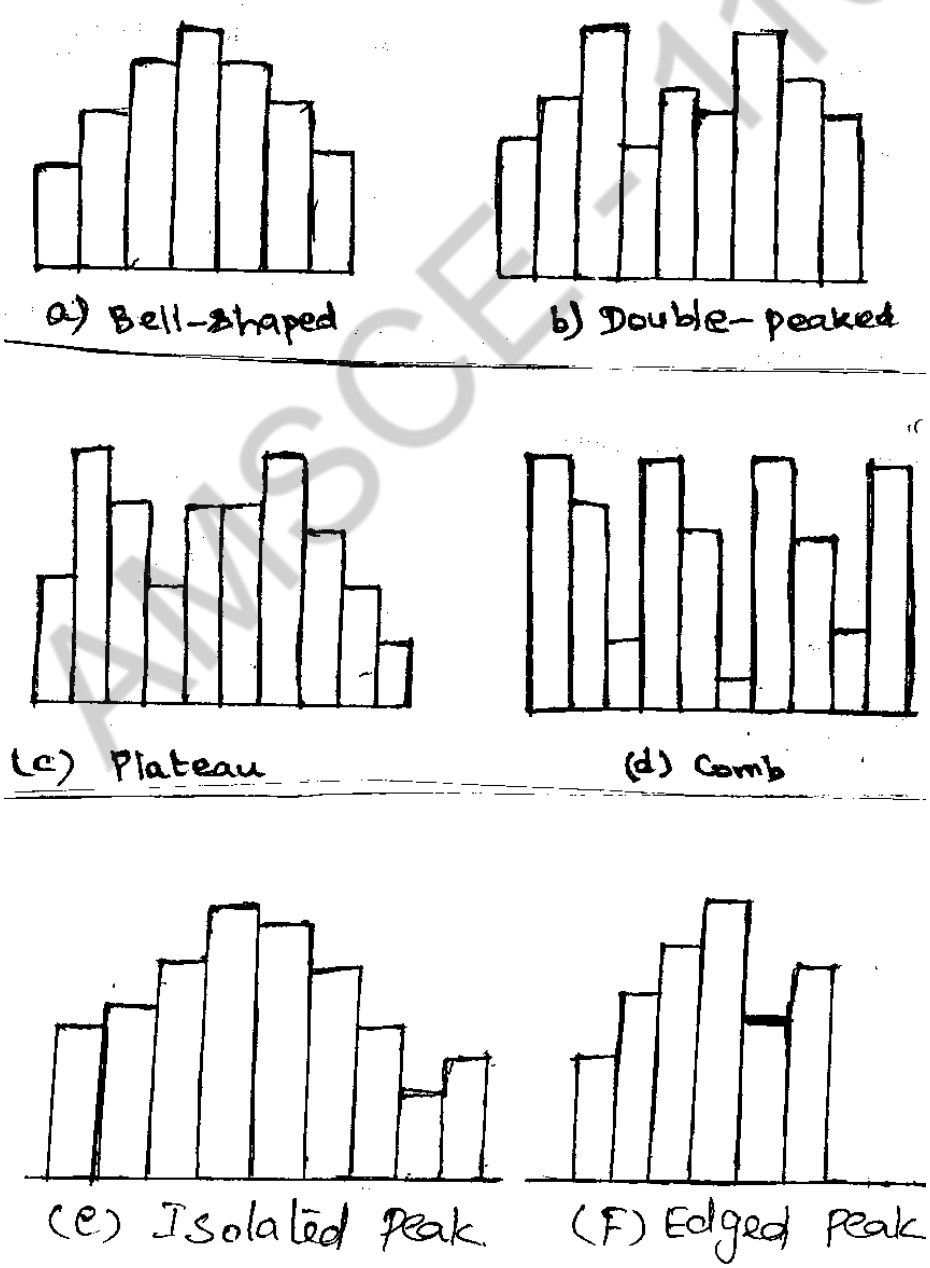
iii. How do we construct it?

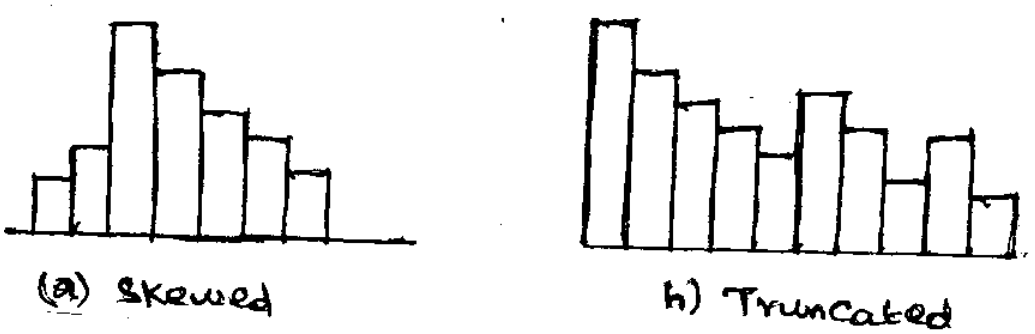
A histogram may be constructed using the following steps:

1. After the data collection, count the number of data values collected.
2. Determine the range of the data.

Range = Highest value – Lowest value

3. Discuss about Types of histograms and their interpretations.





Types of histograms and their interpretations

Shape	Description
Bell-shaped	Symmetrical shape with a peak in middle representing a normal distribution
Double - Peaked	Two normal distribution with two peaks in middle indicating more than one distribution at work
Plateau	Flat top, no distinct peak and tails indicating more than one distribution at work.
Comb	Alternative peaks showing possible errors in data collection and analysis.
Skewed	An asymmetrical shape positively or negatively skewed – usually reflecting limits in the specification on one side.
Truncated	An asymmetrical shape with a peak at the end. Usually being a part of a normal distribution with part of it having been removed.
Isolated peak	Two normal distributions suggesting two processes taking place at the same time.
Edged Peak	A normal distribution curve with a large peak at one end indicating errors in data recoding.

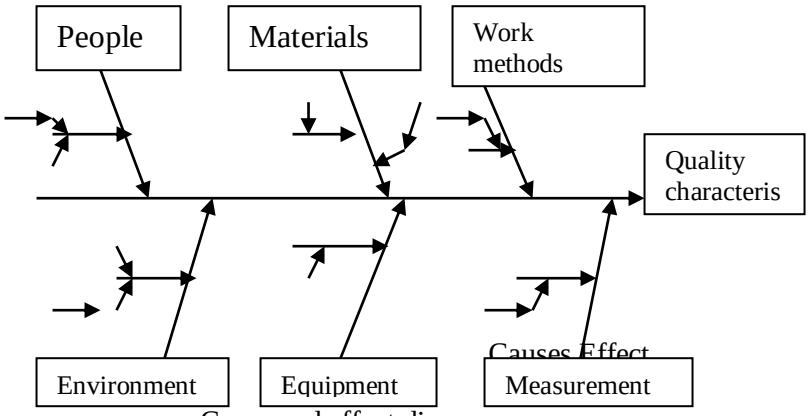
4. Explain the cause and effect diagram (or) fishbone diagram.

What is it?

The cause and effect (CE) diagram is a graphical-tabular chart to list and analysis the potential causes of a given problem.

The cause and effect diagram is also called the fishbone diagram because of its appearance and the Ishikawa diagram after the man who developed it in 1943.

Fig illustrates the basic structure of a cause and effect diagram.



Cause and effect diagram

As shown in fig the diagram consists of a central stem leading to the effect (the problem), with multiple branches coming off the stem listing the various groups of possible causes of the problem.

When do we use it?
The CE diagram has unlimited application in research, manufacturing, marketing, office operations, services and so forth.
The CE diagrams are used:
To analyse cause and effect relationships;
To facilitate the search for solutions of related problems;
To standardize existing and proposed operations; and
To educate and train personnel in decision-making and corrective-action activities.

How do we construct it?
The cause and effect diagram may be constructed using the following steps:

- Define the effect (the problem) clearly and concisely.
- Mark the short description of the effect in a box. Then draw a line from this box towards left.
- List down all the possible minor and major causes through a brainstorming* session.
- Mark the major causes on the branches and minor causes in the sub-branches of the CE diagrams.
- Look for possible solutions for these causes.
- Introduce the changes.

5. Define pareto diagram. Explain how to construct it? Also explain the stratification Analysis.
PARETO DIAGRAM
What is it?

- ***A Pareto diagram*** is a diagnostic tool commonly used for separating the vital few causes that account for a dominant share of quality loss.
- This tool is named after Wilfred Pareto, the Italian economist, who devised this tool first.
- The Pareto diagram is based on the ***Pareto Principle,*** which states that few of the defects account for most of the effects.
- Pareto analysis is also called as ***80/20 rule*** and as ***ABC analysis.*** It means only 20% of problems (defects) account for 80% of the effects.
- This analysis is a method of classifying items, events or activities according to their relative importance.

When do we use it?
Pareto analysis can be used in a wide range of situations where one need to priorities problems based on its relative importance.
It can be used as a risk assessment technique from activity level to system level.
How can we construct it?
A Pareto diagram can be constructed using the following steps:

- Obtain data, using a check sheet or brainstorm.
- Arrange the data in descending order starting from the largest category to smallest.
- Calculate the total and percentage of the total that each category represents.
- Compute the cumulative percentages.

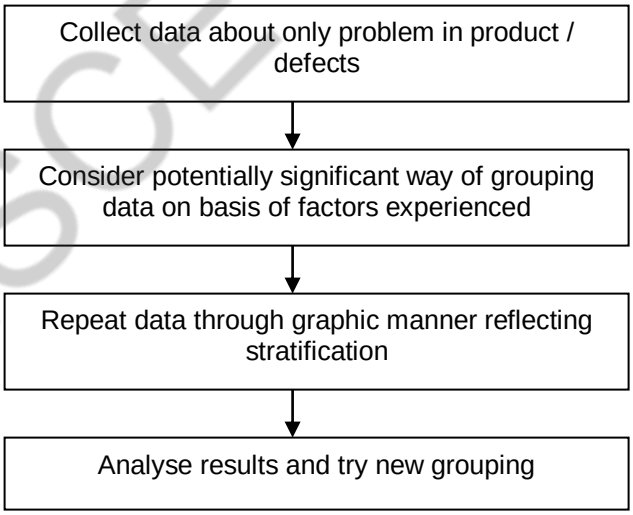
- Draw a bar chart with two vertical axis, mark the measured values for each cause, starting from zero till the total number of causes. The right vertical axis should have the same height and should go from 0 to 100%. This axis displays the cumulative percentages. List the different kinds of causes along the horizontal axis, from left to right in descending order of frequency or costs.
- Draw a bar above each item whose height represents the number for that cause.
- Plot a cumulative percentage line.
- Now draw a horizontal line from 80% (on the right vertical axis) to the left till the point of intersection with the cumulative line, and then draw a vertical line from this intersection down wards till the horizontal axis. Left from this intersection point are the 20% of causes (the most essential bottlenecks) which causes 30% of the damages.

STRATIFICATION ANALYSIS

What is it?

- ***Stratification*** is a method of analysis of data by grouping it in different ways.
- Literally, stratification means segregating a group of measurements, observations or any other data into several sub-groups on the basis of certain characteristics. These stratified data are used for identifying the influencing factors.
- Machines, suppliers, operators, tools gauges or time-dependent sources like shifts, prepost lunch, start or end of shifts, etc., are strata with respect to which the study of various is conducted for diagnosis and possible control/prevention of variations.
- Thus stratification is a simple, very effective QC tool for improving the quality.

Stratification *Analysis procedure*



6. Define the scatter diagram. Mention its types.

SCATTER DIAGRAM

What is it?

- ***The scatter diagram*** is a simple graphical device to depict the relationship between two variables.
- A scatter diagram is composed of a horizontal axis containing the measured values of one variable (independent, i.e., cause) and a vertical axis, representing the measurements of the variable (dependent, i.e., cause) and a vertical axis, representing the measurements of the variable (dependent, i.e., effect).
- This diagram display the paired data as cloud of points. The density and direction of the cloud indicate how the two variables influence each other.

- Although this diagram cannot prove that one variable causes the other, but they do indicates the existence of a relationship as well as the strength of that relationship.

Types of Scatter Diagram Patterns

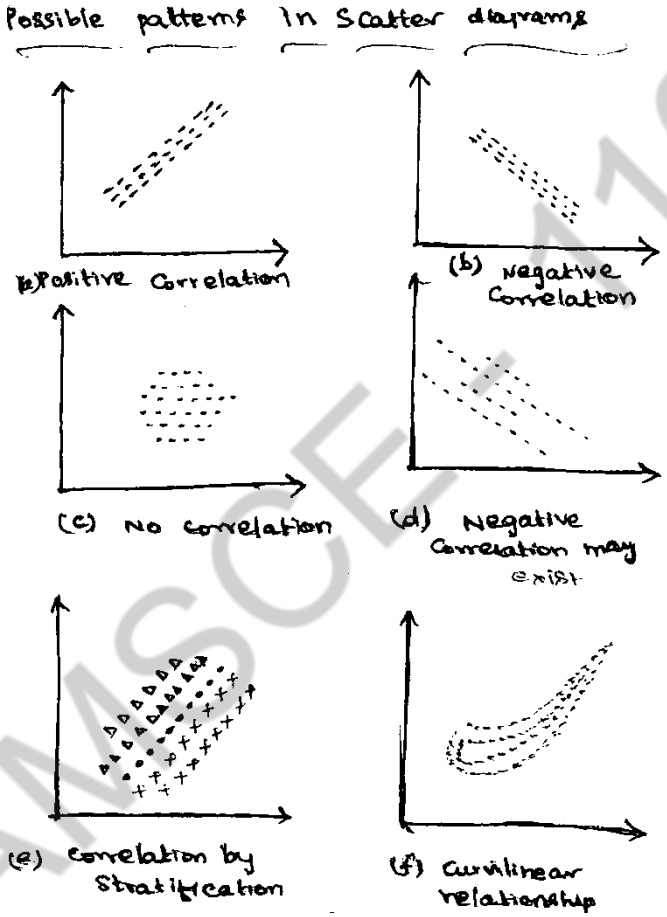
The possible patterns i.e., shapes of clouds are depicted in Fig.(a) to (f).

When do we use it?

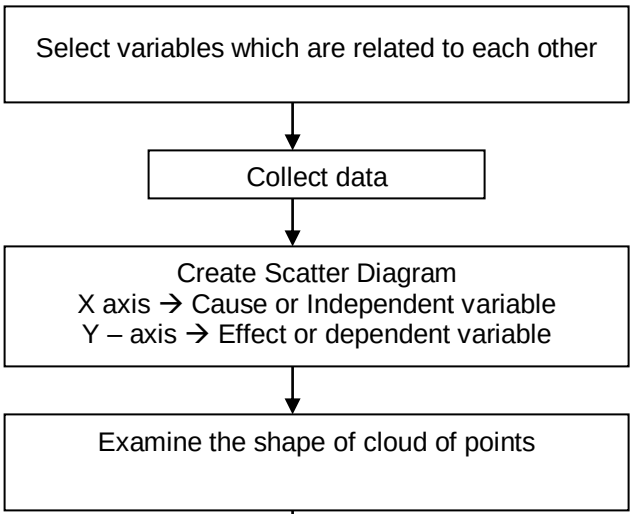
- The purpose of the scatter diagram is, therefore, to display what happens to one variable when another variable is changed.
- This diagram is used to understand, why particular variations occur and how they can be controlled.

How do we construct it?

The sequence of steps used to construct the scatter diagram is outlined in Fig. 6.10.



Construction of a Scatter Diagram

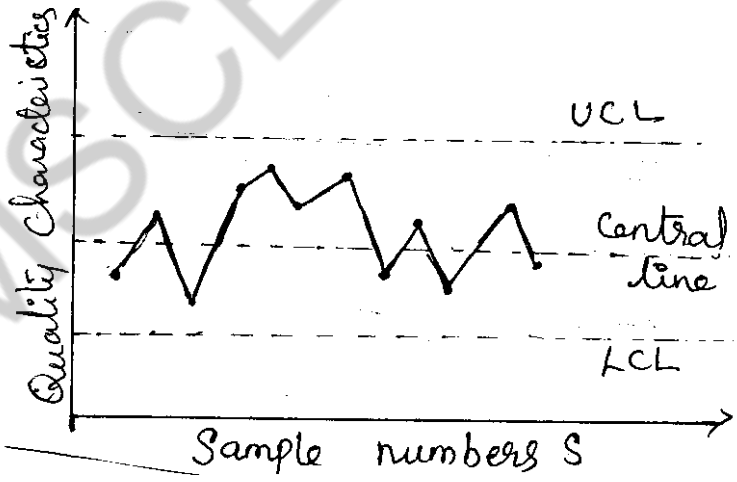


7. Define a control chart (or) Shewhart chart.

CONTROL CHART

What is it?

- ***A control chart,*** invented by Walter A. Shewhart, is the most widely used tool in statistical process control (SPC).
- A control chart is a graph that displays data taken over time and the variations of this data.
- A histogram gives a static picture of process variability, whereas a control chart illustrates the dynamic performance (i.e., performance over time) of the process.
- The control chart is based on a series of random samples taken at regular intervals.
- The general form of the control chart is shown in Fig. 6.11.



The chart consists of three horizontal lines that remain constant over time: a center a lower control limit (LCL), and on upper control limit (UCL). The center is usually set at the normal design value. The UCL and LCL are generally set at +3 standard deviations of the sample means.

If a sample drawn from the process lies inside these (UCL and LCL) limits, it means ***the process is in control.*** On the other hand, if the sample lies outside these limits, then the process is said to be out of control. So appropriate corrective action is necessary to eliminate the condition.

Type of Control Charts
The two basic types of control charts are:
Control charts for variables* **-** for measurable data such as time, length, temperature, weight, pressure, etc.
Control charts for characteristics*- for quantifiable data such as number of defects, typing error in a report, etc.

When do we use it?
The purpose of a control is to identify when the process has gone out of statistical control, thus signaling the need for some corrective action to be taken.

8. Briefly discus the seven book of quality.

ANS: Please refer the answer from question no (1) to (6) fully.

9. Compare the variable charts and Attribute charts.

Comparison of three types of control charts

Statistical measure plotted	**Average $\bar{X}$ and range R**	**Percentage non-conforming (p)**	**Number of non-conformities (c)**
Types of data required	Variable data (measured values of a characteristic)	Attribute data (Number of defective units of product)	Attribute data (number of defects per unit of product)
General field of application	Control of individual characteristics	Control of overall fraction defective of a process	Control of overall number of defects per unit
Significant advantages	Provides maximum utilization of information available from data Provides detailed information on process average and variations for control of individual dimensions	Data required are often already available from inspection records. Easily understood by all personnel. Provides an overall picture of quality.	Same advantages as p-chart but also provides a measure of defectiveness.
Significant disadvantages	Not understood unless training is provided, can cause confusion between control limits and tolerance limits. Cannot be used with go/no go type of data.	Does not provide detailed information for control of individual characteristics. Does not recognize different degrees of defectiveness in units of product.	Does not provide detailed information for control of individual characteristics.
Sample size	Usually 4 or 5	Uses given inspection results for samples of 25, 50 or 100	Any convenient unit of product such as 50 m of wire or one computer set.

10. Explain briefly the concept of Six Sigma.

WHAT IS SIX SIGMA?

- **Six sigma** stands for six standard deviation from mean (sigma is the Greek letter used to represent standard deviation in statistics).
- Six sigma, similar to Zero Defect (ZD), is a philosophical benchmark or standard of excellence proposed by Philip Crosby.
- Six sigma methodology provides the techniques and tools to improve the capability and reduce the defects in any process.
- It was started by Motorola in 1987, in its manufacturing division.
- Six sigma strives for perfection. **It allows for only 3.4 defects per million opportunities (or 99.999666 percent accuracy).** Here a defect can be anything from a faulty party to an incorrect customer bill.
- Six sigma improves the process performance, decrease variation and maintains **consistent quality** of the process output. This leads to defect reduction and improvements in profits, product quality and customer satisfaction.
- Six sigma incorporates the basic principles and techniques used in business, statistics and engineering.

The objective of six sigma principle is to achieve zero defects products/process. It allows 3.4 defects per million opportunities.

WHY DO WE NEED SIX SIGMA?

(Three sigma qualities are not enough. Why?)

We know that, the three sigma quality, i.e., the natural variability ($\bar{x} \pm 3\sigma$) is equal to tolerance (= upper specification limit – lower specification limit). It means, in normal distribution curve, only 0.27% of the output would be expected to fall outside the specifications limits.

The real meaning of 3σ concept: A medium aircraft consists of 10,000 different parts. At 3σ quality, 27 of those parts in an assembled aircraft would be defective. So three sigma quality level cannot be accepted as good enough quality level. So we have to increase the sigma level (i.e., reducing the number of defectives). In fact, even four sigma quality also not sufficient for the aircraft case. That's why six sigma quality level is preferred than 3σ and 4σ quality levels.

THE CONCEPT OF SIX SIGMA

Before studying the concept of six sigma, first let us re-introduce the concept of process capability ratio (C_p)

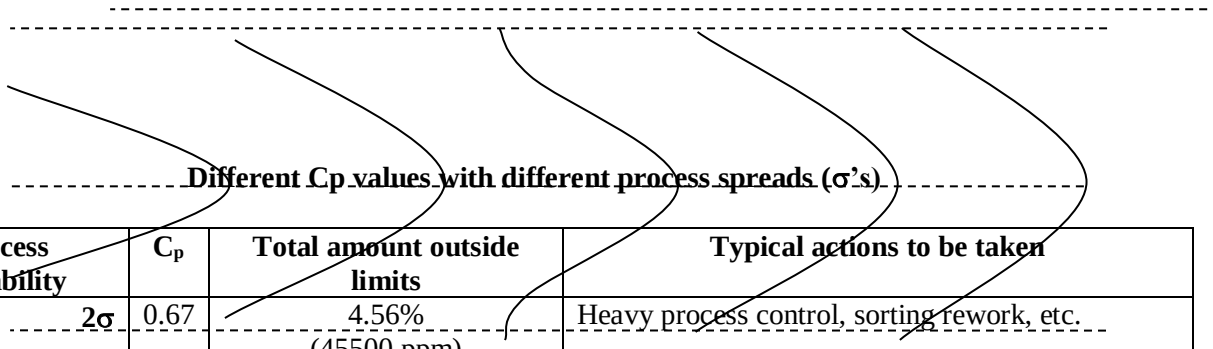
Process capability ratio,

$$C_p = \frac{\text{Design width}}{\text{Process width}} = \frac{USL - LSL}{UCL - LCL}$$

USL = Upper Specification Limit;
LSL = Lower Specification Limit,

(Assumption is that process is centered midway the specification limits, i.e., there is no shift in process mean)

Process capability ratio measures how well the product requirements match with the process capabilities. The higher the value of Cp' the better the match between product and process.



Different Cp values with different process spreads (σ's)

Process variability	C_p	Total amount outside limits	Typical actions to be taken
2σ	0.67	4.56% (45500 ppm)	Heavy process control, sorting rework, etc.
3σ	1.0	2700 ppm	Heavy process control, inspection
4σ	1.33	64 ppm	Reduced inspection, selected use of control charts
5σ	1.67	1 ppm	Spot checking, selected use of control charts
6σ	2	0.001 ppm	Reduced need for control, uniformity in process inputs

USL - Upper Specification Limit LSL – Lower Specification Limit

11. Describe the new seven management tools in detail.

MANAGEMENT TOOLS

Why?

It is a simple and effective tool. This approach focuses on the process (to reveal the causes), rather than the people.

Example: Why was there a delay in dispatch of good?
Cutting tool failed, resulting in delay in manufacture.
Why? The tools were reused?
Why? Ordered tool were not delivered?
Solution changes the dispatch schedule, if ever the tools were not delivered.

Forced Field Analysis

Readers' attention is invited to the discussion in Chapter 2 on this topic.

Nominal Group Technique

This technique provides for ideas input from every one in the team and for effective decision making.

A team wants to decide upon a current complaint to attend. Every one in the team writes the problem on a paper, what they think is most important. They are listed in a chart and then the team members are asked to rank, from most important to least important. The ranking are given a numerical value starting from, say, on a 10 to 1 scale. Points for each problem is totaled and the ones with highest number of points, is considered o be the most important.

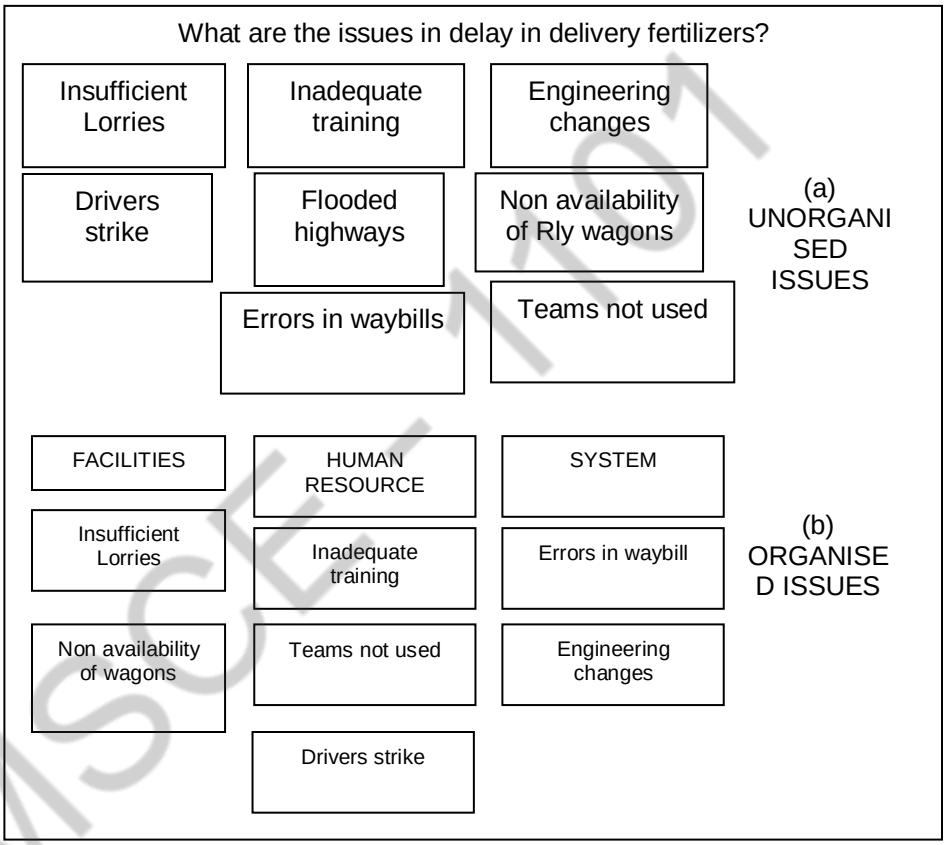
MANAGEMENT AND PLANNING TOOLS

Affinity Diagram

This diagram permits the team to creatively generate large number of ideas and then group them logically for understanding and possible solutions.

In this procedure, the issue is stated in full, then brainstormed using short sentences, posted them for the team to see. The ideas are sorted into logical groups and finally brief headings for each group are identified. The affinity diagram encourages team creativity, break down barriers, promote breakthroughs and motivate ownership of the process. Figure shows a typical example of this approach.

Affinity diagram



Inter-Relationship Diagram

This method is useful in clarifying the relationship in complex situations. The team will be able to classify the cause and effect relationship, so that the key elements can be used to solve the problems.

Steps:

The team agrees on the statement of the problem.

Different ideas or issues from other methods are initially listed and named with alphabets, A B etc.

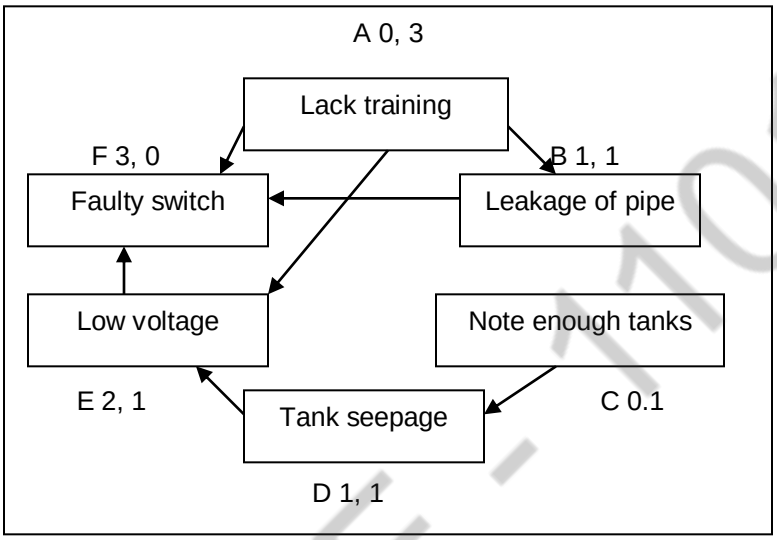
Begin with the issue A, and evaluate the cause and effect relationship with B. If A is stronger, draw the arrow A to B, by a thick line. Each issue is compared with A, one by one. Draw thick arrows wherever strong influence is identified. In this example, only issues B, E and F have relationship with A. The first trial is now over.

Second iteration is to compare B with issues C, D, E and F. The third step is to compare C with other issues. The fourth is compare issue D with E and F. The fifth step is to compare issue E with F.

The diagram may be reviewed and revised, if necessary.

The incoming and outgoing arrows are recorded as indicated, above the rectangle block. The completed diagram is shown in figure.

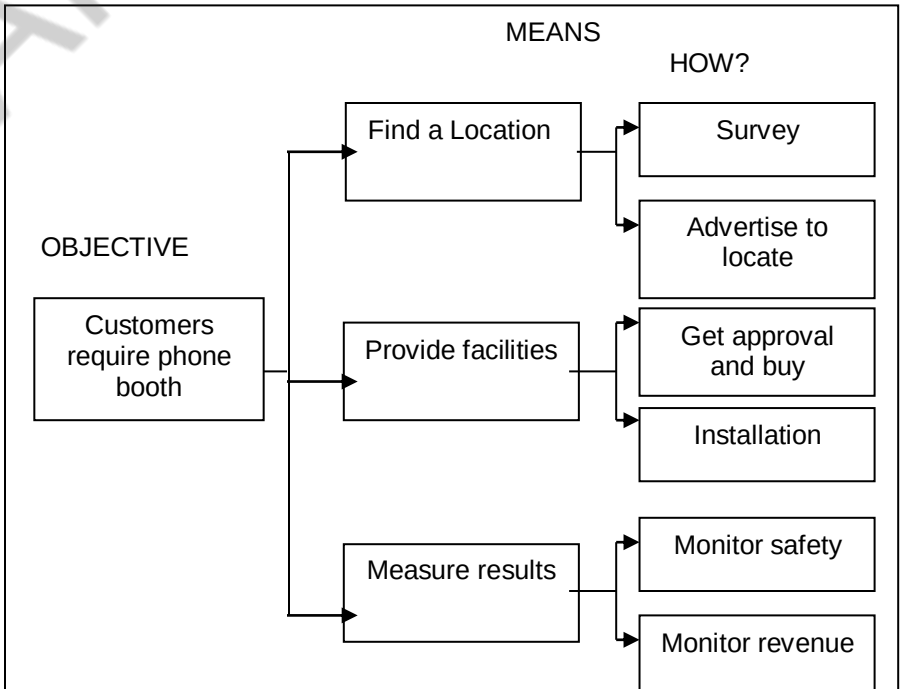
The issue with highest outgoing arrows (A), is the root cause and the issue with highest incoming arrows (F), is the critical issue. This method encourages the team work and effectiveness in identifying major problem and the root cause, to tackles further the problem.



Tree Diagram

In the first step, the objective is traced from the interrelationship diagram, brainstorming and team participation. Using further brainstorming, major means are identified.

In the next step, the next level details are generated for study and solution. The question, "What is need next?" is repeated to two three levels, to complete the diagram. The diagram may be reviewed to find, if any actions are ignored or the action will yield expected results. An example of this approach is shown in figure. The merit of this method is that it encourages the team work and thoroughness.



Tree diagram

Matrix Diagram

The Matrix diagram helps to identify, analyse and rate the relationship among the variables. Data can be presented in tabular form, with numerical values or otherwise. Quality function Deployment, is a typical example of the matrix diagram. The standard formats that are used are: for 2 variables, L shaped; for 3 variables, T shaped, Y shaped and C shaped and for 4 variables, X shaped. L shaped matrix diagram for 2 variables are most frequently used.

Matrix diagram for uses of seven management tools

Tool	Use creativity	Analysis	Consen-sus	Action
Affinity diagram	⊙		O	Δ
Interrelationship diagram			⊙	
Tree diagram		O		
Prioritisation matrix		⊙		⊙
Matrix diagram			O	
Process decision		O	⊙	O
Program chart				
Activity network	⊙	⊙	⊙	O
Diagram			⊙	O

The seven management tools are presented in Table as matrix diagram. The steps involved in its construction are:

select the appropriate format

Determine the relationship symbols. Numerical values may be added when necessary

Complete the matrix, by analyzing each cell and insert appropriate symbol.

The matrix diagram approach encourages lateral thinking by the team, in terms of the relationships, their strengths and patterns.

Prioritization Matrix

In this method the issues, tasks, and characteristics are prioritized, based on weighted criteria, using a combination of tree and matrix diagram techniques. This is the most difficult, of the tools discussed.

Steps:

Construct an L shaped matrix combining the options, which are then lowest level of detail of the tree diagram with the criteria.

Determine the implementation criteria, using the nominal group technique or any other technique, with proper weight age criteria. Each team member submits the most important criteria on a piece of paper. They are listed on as flip chart and the team members submit the rank in another paper, ordering those listed criteria on the chart. Those criteria with greatest value are the most important. Three or four criteria are chosen.

Prioritize the criteria using the NGT. Each team member weighs the criteria so the total weight equals 100%. The results are shown in Table.

Table: Weightage for different criteria

Criteria	Member A	Member J	Member M	Total
Low cost	30	25	35	155
Easy to implement	40	30	30	210
Technology permits	15	20	25	100
Customer preference	20	25	20	110

Using NDT, the options are ranked, in terms of importance by each criterion; the results are averaged, and rounded to the nearest integer.
Compute the option importance score under each criterion, by multiplying the rank by the weight age of criteria. The details are shown in Table. The options with the highest total are those that should be implemented first.

Table: Improvement of a process by consensus criteria method

	CRITERIA						
Options	**Low cost**		**Easy to implement**		**Technology permits**		**Customer preference**	**Total**
1. Train supervisor	10x1.55	+	12x2.10	+	8x1.0	+	9x1.1	58.6
2. Purchase truck	12x1.55	+	8x2.10	+	9x1.0	+	7x1.1	52.1
3. Have teams of 4 men	8x1.55	+	7x2.10	+	10x1.0	+	6x1.1	43.7
4. Training clerks	6x1.55	+	6x2.10	+	8x1.0	+	5x1.1	35.4

Process Decision Program chart

The Process decision program chart avoids unexpected developments and identifies possible counter measures. Figure shows an example of this technique.

Level 1 objective		**Plan Seminar**			
Activities	Call for paper & acceptance	Registration	Conduct Proceedings		Boarding & Lodging
Level 2 What if?	Power Supply fails	Minister arrives Late	Printed proceedings arrived late		Too long Session
	|	|	|	|	|
Level 3 counter Measures	Have a stand by generator	Gave the collector to Inaugurate	Start the session	Send it by Post	Produce the present action

Initially the team states the objective that is to plan a successful industrial seminar. Those activities are listed in the first level, which are, call for papers, screening and acceptance, registration, and conduct proceedings and arranging Boarding and lodging facilities. The activity of conducting the proceedings is explained hereinafter. The team is brainstormed to determine what could go wrong with the seminar proceedings, and these are shown in Level 2 i.e., 'what if level'. Countermeasures are discussed and listed in the last level. Now the countermeasures are evaluated and the optimal ones are selected and marked O, and rejected ones are marked, X, as shown in the figure.

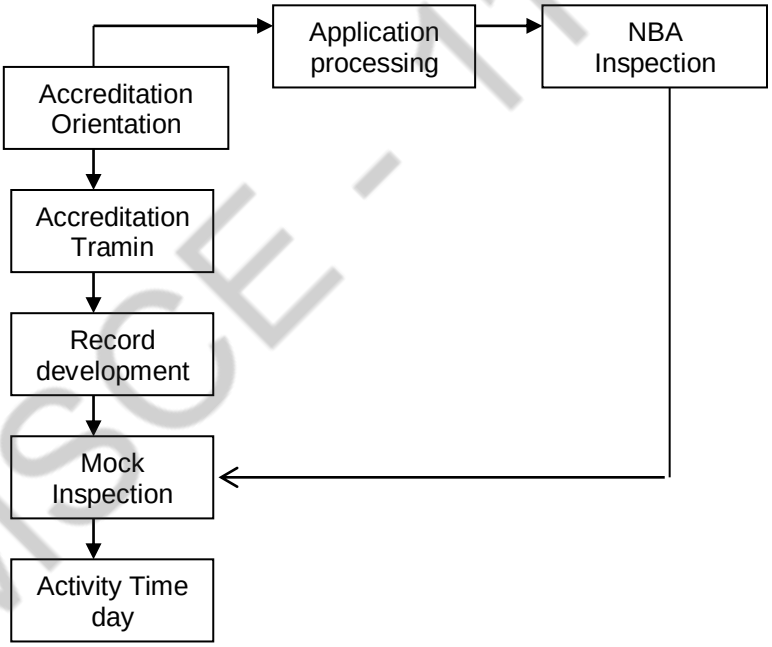
This method is preferred if the task is new or unique, complex, or potential failure has great risks. It provides a means to effectively minimize uncertainty in implementation stage.

Activity Network Diagram

PERT, CPM, and Arrow diagram are the typical variations of this diagram. They allow the team to schedule the project efficiently. The details such as the critical path, project completion time, simultaneous tasks, and precedence relationships are obtained from this diagram.

Steps:

- The team brainstorms or documents all the activities to complete the project.
- The first task is identified and fixed on the extreme left of the board.
- The tasks done simultaneously are placed in parallel.
- Steps (b) and (c) are repeated until all the tasks are located on the board in correct sequence, as shown in figure.
- Number all activities and draw the corresponding arrows. Activity times are recorded in the lower left box. It may be hours, days, weeks or months.
- Find the critical path, after completing the details of box in each activity.



Activity Network Diagram

The critical path is the path along which all the activities are completed in the minimum time. The advantages of this method are:

a. A realistic project execution time is determined.

b. Bottlenecks are identified and when necessary, corrective actions can be planned.

c. Focus is made on the activities lying in the critical path. Time-cost trade off can be worked out, to complete the project earlier, with optimum additional cost.

12. Explain the FAILURE MODE AND EFFECT ANALYSIS (FMEA).

MEANING:

Failure mode and effect analysis also known as risk analysis is a preventive measure to systematically display the causes, effects, and possible actions regarding observed failures.

Objectives of FEMA:

1. The objective of FEMA is to anticipate failures and prevent them from occurring. FEMA prioritizes failures and attempts to eliminate their causes.
2. FEMA is an engineering technique is used to define, identify and eliminate known and or potential failures, problems, errors which occur in the system, design, process and service before they reach the customer.
3. FEMA is a before the event action and is done when existing systems products processes are changed or redesigned.
4. FEMA is a never ending process improvement tool.

Types of FEMA:

1. System FEMA
2. Design FEMA
3. Process FEMA
4. Service FEMA
5. Equipment FEMA
6. Maintenance FEMA
7. Concept FEMA
8. Environmental FEMA

Benefits of FEMA:

1. Improve product/process reliability and quality.
2. Increase customer satisfaction.
3. Early identification and elimination of potential product/process failure modes.
4. Prioritize product or process deficiencies
5. Capture engineering/organization knowledge
6. Document and track the actions taken to reduce risk
7. Provide focus for improved testing and development.
8. Minimize late changes and associated cost.
9. Act as catalyst for teamwork and idea exchange between functions.

Meaning of reliability:

Reliability is one of the most important characteristics of any product, no matter what its application. Reliability is also an important aspect when dealing with customer satisfaction. Whether the customer is internal or external. Customers want a product that will have a relatively long service life, with long times between failures. However, as products become more complex in nature, traditional design methods are not adequate for ensuring low rates of failure. This problem gave rise to the concept of designing reliability into the product itself.

Reliability requirements:

The acceptance of a certain product or process is subject to meeting certain set of given requirements for reliability of the product or process. It is however important to realize that although the definition for reliability is relatively simple, the customer and the supplier may have different definitions of what failure constitute. This common agreement on what constitutes reliability should be defined in terms of influence on other related systems, the complexity of the failure, and finally the relative criticality of the failure.

Failure rate:

A vast majority of products follow a very familiar pattern of failure. When no information is known about the reliability or conversely, failure of a product, component, system or process, except the failure rate which is a constant, periods of failure can conveniently be modeled by an exponential distribution. The failures of most products can be classified in to three main categories: debug, chance, and wear out. The first of these includes a high failure rate at the initial stages because of inappropriate use or flaws in the design or manufacturing. The next category is the failure of the product due to accidents, poor maintenance, or limitations on the design. The final category covers failure after the product or process has performed as expected for at least the amount of time given by the manufacturer as the product or process life. A successful design or process ideally fails only in this method.

13. Explain about STAGES OF FEMA.

The FEMA methodology has four stages: they are:

Stage1: specifying possibilities

1. Functions
2. Possible failure modes
3. Root causes
4. Effects
5. Detection/prevention

Stage 2: quantifying Risk

1. probability of cause
2. severity of effect
3. effectiveness of control to prevent cause
4. Risk priority number

Stage3: correcting High risk causes

1. prioritizing work
2. detailing action
3. assigning action responsibility
4. check points on completion

stage4: re-evaluation of risk

1. Recalculation of risk priority number

STAGES OF FEMA:

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. checks points on completion.
4. Re-evaluation of risk
    A. recalculation of risk priority number

The design of FEMA document:

1. FEMA number
2. item
3. Design responsibility
4. prepared by
5. model number/year
6. key date
7. FEMA date
8. Core team
9. Item function
10. potential failure mode
11. potential effects of failure
12. severity
13. classification
14. potential causes mechanisms of failure
15. occurrence
16. current design controls
17. detection
18. risk priority number
19. Recommend actions Responsibility and target completion dates
20. actions taken

The process of FEMA and documentation

1. process function requirements
2. potential failure mode
3. potential effects of failure
4. severity
5. classification
6. potential causes mechanisms of failure
7. occurrence
8. current process controls
9. detection

14. What is BENCH MARKING? Explain its Types.

MEANING:

Bench marking is the process of determining who is the very best, who sets the standard, and what that standard is. In cricket, one could argue that two consecutive world cup champions made the Australian cricket team the benchmark.

Definition:

American productivity and quality centre has defined the benchmarking as "the process of identifying, understanding, and adopting outstanding practices and process from organizations anywhere in the world to an organization to improve its performance.

DAVID KEARNS defines benchmarking as "the continuous process of measuring products, services and practices against the toughest competitors or those companies recognized as industry leaders."

THORE defines benchmarking as "the systematic comparison of elements of performance of an organization against those of other organizations, usually with the aim of mutual improvement."

Objectives of benchmarking:

1. Benchmarking aims at a goal setting process to facilitate comparison with the best.
2. It aims at motivating and stimulating company employees towards the goal of continuous quality improvement.
3. It aims at external orientation of the company
4. It aims at identifying a technological breakthrough
5. It aims at searching for industry best practices.

Types of Benchmarking

Classification based on the object to be benchmarked:

1. Product Benchmarking: this refers to comparison of different features and attributes of competing products and services.
2. Performance Benchmarking: this refers to comparison of performance indicators related to a business as a whole or to the group of critical activities or processes.

3. Process Benchmarking: this refers to comparison of processes. It identifies a more effective and efficient process to be implemented.

4. Strategic Benchmarking: this refers to examining competitive position in the market place. It helps the company to study the business strategy of another successful business and use the strategy for becoming more competitive.

Classification based on the organizations against whom one is Benchmarking:

1. Internal Benchmarking: it refers to comparison of performance between departments, plants, subsidiaries, within the organization.

2. Industry Benchmarking: It refers to comparison of performance by the organization

3. Competitive Benchmarking: It refers to comparison of performance against direct competitors.

4. Best in class Benchmarking: It refers to comparison of performance with best practices prevalent in an organization irrespective of products and services.

5. Relationship Benchmarking: it refers to comparison of performance with the Benchmarking Company which already has a relationship like customer-supplier relations, joint venture arrangement, etc.

Steps in benchmarking process:

Phase 1**: Planning:**

Step1: What can be benchmarked? (I.e., deciding what to benchmark)
Step2: To whom or what shall we compare (Identifying benchmark partners)
Step3: Determine data collection method and collect data

Phase 2: **Analysis:**
Step4: determine the current performance gap

Step 5: Project future performance levels

Phase 3**: Integration**:
Step6: communicate benchmark findings and gain acceptance.
Step7: **Establish functional goals**

Phase 4**: Action**
Step8: Develop action plans
Step9: Implements specific actions and monitor the progress
Step10: Recalibrate benchmarks

Phase 5: **Maturity:**
Step 11: Attain the leadership position.
Step 12: Integrate practices into the process.

Benefits of benchmarking:

a. . Creating a culture that values continuous improvement to achieve excellence.
b. . Sharing the best practices between benchmarking partners.
c. . Prioritizing the areas that need improvement.
d. . Enhancing creativity by devaluing the not invented here syndrome
e. . Increasing sensitivity to changes in the external environment.
f. .Shifting the corporate mindset from relative complacency to a strong sense of urgency for ongoing improvement.
g. .Focusing resources through performance target set with employee unit.

PITFALLS OF BENCHMARKING:

Bench marking is based on learning from others, rather that developing new and improved approaches. Since the process being studied is there for all to see , therefore a firm will find that benchmarking cannot give them a sustained competitive advantage. Although helpful benchmarking should never be the primary strategy for improvement.

If all the industries employ the benchmarking approach, it will lead to stagnation of ideas, strategies best industry practices, etc. so benchmarking should not be a substitute for innovation. It must be a mere improvement tool.

Unit-IV

1. What are the various approaches to improving reliability of a product?
A. Standardization, redundancy, over-design, de-rating, design simplification, understanding the physics of failure, burn-in, and Failure Mode and Effect Analysis (FMEA).

2. What is Product Life Characteristics Curve?
A. The failure rate curve, called the *product life characteristics curve,* shows the failure rates (failures per unit time) against time. It is also called as *bathtub curve* because of its shape.

3. What are the three stages shown on a Product Life Characteristics Curve?
A. The curve consists of three distinct stages: Early failure (‘infant mortality’ or ‘debug’), useful life (‘normal failure’ or ‘chance’) and wear out (‘old age’) failure. The curve shows that the

failure rates are higher at the early and end stages of a product's life and relatively low in between the two extremes.

4. What is the usefulness of the Product Life Characteristics Curve?
A. Knowing the product life characteristics curve for a particular product helps engineers predict failure behavior and take suitable decisions.

5. What is the essential feature of Total Productive Maintenance (TPM)?
A. TPM is keeping plant and equipment at their highest productive level through cooperation of all areas of the enterprise. TPM brings maintenance into focus as a necessary and vital part of the business. It is not regarded as a non-profit activity. Down time for maintenance is scheduled as an integral part of the manufacturing process.

6. What are the overall goals of TPM (nov/dec 2008)?
A. The overall goals of TPM are: Maintaining and improving equipment capacity. Maintaining equipment for life. Using support from all areas of operation. Encouraging inputs from all employees. Using teams for continuous improvement.

7. What are the different ways of classifying maintenance activities?
A. Maintenance activities can be classified in various ways:
* ***Planned (or preventive) maintenance*** vs. ***Unplanned (or breakdown) maintenance***
* ***Preventive maintenance*** can be sub-classified into *Periodic maintenance and Predictive maintenance*
* ***Running maintenance*** vs. ***Shutdown maintenance***
* ***Time-based maintenance*** vs. ***Condition-based maintenance***

8. What is some performance measures used to assess the success of TPM?
A. Mean Time Between Failures (MTBF), Mean Time To Repair (MTTR), Availability (A), Reliability (R), Maintainability (M), Rate efficiency (RE), Speed efficiency (SE), Performance efficiency (PE), Quality rate (Q), and Overall Equipment Efficiency (OEE).

9. What are the eight pillars of TPM?
A. The eight pillars of TPM are: *[1] 5S, [2] Jishu Hozen (Autonomous Maintenance), [3] Kobetsu Kaizen (KK), [4] Planned Maintenance (PM), [5] Quality Maintenance (QM), [6] Training, [7] Office TPM, and [8] Safety, Health and Environment.*

10. What are the three categories of losses identified in TPM?
A. (A) Losses that impede equipment efficiency (B) Losses that impede human work efficiency and (C) Losses that impede effective use of production resources.

11. What is Office TPM?
A. Office TPM is aimed at improving quality, productivity and efficiency in the administrative functions and identifying and eliminating losses.

12. What is Business Process Reengineering (BPR)?
A. The fundamental rethinking and radical redesign of business processes to improve performance dramatically in terms of measures like cost, quality, service, and speed.

13. What are some key requirements for success in BPR implementation?

A. The key requirements for success in BPR are: (a) fundamental understanding of processes, (b) creative thinking, and (c) effective use of information technology.

14. Distinguish between Kaizen and BPR.
A. Kaizen involves incremental improvements, whereas BPR involves breakthrough improvements. Both are essential for successful implementation of TQM.

15. What are the seven principles of reengineering?
A. 1. Organize around outcomes, not tasks, 2. Those who use the output of the process must perform the process, 3. Merge information processing work into the real work that produces the information, 4. Treat geographically dispersed resources as though they are centralized, 5. Link parallel activities instead of integrating their results, 6. Put the decision point where the work is performed, and 7. Capture information once – at the source.

16. Mention the major steps in BPR implementation.
A. 1. Develop business vision and process objectives. 2. Study the existing procedures. 3. Identify the process for reengineering. 4. Identify customer requirements. 5. Understand the current process. 6. Identify gaps between current process and customer requirements. 7. Evaluate enablers (organizational issues, information technology). 8. Develop improved process. 9. Develop action plan for implementation. 10. Implement the reengineered process. 11. Follow up.

17. What are some factors affecting the success of BPR implementation?
A. (i) Critical/core processes, (ii) Strong leadership, (iii) Cross-functional teams, (iv) Information technology, (v) 'Clean slate' philosophy, and (vi) Process analysis.

18. Mention some major benefits of BPR.
A. 1. Better financial performance, 2. Enhanced customer satisfaction, 3. Cost reduction, 4. Better product/service quality, 5. Increase in productivity, 6. Improved flexibility / responsiveness, 7. Reduced process times, 8. Improved employee participation, 9. Increased competitiveness, 10. Improved delivery performance.

19. Mention some major limitations of BPR.
A. Reengineering involves a great deal of risk. Some major limitations of BPR are: (i) BPR is strong medicine, often resulting in massive layoffs, (ii) It could cause disruptions in existing jobs, management systems, and organizational structures, (iii) It often involves large investments, especially in I.T., (iv) BPR cannot succeed in organizational cultures which are resistant to change, and (v) BPR is not simple or easily done, nor is it appropriate for all processes and for all organizations.

20. What is QFD?
Quality function development may be defined as a system for translating consumer requirements into appropriate requirements at every stage, from research through product design and development, to manufacture, distribution, installation and marketing, sales and service.

PART-B

1. Explain about TAGUCHI'S QUALITY LOSS FUNCTION. (MAY/JUNE 2009)
Taguchi's methods are statistical methods developed largely by Genichi Taguchi to improve the quality of manufactured goods

Taguchi methods are controversial among many convention western statisticians.

Taguchi's principle contributions to statistics are:

1. Taguchi loss function;
2. the philosophy of off-line quality control; and
3. Innovations in the design of experiments.

Taguchi loss function:

Taguchi defines quality as "the loss imparted by the product to society from the time the product is shipped".

This loss includes costs to operate, failure to function, maintenance and repair costs, customer dissatisfaction injuries caused by poor design and similar costs.

Defective products/ parts that are detected repaired reworked or scrapped before shipment are not considered part of this loss.

The essence of the loss function concept is that whenever a product deviates from its target performance it generates a loss to society.

This loss is minimum when performance is right on target, but it grows gradually as one deviates from the target.

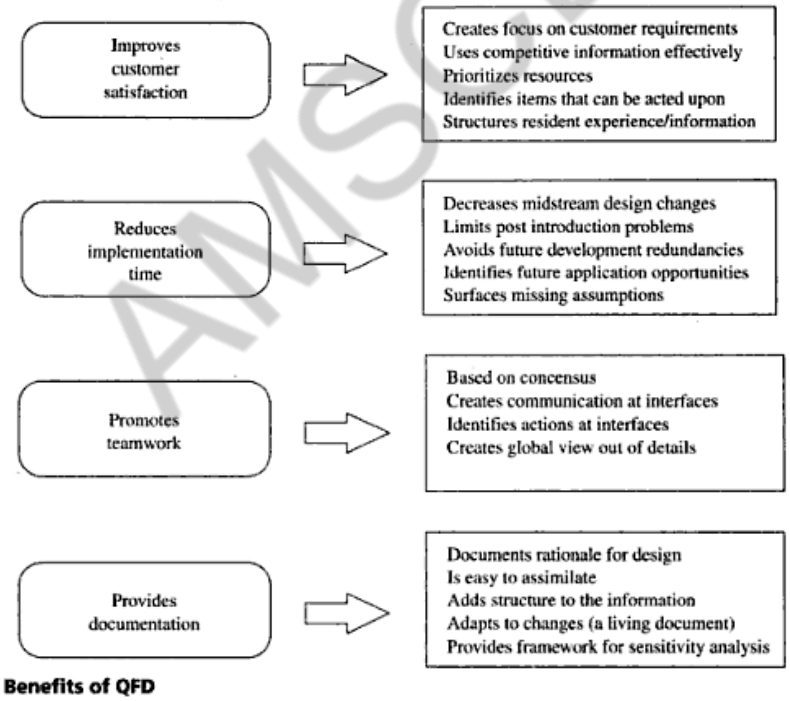
Therefore the loss function philosophy says that for a manufacturer, the best strategy is to produce products as close to the target as possible, rather than aiming at "being"

LOSS FUNCTION:

Taguchi has defined quality as the loss imparted to society from the time a product is shipped. Societal losses include failure to meet customer requirements, failure to meet idea performance, and harmful side effects. Many practitioners have included the losses due to production such as raw material energy and labor consumed on unusable products or toxic by-products.

2. Highlight the benefits of QFD. (Apr /May 2010)

BENEFITS OF QFD:



Benefits of QFD

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. All competitors are evaluated equally from customer and technical perspectives. This information can then be prioritized using a Pareto diagram. Management can then place resources where they will be the most beneficial in improving quality. Also, QFD takes the experience and information that are available within an organization and puts them together as a structured format that is easy to assimilate. This is important when an organization's employee leaves a particular project and a new employee is hired.

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. By using QFD, critical items are identified and can be monitored from product inception to production. Toyota reports that the quality of their product has improved by one-third since the implementation of QFD.

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. This activity avoids misinterpretation, opinions, and miscues. In other words, the left hand always knows what the right hand is doing. Efficiency and productivity always increase with enhanced teamwork.

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. This database also serves as a training tool for new engineers QUALITY function deployment is also very flexible when new information is introduced or things have to be changed on the QFD matrix.

3. Briefly explain the steps involved in QFD (NOV/DEC 2010)

QUALITY FUNCTION DEVELOPMENT PROCESS:

Phase 1: product planning
Step1: list customer requirements
Step2: List technical descriptors
Step3: Develop a relationship between WHATS AND HOWS
Step4: Develop a interrelationship matrix between HOWS
Step5: Do competitive assessments
Step6: Develop prioritized customer requirements
Step7: Develop prioritized technical descriptors.

Phase 2: part development

Step8: Deploy QFD process down to sub-components level both in terms of requirements and characteristics.
Step9: Deploy the component deployment chart. Relate the critical sub-component control characteristics.

Phase 3: process planning

Step10: Develop the relationship between the critical characteristics and process used to create the characteristics

Step11: Develop the control plan relating critical control to critical processes.

Phase 4: production planning

Step 12: Tabulate operating instructions from process requirements
Step13: develop prototype and do testing
Step14: Launch the final product to the market.

4. Explain each section of the basic structures of house of quality. (APR/MAY 2010)

HOUSE OF QUALITY:
The primary planning tool used in QFD is the house of quality. The house of quality converts the voice of the customer into product design characteristics. QFD uses a series of matrix diagrams, also called 'quality tables', resembles connected houses.
Basic structure of house of quality:

1. Customer requirements
2. Prioritized customer requirements
3. Technical descriptors
4. Relationship matrix
5. prioritized technical descriptors
6. Competitive assessments
7. Develop a relationship matrix between WHATS AND HOWS

The parts of the house of QUALITY are described as follows:

The exterior walls of the house are the customer requirements. On the left side is a listing of the voice of the customer, or what the customer expects in the product. On the right side are the prioritized customer requirements, or planning matrix. Listed are items such as customer benchmarking, customer importance rating, target value, scale-up factor, and sales point.

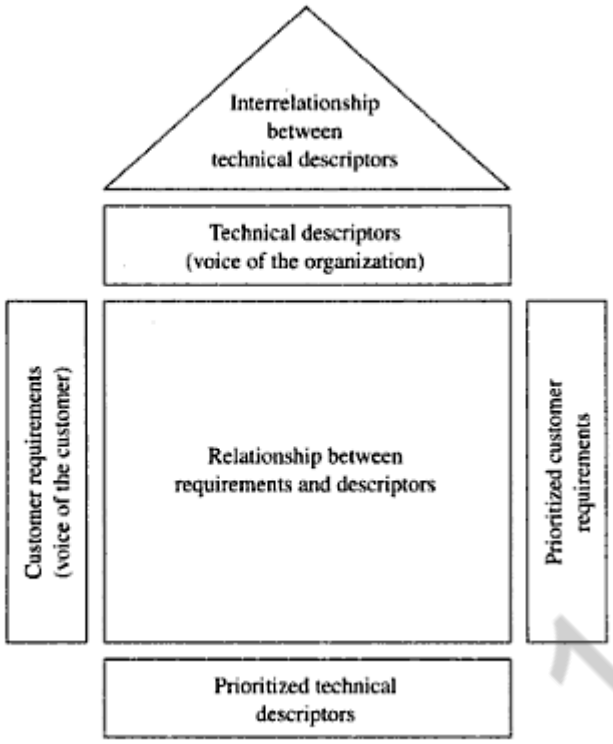
The ceiling, or second floor, of the house contains the technical descriptors. Consistency of the product is provided through engineering characteristics, design constraints, and parameters.

The interior walls of the house are the relationships between customer requirements and technical descriptors. Customer expectations (customer requirements) are translated into engineering characteristics (technical descriptors).

The roof of the house is the interrelationship between technical descriptors. Trade-offs between similar and/or conflicting technical descriptors are identified.

The foundation of the house is the prioritized technical descriptors. Items such as the technical benchmarking, degree of technical difficulty, and target value are listed.

This is the basic structure for the house of QUALITY once this format is understood, any other QFD matrices are fairly straightforward.



House of QUALITY

Constructing the house of quality:

Step1: List customer requirements
Step2: List technical descriptors
Step3: Develop a relationship matrix between HOWS
Step4: competitive assessments
Step5: Develop prioritized customer requirements
Step6: Develop prioritized technical descriptors

4. DISCUSS OBJECTIVES OF QUALITY FUNCTION DEPLOYMENT.

Quality function deployment is a systematic and organized approach of taking customer needs and demands into consideration while designing new products and services or while improving the existing products and services.

Definition:

Quality function deployment may be defined as a system for translating consumer requirements into appropriate requirements at every stage, from research through product design and development, to manufacture, distribution, installation and marketing, sales and service.

OBJECTIVES OF QFD:

1. To identify the true voice of the customer and to use this knowledge to develop products which satisfy customers.
2. To help in the organization and analysis of all the pertinent information associated with the project.
3. Quality function development aims at translating the customers voice into product specifications.

UNIT-V

1. What are the general requirements of quality management system? **(Dec, 2011)**

The organization shall establish, document, implement and maintain a quality management system and continually improve its effectiveness in accordance with the requirements of this International Standard.

The organization shall

a) determine the processes needed for the quality management system and their application throughout the organization

b) determine the sequence and interaction of these processes,

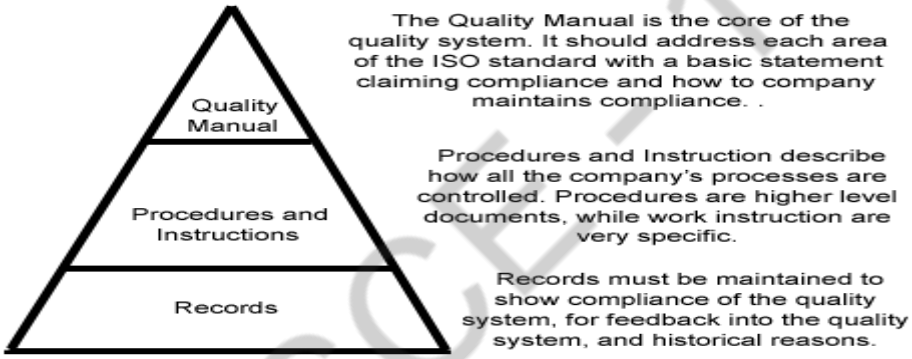
c) determine criteria and methods needed to ensure that both the operation and control of these processes are effective,

d) ensure the availability of resources and information necessary to support the operation and monitoring of these processes,

e) monitor, measure (where applicable), and analyse these processes, and

f) implement actions necessary to achieve planned results and continual improvement of these processes.

2. Draw the documentation pyramid. **(Dec, 2011)**



The ISO 9001 Documentation Pyramid

3. What are ISO 9000 quality standards?

ISO 9000 are a set of quality standards aimed at promoting the growth of international trade by facilitating harmonious interactions between suppliers and customers located in diverse locations globally. It is a quality management system [QMS] to ensure quality of products and services.

4. Define Quality Management Systems?

Quality management systems are the organizational structures, responsibilities, processes, procedures, and resources used for implementing quality.

5. Give any five elements of ISO 9000.

[1] Management responsibility, [2] Quality system, [3] Contract review, [4] Design control, [5] Document control, [6] Purchasing, [7] Purchaser supplied product, [8] Product identification and traceability, [9] Process control, [10] Inspection & testing

6. What are the different types of documents found in ISO 9000?

1) Quality Policy Manual *(What? Why?)*
2) Quality System Procedures *(Who? When? Where?)*
3) Work Instructions *(How?)*
4) Records, formats, forms *(Evidence)*

7. What are the eight quality principles underlying ISO 9000: 2000?
[1] Customer focus, [2] Leadership, [3] Involvement of people, [4] Process approach, [5] System approach to management, [6] Continuous improvement, [7] Decisions based on facts, and
[8] Mutually beneficial supplier relationships.

8. Define quality system audit.
Quality system audits is a systematic, independent examination to determine whether quality activities and results comply with planned arrangements, whether these arrangements are implemented effectively, and whether these are suitable to achieve objectives.

9. What are the different types of audit?
First party audit (internal), Second party audit (by customer), and Third party audit (by independent agency). *Another classification:* System audit, Process audit, Product audit, Adequacy audit, and Compliance audit.

10. What are the different stages in conducting quality audit?
1. Audit planning – schedules, personnel, notifications, checklist.
2. Performance – opening meetings, audit process, noting of non-conformities.
3. Reporting – Observations, suggestions for corrective action
4. Follow-up – implementation of corrective action.

11. What are the quality function needs served by the computer?
[1] data collection, [2] data analysis and reporting, [3] statistical analysis, [4] process control, [5] test and inspection, and [6] system design

12. What are the documentation requirements of quality management systems?
The quality management system documentation shall include
a) documented statements of a quality policy and quality objectives,
b) a quality manual
c)documented procedures and records required by this International Standard, and
d) documents, including records, determined by the organization to be necessary to ensure the effective planning, operation and control of its processes.

13. What is quality manual?
The organization shall establish and maintain a quality manual that includes
a) the scope of the quality management system, including details of and justification for any exclusions
b) the documented procedures established for the quality management system, or reference to them, and
c) a description of the interaction between the processes of the quality management system.

14. Explain the management's responsibility for ISO.
Top management shall provide evidence of its commitment to the development and implementation of the
quality management system and continually improving its effectiveness by
e) communicating to the organization the importance of meeting customer as well as statutory and regulatory
requirements,
f) establishing the quality policy,
g) ensuring that quality objectives are established,

h) conducting management reviews, and
i) ensuring the availability of resources.

15. What is the need for ISO standards?
ISO 9000 is needed to unify the quality terms and definitions used by industrialized nations and use terms to demonstrate a supplier's capability of controlling its processes.

16. What is third party audit? **(Dec, 2010)**
The third party certification audit is carried out much in the same way as first party and second party quality system assessments and audits. However, the big difference is that an independent accredited auditing body carries out the assessment and audit, as opposed to carrying it out by the organization themselves. Also note that the organization going for third party audits are responsible for the payment of the third party audit process.

17. Give the objectives of internal audit.
a) Determine the actual performance conforms to the documented qualitysystems.
b) Initiate corrective action activities in response to deficiencies.
c) Follow up on noncompliance items of previous audits.
d) Provide continued improvement in the system through feedback to management.

18. What is Environment Management Systems Standards?
An EMS meeting the requirements of ISO 14001:2004 is a management tool enabling an organization of any size or type to:

- identify and control the **environmental impact** of its activities, products or services, and to
- **improve** its environmental performance continually, and to
- implement a **systematic approach** to setting environmental objectives and targets, to achieving these and to demonstrating that they have been achieved.

19. What are the benefits of ISO 14001?
• Facilitate trade and remove trade barriers
• improve environmental performance of planet earth
• Build consensus that there is a need for environment management and a common terminology for EMS.

20. What are the requirements of ISO 14001?
i. General requirements
ii. Environmental policy
iii. Planning
iv. Implementation and operation
v. Checking and corrective action
vi. Management review

PART-B

1. Explain the elements of ISO 9000 standards.
• Management responsibility
• The Quality system
• Contract review
• Design control
• Document and data control

• Purchasing
• Control of customer-supplied product
• Product identification and traceability
• Process control
• Inspection and testing
• Control of inspection, measuring and test equipment
• Inspection and test status
• Control of nonconforming product
• Corrective and preventive action
• Handling, storage, packaging, preservation and delivery
• Control of quality records
• Internal quality audits
• Training
• Servicing
• Statistical techniques

2. Discuss about implementation of ISO 9000

Implementation steps

• Top management commitment
• Appoint the management representative
• Awareness
• Appoint an implementation team
• Training
• Time schedule
• Select element owners
• Review the present system
• Write the document
• Install the new system.
• Internal audit
• Management review
• Pre-assessment
• Registration

3. Explain documentation in quality standard.

Documents

- Quality Policy Manual (What?, Why?)
- Quality System Procedures (Who?, When?, Where?)
- Work Instructions (how?)
- Records, Formats, Forms (Evidence)

4. Explain Quality Audits in detail**. (Dec, 2011)**

Quality audit is the process of systematic examination of a quality system carried out by an internal or external quality auditor or an audit team. It is an important part of organization's quality management system and is a key element in the ISO quality system standard, ISO 9001.

- Audit Planning: schedules, personnel, checklist
- Execution – opening meetings, audit process, noting of conformities
- Reporting – observations, suggestions for corrective actions
- Follow-up – implementation of corrective actions
- **Checklist:**

○ Whether system to ensure quality has been established
○ Whether the system is documented

o Whether the documented system meets requirements
o Whether the system implemented is documented
o Whether the system is effective in achieving orgn. objectives & goals

5. Explain ISO 14000 environmental standards.
An EMS meeting the requirements of ISO 14001:2004 is a management tool enabling an organization of any size or type to:

- identify and control the environmental impact of its activities, products or services, and to
- improve its environmental performance continually, and to
- implement a systematic approach to setting environmental objectives and targets, to achieving these and to demonstrating that they have been achieved.

General requirements
• Environmental policy
• Planning
• Implementation and operation
• Checking and corrective action
• Management review

6. Explain the benefits of ISO 9000.
ISO 9000
Fewer on-site audit by customers.
Increased market share.
Improved quality, both internally and externally.
Improve product and service quality levels from suppliers.
Greater awareness of quality by employees.
A documented formal systems.
Reduced operating costs.

7. Explain the benefits of EMS**. (Dec, 2011)**
a. Global
• Facilitate trade and remove trade barriers
• improve environmental performance of planet earth
• Build consensus that there is a need for environment management and a common terminology for EMS.
b. Organizational
• Assuring customers of a commitment to environmental management
• Meeting customer requirements
• Maintaining a good public / community relations image
• Satisfying investor criteria and improving access to capital
• Obtaining insurance at reasonable cost
• Increasing market share that results from a competitive advantage
• Reducing incidents that result in liability