Course Material for Unit - I

Name of the Course : **Total Quality Management**

Name of the Unit : **Introduction to Quality Management**

Name of the Topic : Introduction to the concept of TQM

- Objectives: To understand the Total Quality Management concepts.

1. Outcomes: **Upon successful completion, the student should be able to understand the importance of quality and TQM at managerial level.**

2. Pre-requisites: **To have a basic knowledge of Production Planning and Control.**

1. Inspection, scrap, and repair are examples of _____

A. Internal costs
B. External costs
C. Costs of dissatisfaction
D. Societal costs

2. "Quality is defined by the customer" is

A. An unrealistic definition of quality
B. A user-based definition of quality
C. A manufacturing-based definition of quality
D. A product-based definition of quality

3. Deming's 4 step cycle for improvement is _____

A. Plan, do, check, act
B. Schedule, do, act, check
C. Do, act, check, monitor
D. Plan, control, act, sustain

4. Quality practices must be carried out _____

A. At the start of the project
B. Throughout the life of the project
C. At the end of the project
D. No need to carry out quality practices

5. Elements of quality management system are _____

A. Organizational structure
B. Responsibilities
C. Procedures
D. All the three.

6. Based on his 14 points, Deming is a strong proponent of _____

A. Inspection at the end of the production process
B. An increase in numerical quotas to boost productivity
C. Looking for the cheapest supplier
D. Training and knowledge

7. Costs of dissatisfaction, repair costs, and warranty costs are elements of cost in the _____

A. Taguchi Loss Function
B. Pareto chart
C. ISO 9000 Quality Cost Calculator
D. Process chart

8. Quality management includes forming and directing a team of people to achieve a qualitative goal within an effective cost and time frame that results in _____

A. A project completed in shortest possible time.
B. A product or service that conforms to the required specifications.
C. An award-winning product that brings public recognition to the project.
D. An innovative project that establishes qualification of the project team.

9. Which of the following in not a target of Total Quality Management:

A. Customer Satisfaction
B. Reducing manpower
C. Continuous Cost Reduction
D. Continuous Operational Improvement

10. Juran's quality management philosophy is based on three pillars namely planning, control and _____.

A. Implementation
B. Improvement
C. Monitor
D. Design

3. **Unit Overview**

- This unit is introduction to the concept of TQM and how the top management has to approach and understand the concept.
- TQM must come from the top management and also deals the basic philosophy and difficulties of TQM.
- TQM is defined as both philosophy and a set of guiding principles that represent the foundation of continuously improving organization.
- It is the application of quantitative methods and human resources to improve all the process within the organization and exceed customer needs now and in the future.

4. **TQM Basic Concepts**

- Management Involvement – Participate in quality program, develop quality council, direct participation
- Focus on customer – who is the customer – internal and external, voice of the customer, do it right first time and every time.
- Involvement and utilisation of entire work force – All levels of management.
- Continuous improvement – Quality never stops, placing orders, bill errors, delivery, minimize wastage and scrap etc.
- Treating suppliers as partners – no business exists without suppliers.
- Performance measures – creating accountability in all levels.

5. **Barriers in TQM Implementation**

- Lack of commitment from top management – avoiding training for self and employees, meetings
- Lack of employee involvement – particularly at managerial level, supportive attitude, trust
- Lack of team work – Co-operation and co-ordination within workers.
- Lack of customer oriented approach – Know the customer need, demand, taste, shortcomings
- Lack of attention to feedback and complaints –

- Supplier control – in terms of materials, cost, quality, delivery etc
- Review quality procedures – up gradation, correct past errors. Learn from experience

6. Deming's 14 Points Summarized

- Create **constancy of purpose** and continual improvement
- **Adopt the new (Japanese) philosophy –** by management and workers alike.
- Do not depend on (quality) inspection **– build quality into the product** and process
- **Choose quality suppliers**
- **Improve constantly –** to reduce variation in all aspects
- **Training on the job –** for workers and management.
- **Leadership not supervision –** to get people to do a better job, not just meet targets.
- Eliminate fear – encourage two-way communication, encourage employees
- Break down internal barriers – departments are "**internal customers**"
- Eliminate slogans (exhortations) – processes make mistakes not people.
- **Eliminate numerical targets –** management by objectives not numbers
- Remover barriers to worker satisfaction – including annual appraisals
- **Encourage self-improvement** and education for all
- Everyone is responsible for continual improvement in quality and productivity – particularly top management.

7. Historical Review of TQM

- Industrialization led to mass production in which it led to the concept of one product at a time to the assembly line of production.
- Though workmanship was affected but mass production led to more job and reduction in cost of the product and increase in quality, reduction of defects etc.
- E1924 – After WWI, W.A. Sherwat of Bell Telephone statistical chart for the control of various. Concept of sample tests were followed. It was a failure in the initial stages.

- 1946 – ASQC American Society for Quality Control, now ASQ. Frequent meetings, conferences and publications were made to public.
- 1950 – Edwards Deming's his guidance and lecture to Japan engineers transformed quality concepts in the organization. His cycle ACT-PLAN-DO-CHECK.
- 1954 – Joseph M.Juran Concept of efficient and productive. Juran Trilogy Quality planning – Quality Control – Quality Improvement
- 1960 – Quality control circles was formed. Zero defects concepts
- 1970 – Reactive approach to proactive approach. Shift from Japan to USA
- 1980 – SPC – Statistical Process Control. Concepts of parameter and tolerance. Experiments
- 1990 – Concepts of certification of ISO, CMM etc.,
- 2000 – Six sigma concept - **Six Sigma** stands for Six Standard Deviations (Sigma is the Greek letter used to represent standard deviation in statistics) from mean**. Six Sigma** methodology provides the techniques and tools to improve the capability and reduce the defects in any process.

8. Benefits of TQM

- Improvement in product quality
- Improvement in product design
- Improvement in production flow
- Improvement in employee morale and quality consciousness
- Improvement in product service
- Improvement in market place acceptance

Test after completion

1. Inspection of incoming/outgoing items is an example of _____

A. Prevention cost
B. Appraisal cost
C. Internal failure cost
D. External failure cost.

2. Effective quality improvement can be instrumental in:

A. Increasing productivity
B. Reducing cost
C. Both A and B

D. None of the above

3. Which of the following is responsible for quality objective?

A. Top level management
B. Middle level management
C. Frontline management
D. All of the above

4. Total Quality Management (TQM) focuses on

A. Employee
B. Customer
C. Both (A) and (B)
D. None of the above.

5. The practice of ceasing mass inspections and ending awards based on price is credited to:

A. Edward Deming
B. Philip Crosby
C. Juran
D. Pareto

Conclusion

- Greater accuracy in the evaluation and forecasting of resource use.
- Justification for investment in the prevention and appraisal of failures.
- Ability to cost and compare performance across all departments' functions and activities.
- Identification and prioritization of activities, processes and departments in terms of corrective action, investment, or quality improvement initiatives.
- Ability to set cost-reduction targets and then to measure and report progress.
- Ability to produce "local" data which improves understanding of resource utilization objectives and targets at all levels throughout the company.
- Provision of data to support formal quality management system (including, especially; those based upon the ISO9000).
- Enable decisions about quality to be made in an objective and systematic manner.
- Promoting TQM and a company-wide quality improvement culture.

Demo Videos

http://youtube.com/watch?v=YKwcxjUnots

References

1. DALE H.BESTERFILED, ET AL., "Total Quality Management", Pearson Education, Inc. 2003. (Indian Reprint 2004). ISBN 81-297-0260-6.
2. Feigenbaum. A.V. "Total Quality Management", McGraw-Hill, 1991.
3. ZEIRI, "Total Quality Management for Engineers", Wood Head Publishers, 1991.

Answers to the assignments with full explanation

Assignment 1

1. Total Quality Management is an effective system for integrating the quality development, quality maintenance and quality improvement efforts of various groups in an organization continuously, so as to enable marketing, engineering, production and service at the most economic levels which allow for full customer satisfaction.
2. Quality cost is defined as those costs associated with non-achievement of product or service quality as stated in the requirements established by the organization and with its association to the customers and Society.
3. The term "**trend analysis**" refers to the concept of collecting information and attempting to spot a pattern, or *trend*, in the information. In some fields of study, the term "trend analysis" has more Formally-defined meanings. Although trend analysis is often used to predict future events, it could be used to estimate uncertain events in the past, such as how many ancient kings probably ruled between two dates, based on data such as the average years which other known kings reigned.
4. **Pareto analysis** is a statistical technique in decision making that is used for selection of a limited number of tasks that produce significant overall effect. It uses the Pareto principle - the idea that by doing 20% of work you can generate 80% of the advantage of doing the entire job.
5. Vision statement is a short declaration of what an organization aspires to be tomorrow. It is the ideal state that might never reached but which you continuously strive to achieve.

Course Material

Name of the Course : **Total Quality Management**

Name of the Unit : **Introduction to Quality Management**

Name of the Topic : Introduction to the concept of Quality dimensions and Quality costs

- Objectives: To understand the Total Quality Management concepts.

1. Outcomes: **Upon successful completion, the student should be able to understand the importance of quality and TQM at managerial level.**

2. Pre-requisites: **To have a basic knowledge of Production Planning and Control.**

1. TQM stands for _____

A. Total Quality Management

B. Total Quantity Management

C. Total Qualitative Management

D. To question management

2. After E.deming, who is considered to have the greatest impact in quality management?

A. Kauro Ishikawa

B. Joseph M. Juran

C. W.E. Deming

D. Genichi Taguchi

3. Plan-do-study-act cycle is a procedure to _____

A. Overall improvement

B. Continuous improvement

C. Permanent improvement

D. Immediate improvement

4. Inspection is part of the _____

A. Quality control

B. Quality planning

C. Quality improvement

D. Quality circle

5. According to Deming most of the problems are related to systems and it is the responsibility of the management to improve the systems.

A. Correct

B. Correct to some extent

C. Correct to great extent

D. Taguchi

6. Fourteen points framework for quality and productivity improvement was suggested by _____

A. Crosby

B. Ishikawa

C. Deming

D. Juran

7. Establishing measurements based on customer needs for optimizing product design is known as _____

A. Quality planning

B. Quality improvement

C. Quality control

D. Quality planning

8. Quality fulfills a need or expectation that is:

A. Explicitly stared

B. Implied

C. Legally required

D. All of the above

9. Four basic characteristics of an optimal process are:

A. Economy, efficiency, control, quality

B. Quality, improvement, efficiency, productivity

C. Economy, efficiency, productivity, cost

D. Economy, efficiency, productivity, quality

10. Two major components of fitness of use are Quality of Design and _____

A. Quality of Conformance

B. Quality of Service

C. Quality of Specification

D. Quality of Manufacturing

3. DEFINING QUALITY

Quality can be quantified as follows

Q=P/E

Where

Q = Quality

P = Performance

E = Expectation

DIMENSIONS OF QUALITY:

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

4. QUALITY PLANNING

The following are the important steps for quality planning.

- Establishing quality goals.
- Identifying customers.
- Discovering customer needs.
- Developing product features.
- Developing process features.
- Establishing process controls and transferring to operations.

5. IMPORTANT POINTS TO BE NOTED WHILE QUALITY PLANNING:

- Business, having larger market share and better quality, earn returns much higher than their competitors.
- Quality and Market share each has a strong separate relationship to profitably.
- Planning for product quality must be based on meeting customer needs, not just meeting product specifications.

- For same products. We need to plan for perfection. For other products, we need to plan for value.

6. QUALITY COSTS

- Quality costs are defined as those costs associated with the non- achievement of product/service quality as defined by the requirements established by the organization and its contracts with customers and society. Quality cost is a cost for poor product of service.

ELEMENTS OF QUALITY COST:-

- Cost of prevention
- Cost of appraisal
- Cost of internal failures
- Cost of external failures.

ANALYSIS OF QUALITY COSTS:-

- Trend analysis
- Pareto analysis

1. PREVENTION COST
    - Marketing / Customer / User.
    - Product / Service / Design Development.
    - Purchasing
    - Operations (Manufacturing or Service)
    - Quality Administration.
2. APPRAISAL COST
        - Purchasing Appraisal Costs.
        - Operations Appraisal Costs
        - External Appraisal Costs
        - Review of Test and Inspection Data
        - Miscellaneous Quality Evaluations
3. INTERNAL FAILURE COST
        - Product or Service Design Failure Costs (Internal)

- Purchasing Failure Costs
- Operations (Product or Service) Failure Costs

4. EXTERNAL FAILURE COST

- Complaint Investigations of Customer or User Service
- Returned Goods
- Retrofit and Recall Costs
- Warranty Claims
- Liability Costs
- Penalties
- Customer or User Goodwill
- Lost Sales

ANALYSIS TECHNIQUES OF QUALITY COST

The purpose of quality cost analysis is to determine the cost of maintaining a certain level of quality.

Such activity is necessary to provide feedback to management on the performance of quality assurance and to assist management in identifying opportunities.

INDEX NUMBERS:

Index Numbers are often used in a variety of applications to measure prices, costs (or) other numerical quantities and to aid managers in understanding how conditions in one period compare with those in other periods.

A simple type of index is called a RELATIVE INDEX.

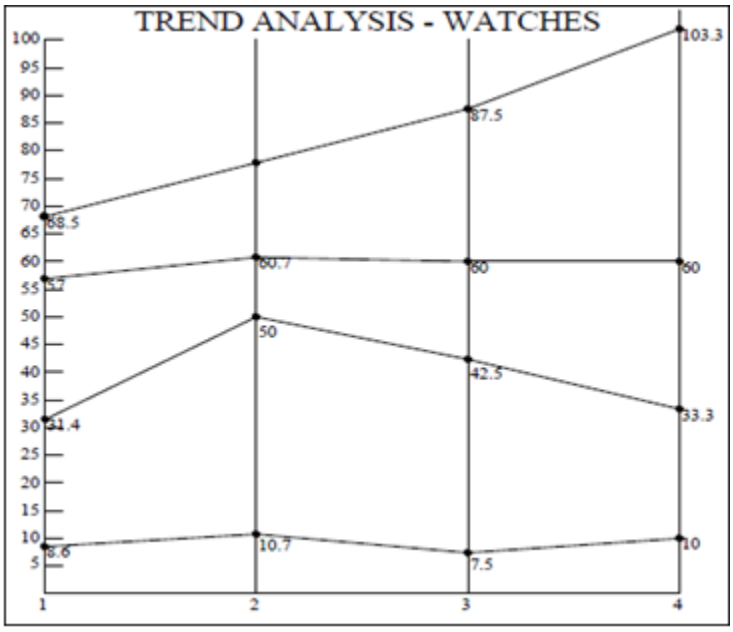
QUARTER	COST IN RS.
1	2000
2	2200
3	2100
4	1900

Cost Index in quarter t = (Cost in quarter t / Base period cost) x 100

QUARTER	COST RELATIVE INDEX
1	(2000/2000) x 100 = 100
2	(2200/2000) x 100 = 110
3	(2100/2000) x 100 = 105
4	(1900/2000) x 100 = 95

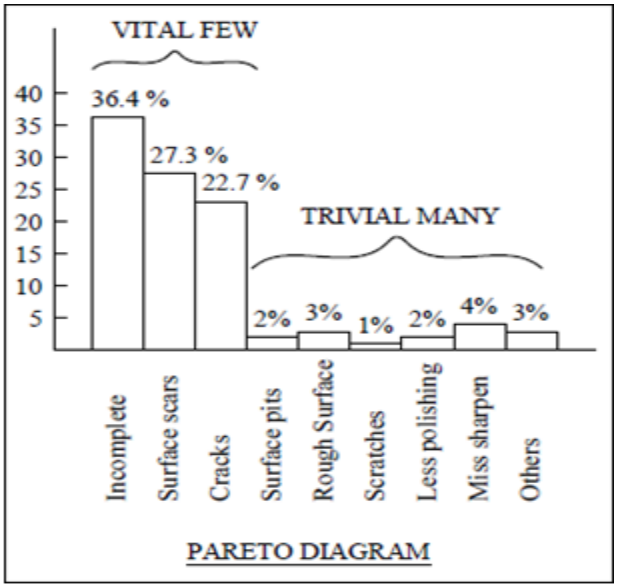
7. TREND ANALYSIS:

- Good visual aids are important communication tools.
- Graphs are particularly useful in presenting comparative results to management.



PARETO ANALYSIS:

- Joseph Juran observed that most of the quality problems are generally created by only a few causes.
- For example, 80% of all internal failures are due to one (or) two manufacturing problems.
- Identifying these "vital few" and ignoring the "trivial many" will make the corrective action give a high return for a low money input.



PRINCIPLES OF TQM:-

- Customer's requirements must be met the first time, every time.
- There must be agreed requirements, for both internal and external customers.
- Everybody must be involved, from all levels and across all functions.
- Regular communication with staff at levels is must. Two way communication at all levels must be promoted.
- Identifying training needs and relating them with individual capabilities and requirements is must.
- Top management's participation and commitment is must.
- A culture of continuous improvement must be established.
- Emphasis should be placed on purchasing and supplier management
- Every job must add value.
- Quality improvement must eliminate wastes and reduce total cost.
- There must be a focus on the prevention of problems.
- A culture of promoting creativity must be established.
- Performance measure is a must at organization, department and individual levels. It helps to asses and meet objectives of quality.
- There should be focus on team work.

Test after completion

1. _____ are the areas that will be covered by the organization's processes.

A. Process areas
B. Product areas
C. Private areas
D. Preset areas

2. Quality fulfills a need or expectation that is:

A. Explicitly stared
B. Implied
C. Legally required
D. All of the above

3. Ease of repair is associated with _____ dimension of quality.

A. Serviceability
B. Performance
C. Durability
D. Perceived

4. Two major components of fitness of use are Quality of Design and _____

A. Quality of Conformance
B. Quality of Service
C. Quality of Specification
D. Quality of Manufacturing

5. According to Deming, Quality problems are

A. Due to management
B. Due to method
C. Due to machine
D. Due to material

Conclusion

Difficulties in using Quality costing

- Quality costing is demanding
    - It requires a lot of data of each activity related to quality

Other limitations

- Does not resolve quality problems
- Does not provide specific actions
- vulnerable to short-term mismanagement
- difficult to match effort and accomplishment
- subject to measurement errors
- may neglect important or include inappropriate costs

Demo Videos

http://youtube.com/watch?v=ZqisrzvVi_8

References

1. DALE H.BESTERFILED, ET AL., "Total Quality Management", Pearson Education, Inc. 2003. (Indian Reprint 2004). ISBN 81-297-0260-6.
2. Feigenbaum. A.V. "Total Quality Management", McGraw-Hill, 1991.
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Answers to the assignments with full explanation

Assignment 2

1. **Quality** – When a product or service meets or exceeds expectation considering the intended use and the selling price.

Quality = performance / expectation

2. Definition by ISO 9000:2000 It if defined as the degree to which a set of inherent characteristics fulfils requirement.

Degree – good, excellent, bad

Inherent – existing, within, natural

Requirement – need or expectation.

3. Quality planning - Identifying customers both internal and external and determining the need and developing product features. Setting goals and objective – Goals are long term objectives are short term.

4. Pareto analysis is a formal technique useful where many possible courses of action are competing for your attention. In essence, the problem-solver estimates the benefit delivered by each action, then selects a number of the most effective actions that deliver a total benefit reasonably close to the maximal possible one.

5. TQM is defined as both philosophy and a set of guiding principles that represent the foundation of continuously improving organization. It is the application of quantitative methods and human resources to improve all the process within the organization and exceed customer needs now and in the future.

Course Material

Name of the Course : **Total Quality Management**

Name of the Unit : **Introduction to Quality Management**

Name of the Topic : Introduction to the concept of Leadership and Quality council

- Objectives: To understand the Total Quality Management concepts.

1. Outcomes: **Upon successful completion, the student should be able to understand the importance of quality and TQM at managerial level.**

2. Pre-requisites: **To have a basic knowledge of Production Planning and Control.**

1. Effective quality improvement can be instrumental in:

E. Increasing productivity

F. Reducing cost

G. Both A and B

H. None of the above

2. Total Quality Management (TQM) focuses on

E. Employee

F. Customer

G. Both (A) and (B)

H. None of the above.

3. 80% of the problems are found in 20% of the work is a concept of:

A. Edward Deming

B. Philip Crosby

C. Juran

D. Pareto

4. All of the following are the elements of a TQM system EXCEPT:

A. Leadership

B. Communications

C. Measurement
D. Detentions
5. Crosby's approach to management is
A. A problem that can never be solved
B. Absolutes of Quality Management
C. Interim Management
D. ISO

6. The practice of ceasing mass inspections and ending awards based on price is credited to:
E. Edward Deming
F. Philip Crosby
G. Juran
H. Pareto

7. Nonconformance is an expense of:
A. Profit of quality
B. Defects of quality
C. Quality of product
D. Cost of quality

8. Which of the following document(s) is (are) included in the quality system?
A. A quality policy
B. Customer focus
C. Commitment
D. All of the given options

9. The overall intentions and direction of an organization with regard to quality as formally expressed by top management is a:
A. Quality Plan
B. Quality Statement
C. Quality Policy
D. TQM
10. Which of the following is not considered a cost of nonconformance to quality?
A. Scrap
B. Rework
C. Expediting
D. Process control

3. **LEADERSHIP:-**

"Leadership is lifting of man's visions to higher sights, the raising of man's performance to a higher standard, the building of man's personality beyond its normal limitations".

CHARACTERISTICS FOR LEADERSHIP:-

The customers first.

Value people.

Built supplier partnership.

Empower people.

Demonstrate involvement/commitment.

Strive for excellence.

Explain and deploy policy.

Improve communication.

Promote teamwork.

Benchmark continuously.

Establish system.

Encourage collaboration.

LEADERSHIP ROLES:-

1. Producer role.
2. Director role.
3. Coordinator role roles.
4. Checker role.
5. Stimulator role.
6. Mentor role.
7. Innovator role.
8. Negotiator role.

Leaders

- Shape the Organization's value
- Promote the Organization's value
- Protect the Organization's value and

- Exemplifies the Organization values

4. **CHARACTERISTICS OF QUALITY LEADERS**

1. They give priority attention to external and internal customers and their needs.
2. They empower, rather than control, subordinates.
3. They emphasis improvement rather than maintenance.
4. They emphasis prevention.
5. They emphasis collaboration rather than competition.
6. They train and coach, rather than direct and supervise.
7. They learn from the problems.
8. They continually try to improve communications.
9. They continually demonstrate their commitment to quality.
10. They choose suppliers on the basis of quality, not price.
11. They establish organizational systems to support the quality effort.
12. They encourage and recognize team effort.

5. **LEADERSHIP CONCEPTS:**

A leader should have the following concepts

1. People, Paradoxically, need security and independence at the same time.
2. People are sensitive to external and punishments and yet are also strongly self- motivated.
3. People like to hear a kind word of praise. Catch people doing something right, so you can pat them on the back.
4. People can process only a few facts at a time; thus, a leader needs to keep things simple.
5. People trust their gut reaction more than statistical data.
6. People distrust a leader's rhetoric if the words are inconsistent with the leader's actions.

6. **THE 7 HABITS OF HIGHLY EFFECTIVE PEOPLE:**

1. Be Proactive
2. Begin with the End in mind
3. Put First Things First
4. Think Win – Win

5. Seek First to Understand, then to Be Understood

6. Synergy

7. Sharpen the Saw (Renewal)

7. **ROLE OF SENIOR MANAGEMENT**

1. Management by Wandering Around (MBWA).
2. Strategy of problem solving and decision making.
3. Strong information base.
4. Recognition and Reward system.
5. Spending most of the time on Quality.
6. Communication.
7. Identify and encourage potential employee.
8. Accept the responsibility.
9. To play a role model.
10. Remove road blocks.
11. Study TQM and investigate how TQM is implemented elsewhere.
12. Establish policies related to TQM.
13. Establish “priority of quality‟ and “customer satisfaction‟ as the basic policy.
14. Assume leadership in bringing about a cultural change.
15. Check whether the quality improvement programmes are conducted as planned.
16. Become coaches and cheer leaders to implement TQM.
17. Generate enthusiasm for TQM activities.
18. Visit other companies to observe TQM functioning.
19. Attend TQM training programme.
20. Teach others for the betterment of society and the surroundings.

8. **QUALITY COUNCIL**

A quality council is established to provide overall direction. The council is composed of

- Chief Executive Officer
- Senior Managers

- Coordinator or Consultant
- A representative from the Union

Duties of the council are

- Develop the core values, vision statement, mission statement and quality policy Statement
- Develop the strategic long term plan with goals and Annual Quality Improvement Program with objectives
- Create the total education and training plan
- Determine and monitor the cost of poor quality
- Determine the performance measures
- Determine projects those improve the process
- Establish multifunctional project and work group teams
- Revise the recognition and rewards system

A typical meeting agenda will have the following items

- Progress report on teams
- Customer satisfaction report
- Progress on meeting goals
- New project teams
- Benchmarking report

Within three to five years, the quality council activities will become ingrained in the culture of the organization.

QUALITY STATEMENTS

VISION STATEMENT:

It is a short declaration of what an organization aspires to be tomorrow. Example: Disney Theme Park - Happiest place on earth

Polaroid - Instant photography

Successful visions provide a guideline for decision making.

MISSION STATEMENT

It answers the following questions

Who are the customers?

What we do?

How we do it?

It describes the function of the organization. It provides a clear statement of purpose for employees, customers & suppliers

A simpler mission statement is

—To meet customer's transportation and distribution needs by being the best at moving their goods on time, safely and damage free

- NATIONAL RAILWAYS

QUALITY POLICY STATEMENT:

It is guide for everyone in the organization as to how they should provide products and services to the customers.

Common characteristics are

- Quality is first among equals
- Meet the needs of the internal & external customers
- Equal or exceed competition
- Continuously improve the quality
- Utilize the entire workforce

Test after completion

1. Cost of quality is a concept that includes:

A. The cost necessary for ensuring conformance to requirements
B. The life cycle cost of the project
C. All research and development costs related to the project
D. Only the cost of the quality control function.

2. Tools and techniques used during the Quality Planning process include:

A. Benefit/cost analysis
B. Benchmarking
C. Quality audits
D. A and B

3. Identification of customers and listening to the Voice of Customer (VoC) are a part of:

A. Quality Assurance
B. Quality Planning
C. Quality Control and improvement
D. Quality Execution

4. The focal point of all quality control should be:

A. Price Focus
B. Cost Focus
C. Customer Focus
D. Manufacturing Focus

5. Fourteen points framework for quality and productivity improvement was suggested by _____

A. Crosby
B. Ishikawa
C. Deming
D. Juran

Conclusion

- Leaders establish unity of purpose and direction of the organization. They should create and maintain the internal environment in which people can become fully involved in achieving the organization's objectives.
- Management decides what to produce in terms of Products (goods and / or services).
- Management assigns responsibilities to produce products.
- Management is accountable for effectively using resources to produce Products.

Demo Videos

http://youtube.com/watch?v=L_IOEJr-ie0

References

1. DALE H.BESTERFILED, ET AL., "Total Quality Management", Pearson Education, Inc. 2003. (Indian Reprint 2004). ISBN 81-297-0260-6.
2. Feigenbaum. A.V. "Total Quality Management", McGraw-Hill, 1991.
3. ZEIRI, "Total Quality Management for Engineers", Wood Head Publishers, 1991.

Answers to the assignments with full explanation
Assignment 3

1. "Organizations depend on their customers and therefore should understand current and future needs of the customer, meet customer requirements and strive to exceed customer expectations".
2. TQM has evolved over a period of time through practice and the contribution of principles by various gurus. The whole system is focused towards the customer, who is the basic purpose for which the organization exists.

3. The purposes of quality control is to ensure the process is running in optimal effectiveness, or to ensure that any level of chronic waste inherent in the process does not get worst. Chronic waste, which is a cost of poor quality that can exist in any process, may exist due to various factors including deficiencies in the original planning.

4. Crosby's approach focuses on doing things right the first time and every time. There is no place in his philosophy for differing levels of quality or categories of quality (e.g., high/low, good/poor). He believes there should be no reason for planning and investing in strategies that are designed in case something does not conform to requirements and goes wrong.

5. Quality Measurement: the status of quality should be determined throughout the company. This means establishing quality measures for each area of activity that are recorded to show where improvement is possible, and where corrective action is necessary. Crosby advocates delegation of this task to the people who actually do the job, so setting the stage for defect prevention on the job, where it really counts.

Course Material for Unit - 2

Name of the Course	:	**Total Quality Management**
Name of the Unit	:	**Total Quality Management Principles**
Name of the Topic	:	Introduction to the customer satisfaction and Employee involvement

- Objectives: To practice the TQM principles.

1. Outcomes: **Upon successful completion, the student should be able to practice the relevant quality improvement tools to implement TQM.**

2. Pre-requisites: **To have a basic knowledge of Production Planning and Control.**

1. Customers are primarily concerned with _____
   A. Communication, courtesy and credibility of the sales person
   B. Competence, courtesy and security of the sales person
   C. Competence, responsiveness and reliability of the sales person
   D. Communication, responsiveness, and cleverness of the sales person.

2._____ is about supplying customers with what they want when they want it.
   A. JUT
   B. HET
   C. JAT
   D. JIT

3. Establishing measurements based on customer needs for optimizing product design is known as _____
   E. Quality planning
   F. Quality improvement
   G. Quality control
   H. Quality planning

4. Effective quality control results in:
   A. Increase in customer satisfaction
   B. Lower cost
   C. None of the above
   D. Both A and B.

5. Service Assurance is
   A. Confidence with customer
   B. Customer has trust
   C. Employee has knowledge
   D. All of the above.

6. Which of the following is responsible for quality objective?
   A. Top level management
   B. Middle level management
   C. Frontline management
   D. All of the above

7. Service Assurance is
   A. Confidence with customer
   B. Customer has trust
   C. Employee has knowledge
   D. All of the above

8. While setting Quality objective, _____ to be considered.
   A. Customer need
   B. Organizational need
   C. Supplier need
   D. Worker need

9. The role of management is to
   A. provide Resources
   B. define EMS
   C. monitor the effectiveness of the system
   D. All of the above

10. What does the transcendent view imply for high quality?
    A. It is something everlasting
    B. It is something timeless and enduring
    C. It is something priceless
    D. It is something perfect

3. Customer satisfaction:-

Customer satisfaction, a business term, is a measure of how products and services supplied by a company meet or surpass customer expectation. It is seen as a key performance indicator within business and is part of the four of a Balanced Scorecard.

In a competitive marketplace where businesses compete for customers, customer satisfaction is seen as a key differentiator and increasingly has become a key element of business strategy.

FEEDBACK (INFORMATION COLLECTING TOOLS):

Feedback enables organization to

- Discover customer satisfaction
- Discover relative priorities of quality
- Compare performance with the competition
- Identify customer needs
- Determine opportunities for improvement

Listening to the voice of the customer can be accomplished by numerous information collecting tools.

1. Comment Card
2. Customer Questionnaire

To make surveys more useful, it is best to remember eight points

- Clients and customers are not the same.
- Surveys raise customers' expectations.
- How you ask a question will determine how the question is answered.
- The more specific the question, the better the answer.
- You have only one chance and only 15 minutes.
- The more time you spend in survey development, the less time you will spend in Data analysis and interpretation.
- Who you ask is as important as what you ask.
- Before the data are collected, you should know how you want to analyze and use the data.

Focus Groups

These groups are very effective for gathering information on customer expectations and requirements.

1. Toll – Free Telephone Numbers
2. Customer Visits
3. Report Card
4. The Internet and Computers
5. Employee Feedback
6. Mass Customization.

4. SERVICE QUALITY

Customer service is the set of activities an organization uses to win and retain customer‟ s satisfaction. It can be provided before, during, or after the sale of the product or exist on its own. Elements of customer service are

ORGANIZATION

1. Identify each market segment.
2. Write down the requirements.
3. Communicate the requirements.
4. Organize processes.
5. Organize physical spaces.

CUSTOMER CARE

6. Meet the customer‟ s expectations.
7. Get the customer‟ s point of view.
8. Deliver what is promised.
9. Make the customer feel valued.
10. Respond to all complaints.
11. Over – respond to the customer.
12. Provide a clean and comfortable customer reception area.

COMMUNICATION

13. Optimize the trade – off between time and personal attention.
14. Minimize the number of contact points.
15. Provide pleasant, knowledgeable and enthusiastic employees.
16. Write document in customer friendly language.

FRONT-LINE PEOPLE

17. Hire people who like people.
18. Challenge them to develop better methods.
19. Give them the authority to solve problems.
20. Serve them as internal customers.
21. Be sure they are adequately trained.
22. Recognize and reward performance.
23. Lead by example.
24. Listen to the front-line people.

25. Strive for continuous process improvement.

5. CUSTOMER RETENTION

It means "retaining the customer" to support the business. It is more powerful and effective than customer satisfaction.

For Customer Retention, we need to have both "Customer satisfaction & Customer loyalty". The following steps are important for customer retention.

1. Top management commitment to the customer satisfaction.
2. Identify and understand the customers what they like and dislike about the organization.
3. Develop standards of quality service and performance.
4. Recruit, train and reward good staff.
5. Always stay in touch with customer.
6. Work towards continuous improvement of customer service and customer retention.
7. Reward service accomplishments by the front-line staff.
8. Customer Retention moves customer satisfaction to the next level by determining what is truly important to the customers.
9. Customer satisfaction is the connection between customer satisfaction and bottom line.

6. EMPLOYEE INVOLVEMENT

Employee involvement is one approach to improve quality and productivity.

It is a means to better meet the organization's goals for quality and productivity.

ACHIEVING A MOTIVATED WORK FORCE:

The building of a motivated work force if for the most part an indirect process. Concepts to achieve a motivated work force are as follows:

1. Know thyself.
2. Know your employees.
3. Establish a positive attitude.
4. Share the goals.
5. Monitor progress.

6. Develop interesting work.
    - Job rotation
    - Job enlargement
    - Job enrichment
7. Communicate effectively
8. Celebrate success.

EMPLOYEE SURVEYS:

Employee surveys help managers assess the current state of employee relations, identify trends, measure the effectiveness of program implementation, identify needed improvements, and increase communication effectiveness.

STEP 1: The Quality Council to create a multifunctional team

STEP 2: The Team will develop survey instrument

STEP 3: Administer the survey

STEP 4: Results are compiled and analyzed

STEP 5: Determine areas for improvement.

Employee involvement is creating an environment in which people have an impact on decisions and actions that affect their jobs.

Tell: the supervisor makes the decision and announces it to staff. The supervisor provides complete direction.

Sell: the supervisor makes the decision and then attempts to gain commitment from staff

By "selling" the positive aspects of the decision.

Consult: the supervisor invites input into a decision while retaining authority to make the final decision herself.

Join: the supervisor invites employees to make the decision with the supervisor. The Supervisor considers her voice equal in the decision process. To round out the model, I add the following.

Delegate: the supervisor turns the decision over to another party.

SEVEN RULES OF MOTIVATION

#1 Set a major goal, but follow a path. The path has mini goals that go in many directions. When you learn to succeed at mini goals, you will be motivated to challenge grand goals.

#2 Finish what you start. A half-finished project is of no use to anyone. Quitting is a habit. Develop the habit of finishing self-motivated projects.

#3 Socialize with others of similar interest. Mutual support is motivating. We will develop the attitudes of our five best friends. If they are losers, we will be a loser. If they are winners, we will be a winner. To be a cowboy we must associate with cowboys.

#4 Learn how to learn. Dependency on others for knowledge supports the habit of procrastination. Man has the ability to learn without instructors. In fact, when we learn the art of self-education we will find, if not create, opportunity to find success beyond our wildest dreams.

#5 Harmonize natural talent with interest that motivates. Natural talent creates motivation, motivation creates persistence and persistence gets the job done.

#6 Increase knowledge of subjects that inspires. The more we know about a subject, the more we want to learn about it. A self-propelled upward spiral develops.

#7 Take risk. Failure and bouncing back are elements of motivation. Failure is a learning tool. No one has ever succeeded at anything worthwhile without a string of failures.

7. EMPOWERMENT

Empowerment is investing people with authority. It's purpose is to tap the enormous reservoir of potential contribution that lies within every worker. The two steps to empowerment are

1. To arm people to be successful through coaching, guidance and training.
2. Letting people do by themselves.

The principles of empowering people are given below.

1. Tell people what their responsibilities are.
2. Give authority.
3. Set standards for excellence.
4. Render training.
5. Provide knowledge and information.
6. Trust them.
7. Allow them to commit mistakes.
8. Treat them with dignity and respect. Three dimensions of empowerment are

    Capability

    Alignment and

Trust

Employee involvement is optimized by the use of teams.

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 during which each member of the team subordinates his individual interests and opinions to fulfill the objectives or goals of the group.

WHY TEAMS WORK:

1. Many heads are more knowledgeable than one.
2. The whole is greater than the sum of its members.
3. Team members develop a rapport which each other.
4. Teams provide the vehicle for improved communication.

TYPES OF TEAMS:

1. Process improvement team.
2. Cross – functional team.
3. Natural work teams.
4. Self – Directed / Self – Managed work teams.

COMMON BARRIERS TO TEAM PROGRESS:

- Insufficient training.
- Incompatible rewards and compensation.
- First-line supervisor resistance.
- Lack of planning.
- Lack of management support.
- Access to information systems.
- Lack of Union support.
- Project scope too large.
- Project objectives are not significant. No clear measures of success.
- No time to do improvement work.

RECOGNITION AND REWARD

Recognition is a process by which management shows acknowledgement of an employee‟ s outstanding performance.

Various ways for Recognition and Rewards are

1. Recognition can be expressed using verbal and written praise.
2. Rewards may be in the form of certificates and plaques.
3. Reward is normally in the form of cinema tickets, dinner for family etc.
4. The financial compensation (for recognition) can be paid in terms of increased salaries, commissions, gain sharing etc.
5. The efforts of employees can be recognized by promotions, special job assignments etc.
6. A letter of appreciation from the CEO or the Top Management will increase the employee‟ s involvement.
7. Reward may be delayed but recognition should be in a timely basis.
8. Rewards should be appropriate to the improvement level.
9. People like to be recognized than any reward.
10. Special forms of recognition include pictures on the bulletin board, articles in newsletters, letter to families etc.
11. Supervisors can give on-the-spot praise for a job which is done well.

EFFECTS OF RECOGNITION AND REWARD SYSTEM:

1. Recognition and reward go together for letting people know that they are valuable members for the organization.

2. Employee involvement can be achieved by recognition and reward system.

3. Recognition and reward system reveals that the organization considers quality and productivity as important.

4. It provides the organization an opportunity to thank high achievers.

5. It provides employees a specific goal to achieve.

6. It motivates employees to improve the process.

7. It increases the morale of the workers.

8. PERFORMANCE APPRAISAL

The performance appraisal is used to let employees know how they are performing. The performance appraisal becomes a basis for promotions, increase in salaries, counseling and other purposes related to an employee's future.

IMPORTANCE OF PERFORMANCE APPRAISALS:

1. It is necessary to prevail a good relationship between the employee and the appraiser.

2. Employee should be informed about how they are performing on a continuous basis, not just at appraisal time.

3. The appraisal should highlight strength and weakness and how to improve the performance.

4. Employee should be allowed to comment on the evaluation and protest if necessary.

5. Everyone should understand that the purpose of performance appraisal is to have employee involvement.

6. Errors in performance evaluations should be avoided.

7. Unfair and biased evaluation will render poor rating and hence should be eliminated.

Test after completion

1. The products manufactured during 1800s were unique. How quality was ensured in this era?

A. Through renovation
B. Through inspection
C. Through calculation
D. Through repair

2. In the project environment, the individual ultimately responsible for quality control is:

A. The line workers who must strive "to do things right the first time" to avoid quality problems
B. The company's quality control manager who must work with the project members to ensure the quality control program is effective
C. The head of the production department who retains ultimate quality control responsibility for all the company's projects
D. The project manager who has ultimately responsibility for the entire project

3. The concept of quality is based on:

A. meeting luxury goods standards
B. producing excellent products that are superior to other similar items
C. conforming to the requirements specifications
D. maintaining uniformity of design

4. The primary components of quality management are quality _____.

A. inspections, certifications, and validations
B. philosophy, assurance, and control
C. form, fit, and function
D. reliability, maintainability, and availability

5. Recognition of personnel achievements is an important building block to the attainment of a superior quality program. The form of recognition should be _____.

A. an annual bonus increase paid at the end of the year
B. an immediate cash award that is commensurate with the deed
C. a non-monetary award presented in a public forum as soon as the deed is identified
D. a non-monetary award presented in private

Conclusion

- Productivity improvement (PI) is critical to every organization for survival.
- Every employee should have basic knowledge and skills to contribute to PI.
- Organizations need to have clear PI strategies.
- Successful PI does not ensure long-term profitability nor competitiveness.
- Employee involvement means allowing employees to participate in work-related decisions and improvement activities that affect them.
- This doesn't mean anarchy, but it means that management shares its responsibilities in decision-making with employees.

Demo Videos

http://youtube.com/watch?v=34hrA6qBjHw

References

3. DALE H.BESTERFILED, ET AL., "Total Quality Management", Pearson Education, Inc. 2003. (Indian Reprint 2004). ISBN 81-297-0260-6.
4. Feigenbaum. A.V. "Total Quality Management", McGraw-Hill, 1991.
5. ZEIRI, "Total Quality Management for Engineers", Wood Head Publishers, 1991.

Answers to the assignments with full explanation
Assignment 4

1. **Features of Feedback**

Finds dissatisfaction – dissatisfied customer normal y tend to report and register complaint Priority for quality – Match between organization perceptions of quality to that of customer Comparison with competitors – Evaluation by customers who would have known the competitors. Customer needs – The real needs of customers is known directly from the customer Scope for improvement – Future enhancement in terms of quality.

2. **Service Quality**

Shift in focus from manufacturing industry to service industry and the services involved in manufacturing organization. Customer service is the set of activities an organization uses to win, attract and retain customers. It can be provided before, during and after the sale of the product.

3. **Customer Retention**

- It is the final result of customer satisfaction and customer loyalty
- Most cases what customer says or feels may vary from actual consumption or purchase
- Customer must refer more customers and increase the revenue
- External research must be done to feel the pulse of the customer
- Employee retention is proportional customer retention

4. **Basic Requirement of Internal and External Customers**

- High level of quality – meeting al his needs
- High degree of flexibility – product flexibility
- High levels of service – maximum service
- Low costs – value for money, customers pride is that he has bought for the lowest cost
- Quick response – Less waiting period, demo, billing, packing, delivery
- Little of no variability – minimum deviation from the target and expectation

5. Handling complaints
    1. Investigate the complaint promptly both positive and negative
    2. Develop procedure for complaints, recording, actions to be taken, inform the staffs
    3. Categories the complaints – product, service, cost, ambience etc
    4. Senior managers must have direct involvement
    5. Communicate the process of handling the complaints to al staffs
    6. Provide regular complaints reports – complaints received, decisions taken etc
    7. Identify customer expectations beforehand.

Course Material

Name of the Course	:	**Total Quality Management**
Name of the Unit	:	**Total Quality Management Principles**
Name of the Topic	:	Introduction to the continuous process Improvement.

- Objectives: To practice the TQM principles.

1. Outcomes: **Upon successful completion, the student should be able to practice the relevant quality improvement tools to implement TQM.**

2. Pre-requisites: **To have a basic knowledge of Production Planning and Control.**

1. Assured quality is necessary for building customer confidence.

A. Correct

B. Correct to some extent

C. Correct to great extent

D. Incorrect

2. Plan-do-study-act cycle is a procedure to _____

E. Overall improvement

F. Continuous improvement

G. Permanent improvement

H. Immediate improvement

3. Quality circles work best if employees are initially trained in _____

A. Group dynamics

B. Motivation principles

C. Communications

D. All of the three.

4. Quality Trilogy includes

A. Quality planning

B. Quality improvement

C. Quality control

D. All of the three.

5. Juran's Quality trilogy emphasizes the roles of quality planning, quality control and _____

A. Quality definition
B. Quality enhancement
C. Quality improvement
D. Quality maintenance

6. Quality Circles members are _____

A. Paid according to their contribution to quality
B. External consultants designed to provide training in the use of Quality tools
C. Always machine operators
D. None of the three.

7. Identify the cost not likely to reduce as a result of better quality.

A. Maintenance costs
B. Inspection costs
C. Scrap costs
D. Warranty and service costs

8. Kaizen is a Japanese term meaning _____

A. Continuous improvement
B. Just-in-time (JIT)
C. A fishbone diagram
D. Setting standards

9. The _____ is used to identify what might go wrong in a plan under development.

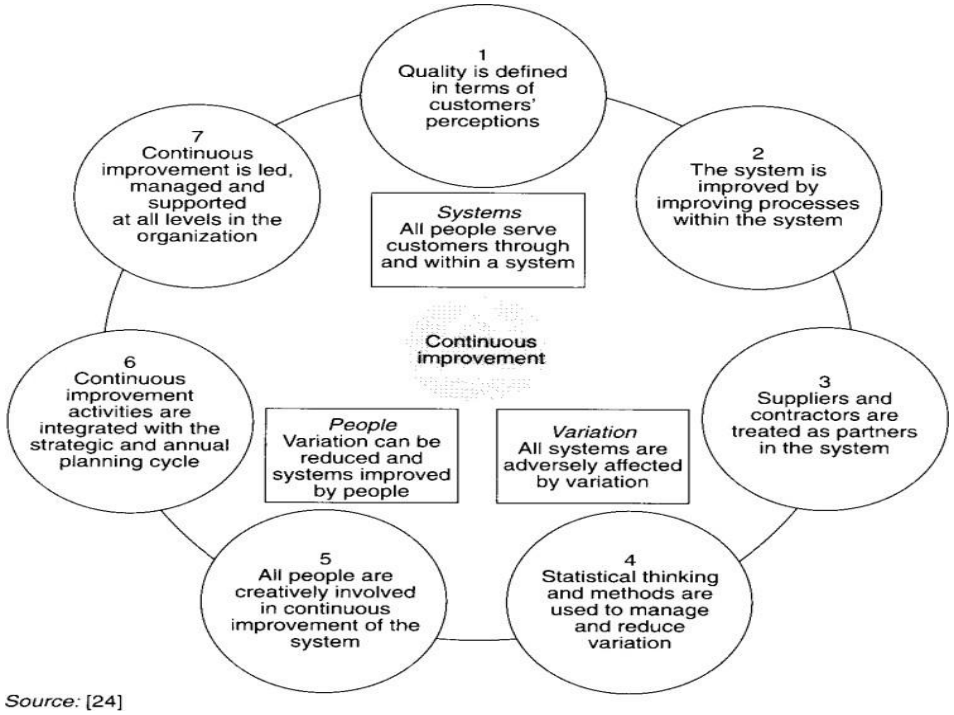
A. Pareto Chart
B. PDPC
C. Arrow Diagram
D. Matrix Diagram

10. Juran's quality management philosophy is based on three pillars namely planning, control and _____.

E. Implementation
F. Improvement
G. Monitor
H. Design

3. CONTINUOUS PROCESS IMPROVEMENT

Continuous process improvement is designed to utilize the resources of the organization to achieve a quality-driven culture.



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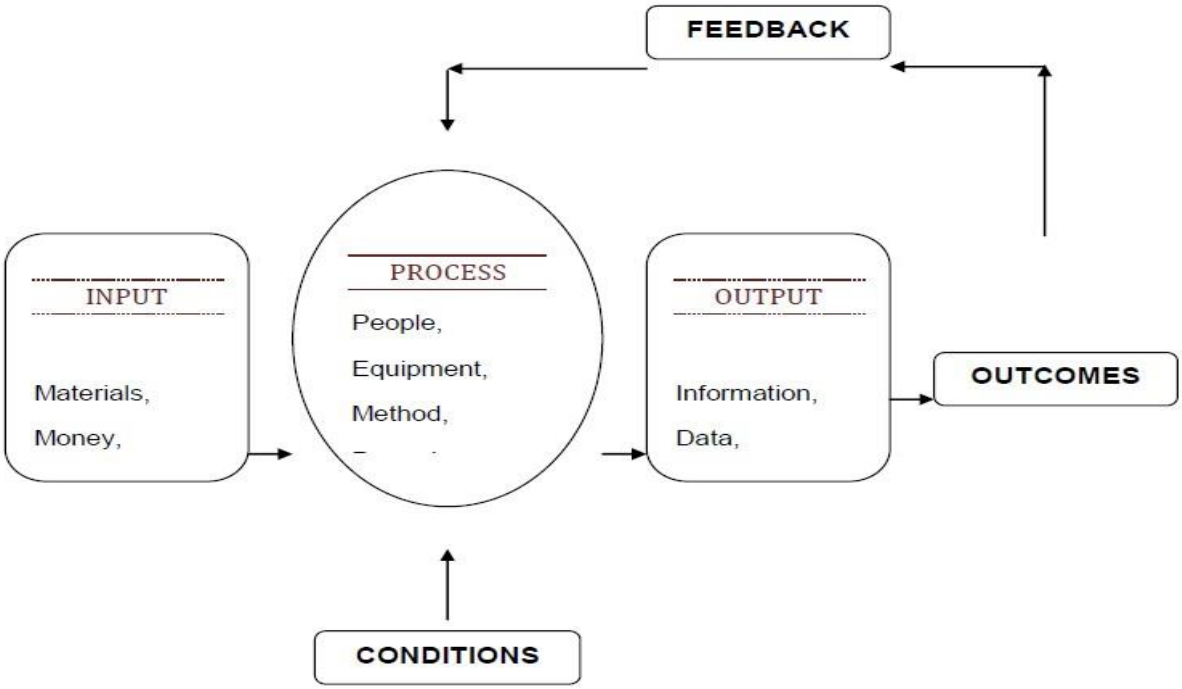
PROCESS:

Process refers to business and production activities of an organization.



INPUT / OUTPUT PROCESS MODEL

There are five basic ways for improvement.

- Reduce resources.
- Reduce errors.
- Meet or exceed expectations of downstream customers.
- Make the process safer.
- Make the process more satisfying to the person doing it.

4. THE JURAN TRILOGY

1. PLANNING
    - Determine internal and external customers.
    - Their needs are discovered.
    - Develop product/service features.
    - Develop the processes able to produce the product/service features.
    - Transfer plans to operations.
2. CONTROL

    Control is used by operating forces to help meet the product, process and service requirements.

    It consists of the following steps

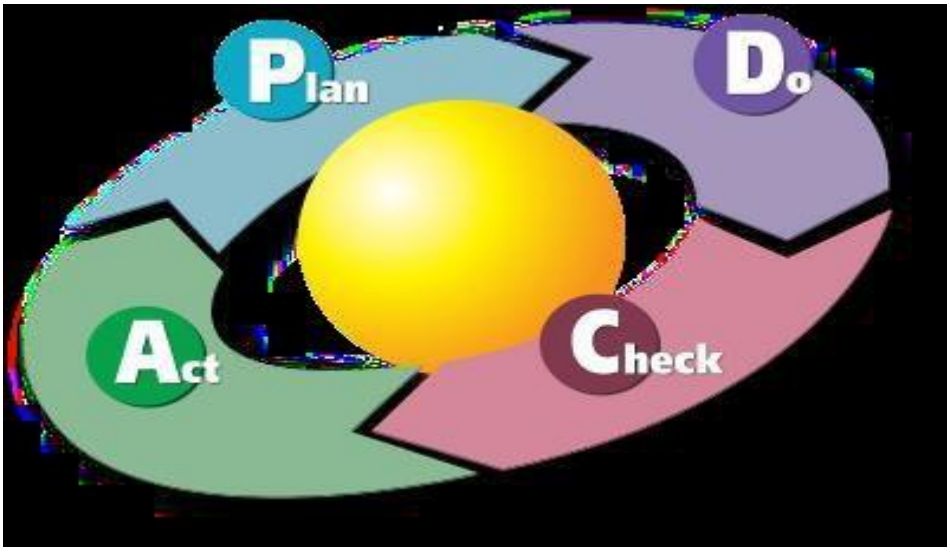
    - Determine items to be controlled.
    - Set goals for the controls.
    - Measure actual performance.
    - Compare actual performance to goals.
    - Act on the difference.
3. IMPROVEMENT

    Aims to attain levels of performance that are higher than current levels.

It consists of the following steps

- Establishment of quality council.
- Identify the improvement projects.
- Establish the project teams with a project leader.
- Provide the team with the resources.

5. THE PDCA CYCLE:



PROBLEM SOLVING METHOD:

1. IDENTIFY THE OPPORTUNITY
    - Identify the problem.
    - Pareto analysis of external alarm signals.
    - Pareto analysis of internal alarm signals.
    - Proposals from key insiders.
    - Proposals from suggestion schemes.
    - Field study of user's needs.
    - Comments of key people outside the organization.
    - Customer surveys.
    - Employee surveys.
    - Brainstorming by work groups.
    - Form the team.
    - Team should be selected.
    - Goals and milestones should be established.
    - Define the scope.

Criteria for a good problem statement is as follows

It clearly describes the problem.

It states the effect.

It focuses on what is known, unknown etc.

It emphasizes the impact on the customer.

2. ANALYZE THE CURRENT PROCESS

The objective is to understand the process and how it is currently performed. Step 1: The team to develop a process flow diagram.

Step 2: The target performance measures are defined.

Step 3: Collection of all available data and information.

Common items of data and information are

1. Customer information
2. Design information
3. Process information
4. Statistical information
5. Quality information
6. Supplier information

3. DEVELOP THE OPTIMAL SOLUTION(S)

This phase has the objective of establishing potential and feasible solutions and recommending the best solution to improve the process.

Creativity plays the major role, and brainstorming is the principal technique.

There are three types of creativity:

Create new processes.

Combine different processes.

Modify the existing process.

4. IMPLEMENT CHANGES

- This phase has the objective of preparing the implementation plan, obtaining approval and implementing the process improvements.
- Approval of the quality council.

- Obtain the advice and consent of departments, functional areas, teams, individuals etc.
- Monitor the activity.

5. STUDY THE RESULTS

   This phase has the objective of monitoring and evaluating the change by tracking and studying the effectiveness of the improvement efforts.

6. STANDARDIZE THE SOLUTION
   - Institutionalize by positive control of the process.
   - The quality peripherals - the system, environment and supervision must be certified.
   - Operators must be certified.
7. PLAN FOR THE FUTURE

   The objective is to achieve improved level of process performance.
   - Regularly conduct reviews of progress by the quality council.
   - Establish the systems to identify area for future improvements.
   - Track performance with respective internal and external customers.
   - TQM tools and techniques are used to improve quality, delivery and Cost.

6. IMPLEMENTING 5-S

1. Top Management resolve and training.
2. Formation of a top level team.
3. Understanding current circumstances.
4. Establishing priorities and targets.
5. Forming sub-teams and training.
6. Major cleaning.
7. Establishing improvement plans in each priority area.
8. Implementing the plan.
9. Verifying results.
10. Standardizing.
11. Establishing full control.
12. Looking for further improvements.

7. KAIZEN

Kaizen is a Japanese word for the philosophy that defines management‟ s roles in continuously encouraging and implementing small improvements involving everyone.

It focuses on simplification by breaking down complex progress into their sub – processes and then improving them.

The Kaizen improvement focuses on the use of:

- Value-added and non-value work activities.
- Muda, which refers to the seven classes of waste – over-production, delay, Transportation, processing, inventory, wasted motion and defective parts.
- Principles of motion study and the use of cell technology.
- Principles of materials handling and use of one-piece flow.
- Documentation of standard operating procedures.

The five S‟ s for workplace organization.

- Visual management
- Just – in – time principles.
- Poka – Yoke.
- Team dynamics.

Test after completion

1. Kaizen is a _____ process, the purpose of which goes beyond simple productivity improvement.

A. Weekly
B. Daily
C. Monthly
D. Annual

2. “Poka-yoke” is the Japanese term for _____

A. Card
B. Fool proof
C. Continuous improvement
D. Fishbone diagram

3._____ helps organization reduce employee turnover and absenteeism.

A. Job design
B. Training & development
C. Wage revision
D. All of the above

4. One of the advantages of team work is:

A. It breaks down barriers between internal
B. Customers and suppliers
C. It results in promotion
D. It results in salary increment

5. All of the following costs are likely to decrease as a result of better quality except _____

A. Customer dissatisfaction costs
B. Inspection costs
C. Maintenance costs
D. Warranty and service costs

Conclusion

- View all work as process – production and business.
- Process – purchasing, design, invoicing, etc.
- Inputs – PROCESS – outputs.
- Process improvement – increased customer satisfaction.
- Improvement – 5 ways; Reduce resources, Reduce errors, Meet expectations of downstream customers, Make process safer, make process more satisfying to the person doing.

Demo Videos

http://youtube.com/watch?v=-8e-ZjcS-8w

References

1. DALE H.BESTERFILED, ET AL., "Total Quality Management", Pearson Education, Inc. 2003. (Indian Reprint 2004). ISBN 81-297-0260-6.

2. Feigenbaum. A.V. "Total Quality Management", McGraw-Hill, 1991.

3. ZEIRI, "Total Quality Management for Engineers", Wood Head Publishers, 1991.

Answers to the assignments with full explanation
Assignment 5

1. **Five S**

Seiri – Sorting, **Seiton** – Straighten, in Order, **Seiso** – Sweep, **Seiketsu** -Standardizing **Shitsuke** Sustaining.

2. **Kaizen** is defined as making ―continuous improvement‖ - slow, incremental but constant. Western way of pragmatic approach ―why-fix-it-if-it-ain't-broke‖ Kaizen extends a more optimistic philosophical view: ―Everything―even if it ain't broke―can be made better!‖
"kai― > Means "change" or "the action to correct" "zen― > means "good―
Importance is given to the process not the results, as Japanese believe that good process will deliver good results.

3. **Juran Trilogy**

The Trilogy consists of three sequential and logical groups of activities:

- Quality Planning
- Quality Control
- Quality Improvement

4. The PDCA (or PDSA) Cycle was original y conceived by Walter Shewhart in 1930's, and later adopted by W. Edwards Deming.

- The model provides a framework for the improvement of a process or system.
- It can be used to guide the entire improvement project
- It can be used to develop specific projects once target improvement areas have been Identified.

5. Cause-and-Effect Diagrams - 1943 by Mr. Kaoru Ishikawa at the University of Tokyo

Purpose:

One important part of process improvement is continuously striving to obtain more Information about the process and its output. Cause-and-effect diagrams allow us to do not Just that, but also can lead us to the root cause, or causes, of problems.

Course Material

Name of the Course : **Total Quality Management**

Name of the Unit : **Total Quality Management Principles**

Name of the Topic : Introduction to the Supplier partnership and Performance measures.

- Objectives: To practice the TQM principles.

1. Outcomes: **Upon successful completion, the student should be able to practice the relevant quality improvement tools to implement TQM.**

2. Pre-requisites: **To have a basic knowledge of Production Planning and Control.**

1._____ are the charts that identify potential causes for particular quality problems.

A. Control chart

B. Flow chart

C. Cause and effect diagram

D. Pareto chart

2. At the time of making a purchase agreement with a vendor, what is important to mention about inspection?

A. The characteristics of the product that are to be inspected

B. The tolerances that would be allowed

C. The reputation of the vendor

D. A & B both

3. A fishbone diagram is also known as a _____

A. Cause-and-effect diagram

B. Poka-yoke diagram

C. Kaizen diagram

D. Taguchi diagram

4._____ is the set of activities that ensures the quality levels of products and services are properly maintained and that supplier and customer quality issues are properly resolved.

A. Quality Assurance
B. Quality Planning
C. Quality control
D. Quality management

5. The Toyota Production System is based on two pillars namely _____ and _____

A. Kaizen, Six Sigma
B. Lean, Six Sigma
C. Just in Time, Jidoka
D. Just in Time, Kaizen

6. A _____ chart can be used to identify the most frequently occurring defect.

A. Pareto
B. Ishikawa
C. Histogram
D. Scatter

7._____ refers to general processes of improvement and encompasses discontinuous improvements

A. Continuous improvement
B. Continual improvement
C. Constant improvement
D. Consecutive improvement

8. In the project environment, the individual ultimately responsible for quality control is:

A. The line workers who must strive "to do things right the first time" to avoid quality problems
B. The company's quality control manager who must work with the project members to ensure the quality control program is effective
C. The head of the production department who retains ultimate quality control responsibility for all the company's projects
D. The project manager who has ultimately responsibility for the entire project

9. Quality planning is:

A. identifying which quality standards are relevant to the project and determining how to satisfy them

B. monitoring specific project results to determine if they comply with relevant quality standards and identifying ways to eliminate causes of unsatisfactory performance

C. evaluating overall project performance on a regular basis to provide confidence that the project will satisfy the relevant quality standards

D. taking action to increase the effectiveness and efficiency of the project so as to provide added benefits to both the performing organization and the project customer.

10. The concept of quality is based on:

A. meeting luxury goods standards

B. producing excellent products that are superior to other similar items

C. conforming to the requirements specifications

D. maintaining uniformity of design

1. **SUPPLIER PARTNERSHIP**

The suppliers should be treated as partners to achieve the same quality level as attained within the organization.

The following forces need Supplier Partnership to improve quality, reduce costs and increase market share.

- Deming Philosophy (Deming's 4th point)
- Just – in – time
- Continuous process improvement
- ISO 9000

CUSTOMER – SUPPLIER RELATIONS:

Dr. Kaoru Ishikawa has given ten principles of customer-supplier relations. They are

1. Both the customer and supplier are fully responsible for the control of quality.
2. Both the customer and supplier should be independent of each other.

3. The customer is responsible for providing the supplier with clear and sufficient requirements so that the customer can know precisely what to produce.
4. Both the customer and supplier should enter into a non-adversarial contract.
5. The supplier is responsible for providing the quality that will satisfy the customer.
6. Both the customer and supplier should decide the method to evaluate the quality of the product or services.
7. Both the customer and supplier should establish in the contract the method by which they can reach an amicable settlement in case of any dispute.
8. Both the customers and supplier should continually exchange information.
9. Both the customer and supplier should perform business activities.
10. Both the customer and supplier should have the best interest of the end user in mind.

2. PARTNERING

Partnering is a relationship between two or more parties based upon trust, dedication to common goals.

The benefits of partnering are

- Improved quality
- Increased efficiency
- Lower cost
- Increased opportunity for innovation
- Continuous improvement

The three key elements to a partnership relationship are

Long term commitment

Trust

Shared vision

SOURCING

The three types of sourcing are

Sole sourcing

Multiple sourcing

Single sourcing

3. SUPPLIER SELECTION

The suppliers should be selected with the following ten conditions

1. The supplier should understand clearly the management philosophy of the Organization.
2. The supplier should have stable management system.
3. The supplier should maintain high technical standards.
4. The supplier should provide the raw materials and parts which meet quality Specifications required by the purchaser.
5. The supplier should have the required capability in terms of production.
6. The supplier should not leak out the corporate secrets.
7. The supplier should quote right price and should meet the delivery schedule. The supplier should be accessible with respect to transportation and communication.
8. The supplier should be sincere in implementing the contract provisions.
9. The supplier should have an effective quality system such as ISO / QS 9000.
10. The supplier should be renowned for customer satisfaction.

SUPPLIER CERTIFICATION:

A certified supplier is one which, after extensive investigation, is found to supply material of such quality that is not necessary to perform routine testing.

The Eight criteria for supplier certification are

1. No product related lot rejections for at least 1 year.
2. No non-product related rejections for at least 6 months.
3. No production related negative incidents for at least 6 months.
4. Should have passed a recent on-site quality system evaluation.
5. Having a fully agreed specifications.
6. Fully documented process and quality system.
7. Timely copies of inspection and test data.
8. Process that is stable and in control.

4. SUPPLIER RATING:

Supplier Rating is done

- To obtain an overall rating of supplier performance.
- To communicate with suppliers regarding their performance.
- To provide each supplier with a detailed and true record of problems For Corrective action.
- To enhance the relationship between the buyer and the supplier.

RELATIONSHIP DEVELOPMENT:

For establishment of supplier relationship, the following are necessary.

(a) Partnering
(b) Supplier selection
(c) Principles of customer / supplier relations
(d) Certification
(e) Periodic rating

For relationship development, the following are necessary.

(a) Inspection
    - 100% inspection.
    - Sampling
    - Audit
    - Identity check
(b) Training.
(c) Teams.
(d) Recognition and Reward.

5. PERFORMANCE MEASURES

Performance measures are required for the managers for managing an organization perfectly.

Performance measures are used to achieve the following objectives.

- To establish performance measures and reveal trend.
- To identify the processes to be improved.
- To determine the process gains and processes.

- To compare the actual performance with standard performance.
- To provide information for individual and team evaluation.
- To determine overall performance of the organization.
- To provide information for making proper decisions.

WHAT SHOULD BE MEASURED?

HUMAN RESOURCES

1. Lost time due to accidents, absenteeism.
2. Employee turnover.
3. Employee satisfaction index.
4. Training cost per employee.
5. Number of grievances.

CUSTOMERS

1. Number of complaints from customers.
2. Number of on-time deliveries.
3. Warranty data.
4. Dealer satisfaction.

PRODUCTION

1. Inventory.
2. SPC Charts.
3. Amount of scrap / rework.
4. Machine down time.

RESEARCH AND DEVELOPMENT

1. New product time to market.
2. Design change orders.
3. Cost estimating errors.

SUPPLIERS

1. On-time delivery.
2. Service rating.
3. Quality performance.
4. Average lead time.

MARKETING / SALES

1. Sales expense to revenue.
2. New product sales to total sales.
3. New customers.

ADMINISTRATION

1. Revenue per employee.
2. Purchase order error.
3. Billing accuracy.
4. Cost of poor quality.

6. STRATEGY:

The quality council has the overall responsibility for the performance measures. It ensures that all the measures are integrated into a total system of measures.

A typical system contains the following function:

Quality
Cost
Flexibility
Reliability
Innovation

PERFORMANCE MEASURE PRESENTATION:

There are six basic techniques for presenting performance measures. They are

1. Time series graph.
2. Control charts.
3. Capability Index.
4. Taguchi‟ s loss function.
5. Cost of poor quality.
6. Malcolm Baldrige National Quality Award.

In MBNQA, five categories are analyzed. They are

a) Manufacturing

b) Service

c) Small business

d) Health care

e) Education

Test after completion

1. Which of the following is not part of the Total Quality Approach?

A. holistic thinking
B. focus on short-term financial performance
C. focus on desirability
D. team thinking

2. The majority of advertisers appeal the public on thebasis of which of the following?

A. Quality of product
B. Quality of staff
C. Inferiority of product
D. Inferiority of service

3. The Japanese Quality Control (QC) Circle movement motivated its participants in many ways. Which of the following represents the most important motivation for the QC circle participant:

A. Improving the performance of the company
B. Self-Improvement
C. Financial Incentives
D. Recognition among co-workers

4. Quality control is the technical processes that _____ the project's progress against the performance standards.

A. inspect, certify, and verify
B. examine, analyze, and report
C. inspect, examine, and determine
D. identify, measure, and report

5. All of the following are the elements of a TQM system EXCEPT:

A. Leadership
B. Communications
C. Measurement
D. Detentions

Conclusion

- A philosophy that involves everyone in an organization in a continual effort to improve quality and achieve customer satisfaction.
- Find out what the customer wants.
- Design a product or service that meets or exceeds customer wants.
- Design processes that facilitates doing the job right the first time.
- Keep track of results.
- Extend these concepts to suppliers.
- Philosophy that seeks to make never-ending improvements to the process of converting inputs into outputs.

Demo Videos

http://youtube.com/watch?v=oJwnf0vsfxQ

References

1. DALE H.BESTERFILED, ET AL., "Total Quality Management", Pearson Education, Inc. 2003. (Indian Reprint 2004). ISBN 81-297-0260-6.
2. Feigenbaum. A.V. "Total Quality Management", McGraw-Hill, 1991.
3. ZEIRI, "Total Quality Management for Engineers", Wood Head Publishers, 1991.

Answers to the assignments with full explanation

Assignment 6

1. The first stage in implementing successful continuous improvement is understanding the basic concepts behind it and also the benefits to the organization. Continuous improvement is based on quality, process improvements and teamwork. The organization needs to identify the needs of your customers first and then produce products that meet those needs. Also, there is need to leverage on technology. For example you could use IT for sending out electronic invoices as opposed to paper invoices. This will save time as well as postage money. As there is instant delivery of the invoice, there are higher chances that payment will be received early from your customer.

2. Just-in time supply is a concept which gaining ground and is being accepted as the norm. For example, Hyundai Motor Company keeps only a few days stock of its components and supplies. The suppliers are expected to supply good quality components in time in full to the point of use. The suppliers, as their overheads would be lesser would keep stock of their finished goods and ensure that they send their products to the manufacturer as planned. This will enable continuous production in the manufacturer's place.

3. **Supplier certification:** It is a concept wherein the supplier is certified by the buyer to supply materials to the buyer at the point of use at the right time. The buyer will not inspect the material at his end. It is the responsibility of the supplier to supply good quality material in full quantity at the right time to the point of use. This is possible only when the supplier has a history of supplying good quality material without getting rejected by the buyer.

4. **Cross Functional Teams:** The supplier is part of a team formed by the buyer for sorting out and for improving an ongoing problems related to the product. They exchange information in a timely manner so that the end user is benefited.

5. **Supplier Rating:** Suppliers are rated periodically by the buyer to know the status of the supplier with respect to his manufacturing performance (Line rejections, process control equipments available, supply rejections, penalties paid, PPM deductions, sourcing patterns, etc) and Supply performance (on time delivery, lead time, full quantity delivery, etc). Once the supplier is assessed on the above points, he is graded as an A class, B class or a C class supplier. Accordingly, the type of component and the inspection level (Normal, Tightened or Liberal) can be decided.

Course Material for Unit - 3

Name of the Course	:	**Total Quality Management**
Name of the Unit	:	**Total Quality Management Tools**
Name of the Topic	:	Introduction to the Benchmarking and Quality Function Deployment.

- Objectives: To analyse the various TQM tools.

1. Outcomes: **Upon successful completion, the student should be able to assess various TQM Techniques.**

2. Pre-requisites: **To have a basic knowledge of Production Planning and Control.**

1. QFD stands for _____
   A. Quantity for deployment
   B. Quality for deployment
   C. Quality function deployment
   D. Quality for decision.
2. A maturity model can be used as a benchmark for comparison and as an aid to understanding
   A. True
   B. False
   C. Depends
   D. Can't say
3. The main aim of QFD is to
   A. Listen to the voice of customer
   B. Lower cost
   C. Reduce errors
   D. Reduce supplier defect
4. In _____ step of Quality Function Deployment, product or service requirements are collected and analyzed through techniques like market research.
   A. Identify Customer Attributes
   B. Identify Design Attributes/Requirements
   C. Conduct an Evaluation of Competing Products.
   D. Evaluate Design Attributes and Develop Targets

5. Quality fulfils a need or expectation that is:

A. Explicitly stated

B. Implied

C. Legally required

D. All of the above

6. The taste of burgers across all McDonald outlets should be same. This is an example of _____.

A. Sensory critical to quality Characteristic

B. Physical critical to Quality Characteristic

C. Time Orientation critical to Quality Characteristic

D. None of the above

7. The primary responsibility for establishing design and test specifications should rest with

A. senior management

B. procurement or purchasing

C. engineering

D. manufacturing

8. The majority of advertisers appeal the public on the basis of which of the following?

A. Quality of product

B. Quality of staff

C. Inferiority of product

D. Inferiority of service

9. The job characteristic of quality professionals is:

A. Educating others

B. Achieving personal targets

C. Consultative work with other departments

D. None of the above

10. Quality control is the technical processes that _____ the project's progress against the performance standards.

A. inspect, certify, and verify

B. examine, analyze, and report

C. inspect, examine, and determine

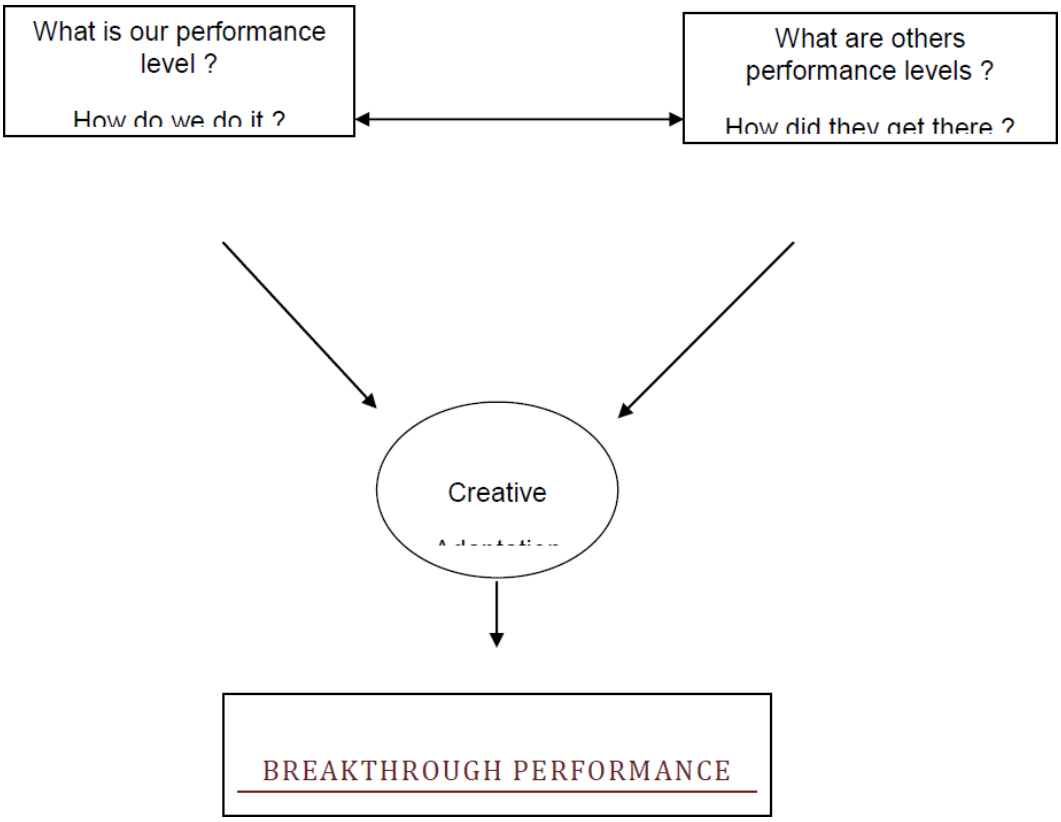
D. identify, measure, and report

3. **BENCHMARKING**

- Benchmarking is a systematic method by which organizations can measure themselves against the best industry practices.

- Benchmarking is a systematic search for the best practices, innovative ideas, and highly effective operating procedures.

BENCHMARKING CONCEPT



REASONS TO BENCHMARK:

- It is a tool to achieve business and competitive objectives.
- It can inspire managers (and organizations) to compete.
- It is time and cost effective.
- It constantly scans the external environment to improve the process.
- Potential and useful technological breakthroughs can be located and adopted early.

PROCESS OF BENCHMARKING

1. Decide what to benchmark
    - Benchmarking can be applied to any business or production process
    - The strategy is usually expressed in terms of mission and vision Statements.
    - Best to begin with the mission and critical factors.
    - Choosing the scope of the Benchmarking study
    - Pareto analysis – what process to investigate?
    - Cause and Effect diagram – for tracing outputs back
2. Understand current performance
    - Understand and document the current process.
    - Those working in the process are the most capable of identifying and correcting problems.
    - While documenting, it is important to quantify.
    - Care should be taken during accounting information.
3. Plan
    - A benchmarking team should be chosen.
    - Organizations to serve as the benchmark need to be identified.

- Time frame should be agreed upon for each of the benchmarking tasks.
- There are three types of benchmarking
    - ✓ Internal
    - ✓ Competitive
    - ✓ Process

4. Study Others

Benchmarking studies look for two types of information

How best the processes are practiced.

Measurable results of these practices.

Three techniques for conducting the research are

Questionnaires

Site visits

Focus groups

5. Learn from the data

Answering a series of questions like

- Is there a gap between the organization's performance and the Performance of the best-in-class organizations?
- What is the gap? How much is it?
- Why is there a gap? What does the best-in-class do differently that is Better?
- If best-in-class practices were adopted, what would be the resulting Improvement?
- Benchmarking studies can reveal three different outcomes.
- Negative gap.
- Parity
- Positive gap.

6. Using the findings

The objective is to close the gap. For this

- Findings must be communicated to the people within the Organization.
- Action plans must be developed to implement new processes.

Groups that must agree on the change

- Process owners
- Upper management

Steps for the development and execution of action plans are

1. Specify tasks
2. Sequence tasks
3. Determine resources needs
4. Establish task schedule
5. Assign responsibility for each task
6. Describe expected results
7. Specify methods for monitoring results

PITFALLS AND CRITICISMS OF BENCHMARKING:

- Idea of copying others
- It is not a cure or a business philosophy
- Some process have to be benchmarked repeatedly
- It is not a substitute for innovation

4. QUALITY FUNCTION DEPLOYMENT

- Quality Function Deployment is a planning tool used to fulfill Customer expectations.
- Quality Function Deployment focuses on customer expectations or requirements, often referred to as voice of the customer.

QFD TEAM:

There are two types of teams namely

1. Team for designing a new product.
2. Team for improving an existing product.

BENEFITS OF QFD:

1. Improves Customer satisfaction.
    - Creates focus on customer requirements.
    - Uses competitive information effectively.
    - Prioritizes resources.
    - Identifies items that can be acted upon.

2. Reduces Implementation Time
    - Decreases midstream design changes.
    - Limits post introduction problems.
    - Avoids future development redundancies.

3. Promotes Team Work

    Based on consensus.

    Creates communication.

    Identifies actions.

4. Provides Documentation
    - Documents rationale for design.
    - Adds structure to the information.
    - Adapts to changes (a living document).

Test after completion

1. The Japanese Quality Control (QC) Circle movement motivated its participants in many ways. Which of the following represents the most important motivation for the QC circle participant:

A. Improving the performance of the company
B. Self-Improvement
C. Financial Incentives
D. Recognition among co-workers

2. The project management teams for quality should:

A. extend beyond the completion of the project
B. stop at the point of delivery
C. be significantly reduced by a good warranty
D. be ignored by the project manager

3. All of the following are the elements of a TQM system EXCEPT:

A. Leadership
B. Communications
C. Measurement
D. Detentions

4. Some organizations emphasizes the use of quality tools but failed to do which of the following?
A. Focus on what is truly important to the distributors
B. Incorporate continuous improvement efforts
C. Make fundamental changes in their processes and culture
D. Focus on what is truly important to the customer.

5. Which of the following is least likely to contribute to developing an effective project team supportive of quality?
A. Commitment to the project
B. Team member flexibility
C. Frequent turnover of personnel
D. Team interest in workmanship

Conclusion

- Customers are our number one concern. Satisfied customers keep us in business. Therefore, we must have an excellent understanding of their needs.
- Proactive product development is better than reactive product development. QFD can help a company move toward a more proactive approach.
- Quality is a responsibility of everyone in the organization. QFD is a team methodology which encourages a broader employee involvement and focus.
- The QFD methodology helps an organization determine the most effective applications for many engineering and analytical tools such as: Problem Solving, FMEA and Statistical Process Control.

Demo Videos

http://youtube.com/watch?v=B4hiJ-SK4TI

References

1. DALE H.BESTERFILED, ET AL., "Total Quality Management", Pearson Education, Inc. 2003. (Indian Reprint 2004). ISBN 81-297-0260-6.
2. Feigenbaum. A.V. "Total Quality Management", McGraw-Hill, 1991.
3. ZEIRI, "Total Quality Management for Engineers", Wood Head Publishers, 1991.

Answers to the assignments with full explanation
Assignment 7

1. **Benchmarking** is the process of comparing the cost, time or quality of what one organization does against what another organization does. The result is often a business case for making changes in order to make improvements. —The systematic process of comparing an organization's products, services and practices against those of competitor organizations or other industry leaders to determine what it is they do that allows them to achieve high levels of performance.
2. **Process benchmarking** - the initiating firm focuses its observation and investigation of business processes with a goal of identifying and observing the best practices from one or more benchmark firms. Activity analysis will be required where the objective is to benchmark cost and efficiency; increasingly applied to back-office processes where outsourcing may be a consideration.
3. QFD is a powerful tool that leads to significant improvements in product/process performances. However, it is not a short-term answer to product development problems. The method on which QFD is implemented may have a large impact on benefits derived and companies should take up QFD only after getting the consent and commitment of the team members.
4. **Advantages of benchmarking**
   - Benchmarking is a powerful management tool because it overcomes "paradigm blindness."
   -Benchmarking opens organizations to new methods, ideas and tools to improve their effectiveness.
   - It helps crack through resistance to change by demonstrating other methods.

- Allows employees to visualize the improvement which can be a strong motivator for change
- Helps to identify weak areas and indicates what needs to be done to improve.

5. **Functional benchmarking** - a company will focus its benchmarking on a single function in order to improve the operation of that particular function. Complex functions such as Human Resources, Finance and Accounting and Information and Communication Technology are unlikely to be directly comparable in cost and efficiency terms and may need to be disaggregated into processes to make valid comparison.

Course Material

Name of the Course : **Total Quality Management**

Name of the Unit : **Total Quality Management Tools**

Name of the Topic : Introduction to the House of Quality, Taguchi Quality Loss function and FMEA.

- Objectives: To analyse the various TQM tools.

1. Outcomes: **Upon successful completion, the student should be able to assess various TQM Techniques.**

2. Pre-requisites: **To have a basic knowledge of Production Planning and Control.**

1. The roof of house of quality shows the interrelationship between:
A. Functional Requirements
B. Design Attributes
C. Service Process
D. Manufacturing Process

2. Failure Mode and Effects Analysis, which prioritizes different sources of error, is used in _____ stage.
A. Define
B. Measure
C. Improve
D. Analyze

3. _____ is a graphic tool for defining the relationship between customer desires and the firm/product capabilities.
A. House of Quality
B. Affinity diagram
C. Arrow diagram
D. None of the given option

4. Taguchi suggested that loss in a process is increased with increase in which of the following?

A. Specifications
B. Standards
C. Competition
D. Variability

5. Quality control methods extend beyond the external characteristics of the Product or components of the product. The types of testing of the product or Components include _____.

A. operator, maintainer, and environmental
B. stress, destructive, and operating
C. in-house, public, and private
D. laboratory, destructive, and non-destructive

6. Which of the following models value stability?

A. Organism model
B. Mechanistic model
C. Cultural model
D. Total Quality model

7. Which of the following document(s) is (are)'included in the quality system?

A. A quality policy
B. Customer focus
C. Commitment
D. All of the given options

8. The overall intentions and direction of an organization with regard to quality as formally expressed by top management is a:

A. Quality Plan
B. Quality Statement
C. Quality Policy
D. TQM

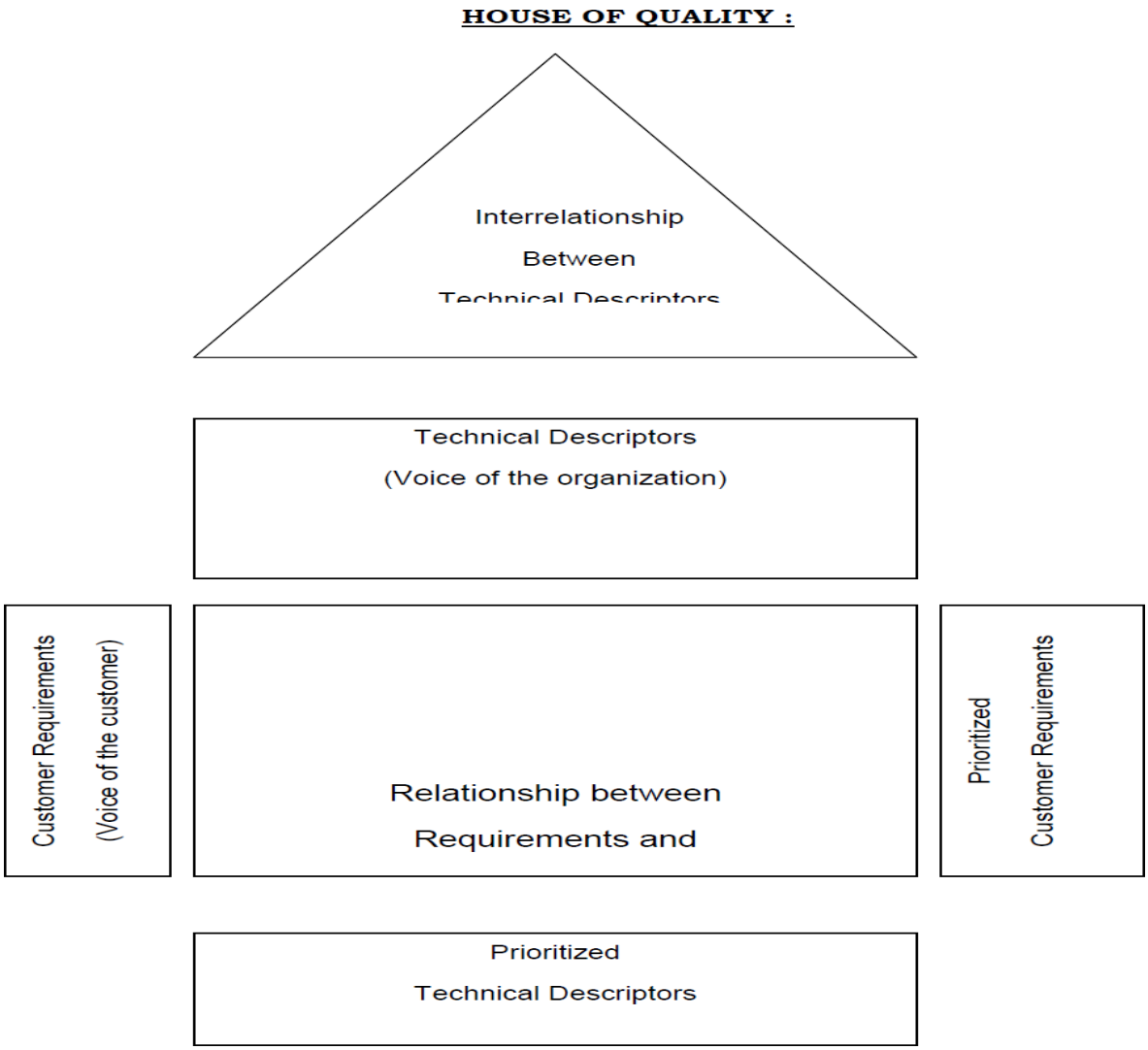
9. Each project needs a quality program plan to define the parameters of the overall approach to meeting quality requirements. As a minimum, the quality program plan addresses _____.

A. the required processes and procedures
B. the inspection plan
C. the types of test to be conducted
D. the documentation requirements for actions (testing, inspections, etc.)

10. Why the factory managers created inspection departments?

A. To keep defective products aside, ensuring
B. they do not reach the customers
C. To ensure quantity of goods/services
D. To count, grade, and rework

3. **House of Quality**



THE STEPS IN BUILDING A HOUSE OF QUALITY ARE:

1. List Customer Requirements (WHAT‟s)
2. List Technical Descriptors (HOW‟s)
3. Develop a Relationship Matrix between WHAT‟s and HOW‟s
4. Develop an Inter-relationship Matrix between HOW‟s
5. Competitive Assessments
    a. Customer Competitive Assessments
    b. Technical Competitive Assessments
6. Develop Prioritized Customer Requirements
7. Develop Prioritized Technical Descriptors.

4. **TAGUCHI'S QUALITY LOSS FUNCTION**

- Taguchi's Quality Loss Function concept combines cost, target and Variation in one metric with specifications being of secondary Importance.
- 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 ideal performance and harmful side effects.

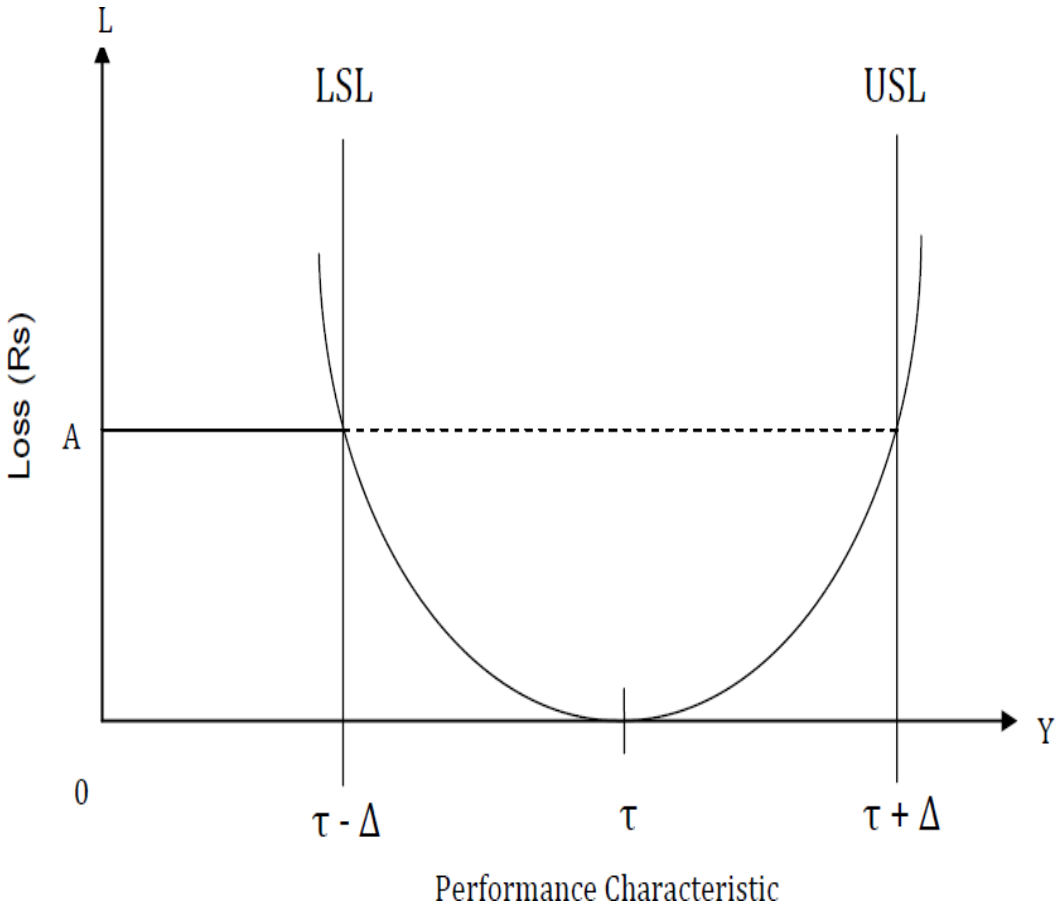
CUSTOMERS PERCEIVE QUALITY AS MEETING THE TARGET RATHER THAN JUST MEETING THE SPECIFICATIONS.

There are three common quality loss functions

1. Nominal - the - best.
2. Smaller - the - better.
3. Larger - the - better.

NOMINAL – THE – BEST:

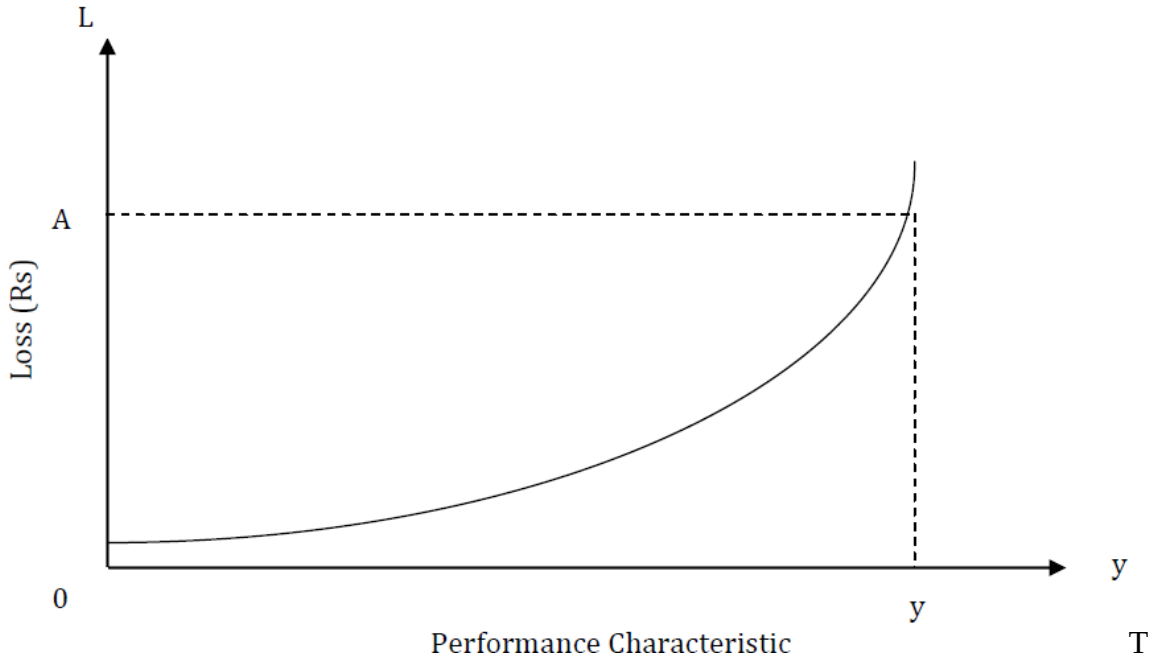
Although Taguchi developed so many loss functions, many situations are approximated by the quadratic function which is called the **Nominal – the – best** type.



The quadratic function is shown in figure. In this situation, the loss occurs as soon as the performance characteristic, y, departs from the target τ.

At τ, the loss is Rs. 0.
At LSL (or) USL, the loss is Rs. A.
The quadratic loss function is described by the equation $L = k (y - \tau) 2$. Where,
L = cost incurred as quality deviates from the target. y = Performance characteristic
τ = target
k = Quality loss coefficient.
The loss coefficient is determined by setting $\Delta = (y - \tau)$, the deviation from the target. When Δ is the USL (or) LSL, the loss to the customer of repairing (or) discarding the product is Rs. A. Thus,
$K = A / (y - \tau)2 = A / \Delta 2$.

SMALLER – THE – BETTER :



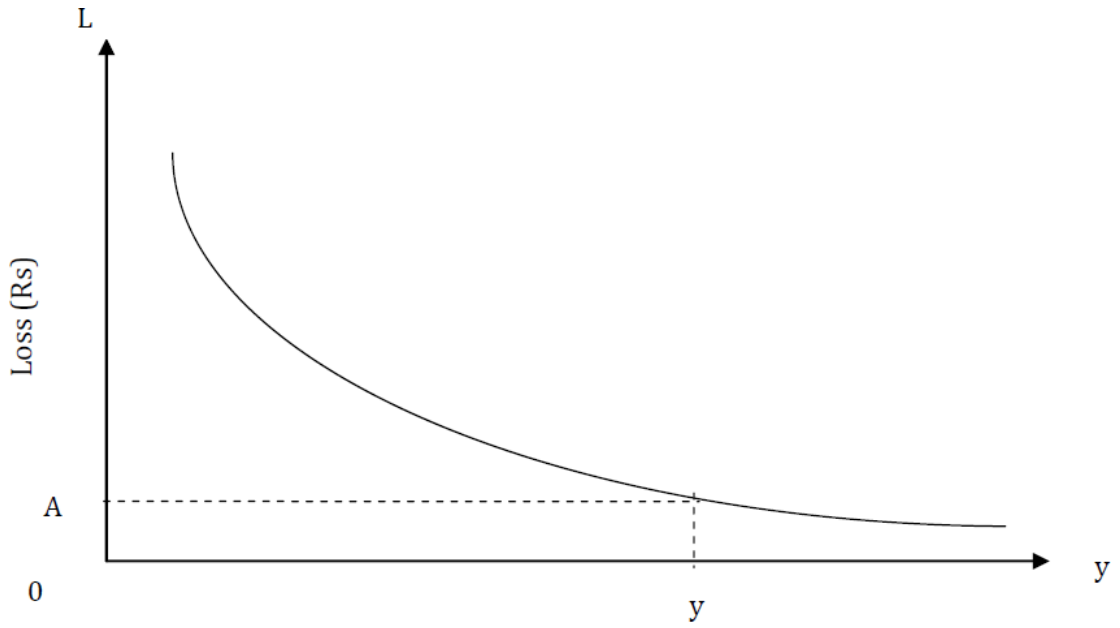
he above figure shows the smaller – the – better concepts.

- The target value for **smaller – the – better** is 0. There are no negative values for the performance characteristic.
- The radiation leakage from a microwave appliance, the response time for a computer, pollution from an automobile, out of round for a hole etc. are the performance characteristics for this concept.

LARGER – THE – BETTER:

The following figure shows the concept of the Larger – the – better.

In the Larger – the – better concept, the target value is ∞ (infinity), which gives a zero loss. There are no negative values and the worst case is at y = 0. Actually, larger – the – better is the reciprocal of smaller – the – better. The performance characteristics in Larger – the – better are bond strength of adhesives, welding strength etc.



Performance Characteristic

5.TOTAL PRODUCTIVE MAINTENANCE (TPM)

- Total Productive Maintenance (TPM) is defined as keeping the running plant and equipment at its highest productive level with the co-operation of all areas of the organization.
- Predictive and Preventive maintenance are essential to building a foundation for a successful TPM environment.
- **Predictive Maintenance** is the process of using data and statistical tools to determine when a piece of equipment will fail.
- **Preventive Maintenance** is the process of periodically performing activities such as lubrication on the equipment to keep it running.

OBJECTIVES OF TPM:

1. To maintain and improve equipment capacity.
2. To maintain equipment for life.
3. To use support from all areas of the operation.
4. To encourage input from all employees.
5. To use teams for continuous improvement.

TPM PHILOSOPHY – CONCEPT OF TPM:

Total Productive Maintenance (TPM) is an extension of the Total Quality Management (TQM) philosophy to the maintenance function.

TPM has the following steps:

1. Management should learn the new philosophy of TPM.

2. Management should promote the new philosophy of TPM.
3. Training should be funded and developed for everyone in the organization.
4. Areas of needed improvement should be identified.

Loss measurements to identify improvement needs are

- Down time losses.
- Reduced speed losses.
- Poor quality losses.

4. Performance goals should be formulated.
5. An implementation plan should be developed.
6. Autonomous worth groups should be established.

6. FAILURE MODE AND EFFECTS ANALYSIS

FMEA is an analytical technique that combines the technology and experience of people in identifying foreseeable failure modes of a product or process and planning for its elimination.

It is a group of activities comprising the following:

1. Recognize the potential failure of a product or process.
2. Identify actions that eliminate / reduce the potential failure.
3. Document the process.

Two important types of FMEA are

- Design FMEA
- Process FMEA

INTENT OF FMEA**:**

- Continually measuring the reliability of a machine, product or process.
- To detect the potential product – related failure model.
- FMEA evaluation to be conducted immediately following the design phase.

BENEFITS OF FMEA:

- Having a systematic review of components failure modes to ensure that any failure produces minimal damage.
- Determining the effects of any failure on other items.

- Providing input data for exchange studies.
- Determining how the high-failure rate components can be adapted to high-reliability components.
- Eliminating / minimizing the adverse effects that failures could generate.
- Helping uncover the misjudgments, errors etc.
- Reduce development time and cost of manufacturing.

FMEA TEAM:

Engineers from

- Assembly - Manufacturing - Materials - Quality - Service - Supplier - Customer

FMEA DOCUMENTATION:

The purpose of FMEA documentation is

To allow all involved Engineers to have access to others thoughts.

To design and manufacture using these collective thoughts (promotes team approach).

Test after completion

1. Which of the following is correct for TQM?
a) **Quality strategy in TQM emanates from top**
b) TQM is a static process
c) It is a management approach to short-term success through customer
d) It is used to improve processes not products

2. Which part in quality management is the critical part?
a) Process thinking
b) Performance measurement
c) Customer's view
d) **Systematic approach**

3. Which of the following is not true for communication in TQM?
a) **Three way communication**
b) It should be clear
c) Forceful
d) Open involvement

4. What are the core principles of the TQM in a company-wide effort?
a) Customer and process orientation only
b) Continuous improvement only
c) Process orientation and continuous improvement only
d) **Continuous improvement, process and customer orientation.**

5. What is included in the quality assessment in TQM?
a) Strategic quality planning
b) **Management of process quality**
c) Quality and operational results
d) Information and analysis

Conclusion

- Identification of potential inconsistencies within a QFD matrix and the implication of these inconsistencies on system requirements
- Identification of potential and strategic opportunities implied within a QFD matrix and the nature of these opportunities and their exploitation by a strategic product planning team
- Representation of above knowledge and other heuristics within an embedded expert system for increasingly mature responsiveness of the approach and its tailoring to a domain/business area.
- Customer loyalty is driven by delivered value.
- Delivered value is created by business processes.
- Sustained success in competitive markets require a business to continuously improve delivered value.
- To continuously improve value creation ability, a business must continuously improve its value creation processes.

Demo Videos

http://youtube.com/watch?v=8u7bTbB1sEQ

References

1. DALE H.BESTERFILED, ET AL., "Total Quality Management", Pearson Education, Inc. 2003. (Indian Reprint 2004). ISBN 81-297-0260-6.
2. Feigenbaum. A.V. "Total Quality Management", McGraw-Hill, 1991.
3. ZEIRI, "Total Quality Management for Engineers", Wood Head Publishers, 1991.

Answers to the assignments with full explanation
Assignment 8

1. **Failure modes and effects analysis (FMEA)** is a procedure for analysis of potential failure modes within a system for the classification by severity or determination of the failures' effect upon the system. It is widely used in the manufacturing industries in various phases of the product life cycle and is now increasingly finding use in the service industry as well. Failure causes are any errors or defects in process, design, or item especial y ones that affect the customer, and can be potential or actual. Effects analysis refers to studying the consequences of those failures.
2. **FEATURES of QFD:**
    - Concept of matrix and its correlation
    - Plan as per the voice of the customer
    - Focus on Customers need and technicalities
    - WHAT the Customer wants and HOW to do it
    - It is base tool for quality planning managers
3. **Uses of FMEA**
    - Development of system requirements that minimize the likelihood of failures.
    - Development of methods to design and test systems to ensure that the failures have been eliminated.
    - Evaluation of the requirements of the customer to ensure that those do not give rise to potential failures.

- Identification of certain design characteristics that contribute to failures, and minimize or eliminate those effects.
- Tracking and managing potential risks in the design. This helps avoid the same failures in future projects.
- Ensuring that any failure that could occur wil not injure the customer or seriously impact a system.

4. **Goals of TPM**
   - Maintaining and Improving equipment capacity
   - Maintaining equipment for longer life
   - Using support from al areas of operation
   - Encouraging input from al employees
   - Continuous improvement
5. **House of Quality Benefits**
   - ✓ Orderly way of obtaining information
   - ✓ Shorter product development cycle
   - ✓ Considerably reduced startup cost
   - ✓ Fewer engineering changes
   - ✓ Reduces design process
   - ✓ Leads to teamwork
   - ✓ Consensus decision
   - ✓ Everything is preserved in writing

Course Material for Unit - 4

Name of the Course	:	**Total Quality Management**
Name of the Unit	:	**Quality systems**
Name of the Topic	:	Introduction to the quality auditing and ISO 9000.

- Objectives: To adopt the quality systems.

1. Outcomes: **Upon successful completion, the student should be able to Practice the Quality Management Systems in a different organization Environment.**

2. Pre-requisites: **To have a basic knowledge of Production Planning and Control.**

1. What is ISO?
   A. Indian organization for standard
   B. Internal organization for standard
   C. International organization for standard
   D. None of the above.

2. The objective of ISO-9000 family of Quality management is
   A. Customer satisfaction
   B. Employee satisfaction
   C. Skill enhancement
   D. Environmental issues

3. TQM & ISO both focuses on
   A. Customer
   B. Employee

C. Supplier

D. All of the above

4. The process of evaluating overall project performance on a regular basis to provide confidence that the project will satisfy the relevant quality standards is called:

A. Quality Assurance

B. Quality Control

C. Quality Planning

D. Quality Review

5. Taguchi suggested that loss in a process is increased with increase in which of the following?

E. Specifications

F. Standards

G. Competition

H. Variability

6. Following is (are) the phase(s) of intervention

A. Formulation stage
B. Maintenance stage
C. Implementation stage
D. All of the above

7. The following is (are) the machine down time.

A. Waste
B. No material
C. Breakdown
D. All of the above

8. Marketing research carried out to know whether the particular area should be covered in this course. What the course instructor should develop?

A. The course meeting requirements of the university
B. The course meeting requirements of the instructor
C. The course meeting requirements of the students
D. The course meeting requirements of the bookseller

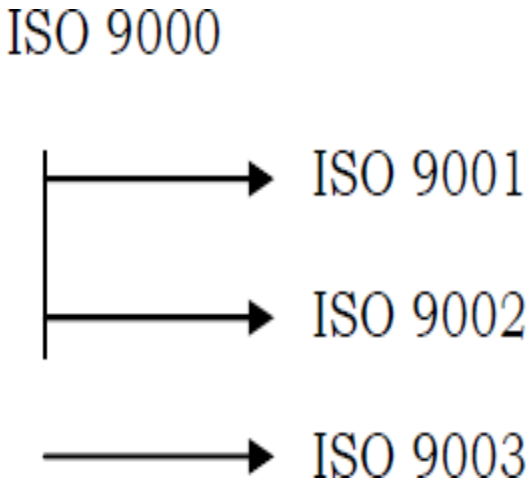
9. Learn how to tell when nothing can be gained from further discussion. This refers to which of the following discussion skills in meetings?

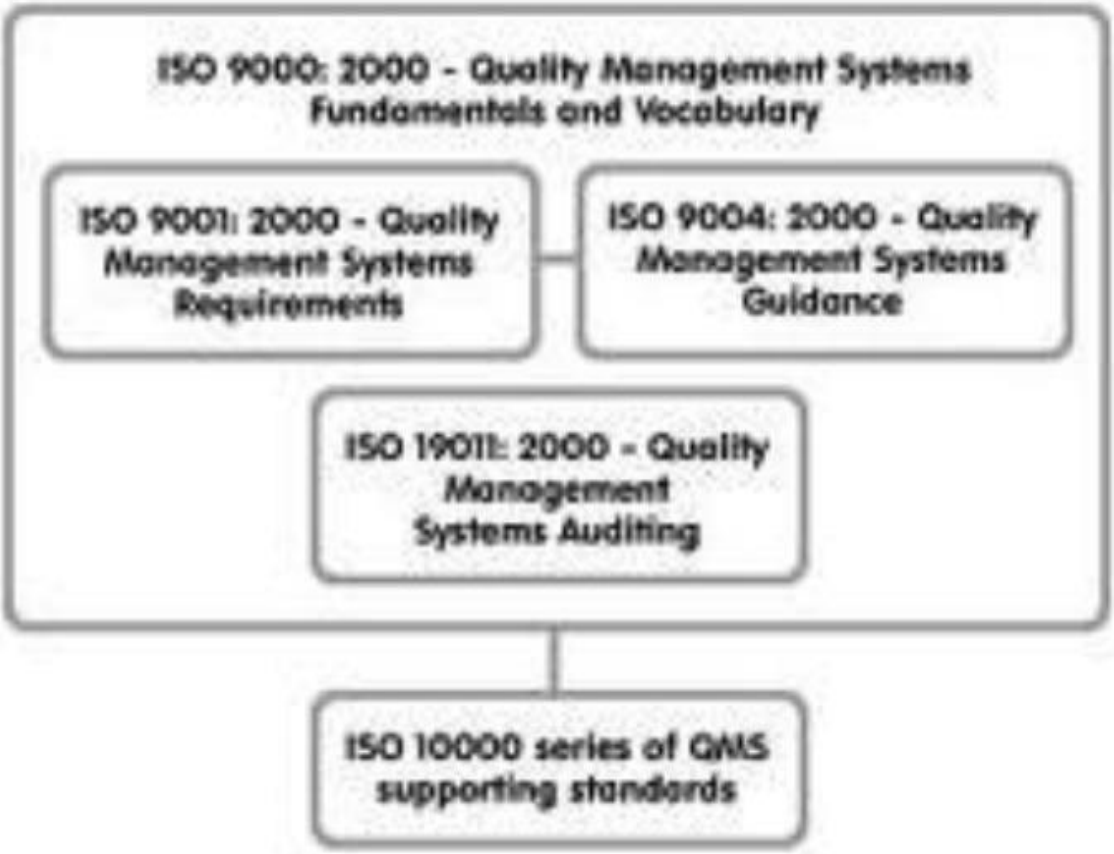
A. Acting as gatekeepers
B. Closing the discussion
C. Asking for clarification
D. Testing for consensus

10. From a high level perspective, quality:

A. is ensured by having inspectors
B. cannot be quantitatively measured
C. and productivity are inconsistent objectives
D. is primarily (85 - 95%) a management problem

3. **ISO 9000 STANDARDS**





ISO 9001

Design, Development, Production, Installation & Servicing

ISO 9002

Production, Installation & Servicing

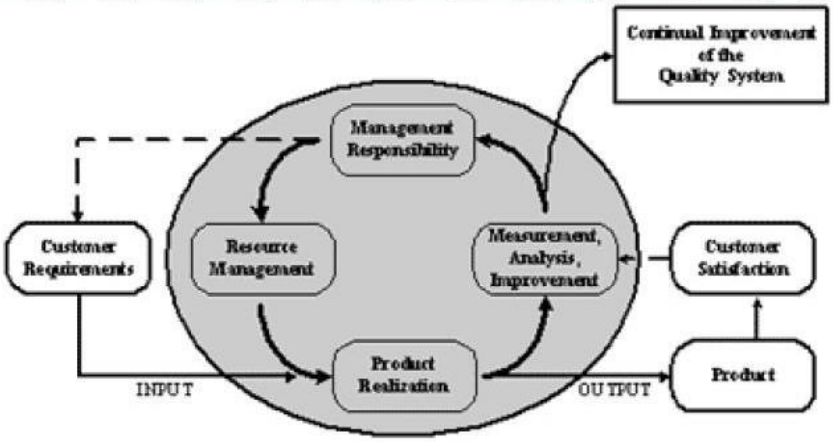
ISO 9003

Inspection & Testing

ISO 9004

Provides guidelines on the technical, administrative and human factors affecting the product or services


Vision:
Sustainable
Successful
Safe
EH&S Policy Commitment
Quality Based Systems
Covering ALL Internal Operations,
Suppliers, and Contractors
Performance Driven EH&S Programs
Third Party Certified by
Lloyd's Register Quality Assurance
ISO 14001 based
Environmental
Management System
OHSAS 18001 based
Safety Management System


Continual Improvement
of the
Quality System
Management
Responsibility
Customer
Requirements
Resource
Management
Measurement,
Analysis,
Improvement
Customer
Satisfaction
Product
Realization
Product
INPUT
OUTPUT

ISO 9000: 2000 Sector Standard

BENEFITS OF ISO 9000 STANDARDS:

- Achievement of international standard of quality.
- Value for money.
- Customer satisfaction.
- Higher productivity
- Increased profitability
- Improved corporate image.
- Access to global market.
- Growth of the organization.
- Higher morale of employees.

4. CLAUSES (ELEMENTS) OF ISO 9000 (DURING THE YEAR 1987)

1. Management Responsibility
    - Adequate resources for the verification activities.
    - Need for trained personnel.
    - Work and verification activities including audits.
    - A Management Representative to be identified.
    - Review the Quality System performance and customer complaints periodically.
2. Quality System
3. Contract review
4. Design Control
5. Documents Control
6. Purchasing
7. Purchaser – Supplied
8. Product Identification and Traceability
9. Process Control
10. Inspection and Testing
11. Inspection Measuring and Test Equipment
12. Inspection and Test Status
13. Control of Non – Conforming Product
14. Corrective Action
15. Handling, Storage, Packaging and Delivery
16. Quality Records
17. Internal Quality Audits
18. Training
19. Servicing
20. Statistical Techniques

5. CLAUSES (ELEMENTS) OF ISO 9000 (During the year 2000)

1. Scope
2. Normative Reference
3. Terms and Definitions
4. Quality Management System (QMS)
    - General Requirements
    - Documentation
5. Management Responsibility
    - Management Commitment
    - Customer Focus
    - Quality Policy Planning
    - Responsibility, Authority and Communication
    - Management Review

6. Resource Management
    - Provision of Resources
    - Human Resources
    - Infrastructure Work Environment

7. Product Realization
    - Planning of Product Realization
    - Customer related processes
    - Design and Development
    - Purchasing
    - Production and Service Provision
    - Control of Monitoring and Measuring devices

8. Monitoring and Measurement
    - General
    - Monitoring and Measurement
    - Control of Non-Conforming Product
    - Analysis of Data
    - Improvement

6. IMPLEMENTATION OF QUALITY MANAGEMENT SYSTEM:

1. Top Management Commitment
2. Appoint the Management Representative
3. Awareness
4. Appoint an Implementation Team
5. Training
6. Time Schedule
7. Select Element Owners
8. Review the Present System

9. Write the Documents
10. Install the New System
11. Internal Audit
12. Management Review
13. Pre-assessment
14. Registration

PITFALLS OF SUCCESSFUL IMPLEMENTATION:

1. Using a generic documentation program or another organization's documentation program.
2. Over-documentation or documentation that is too complex.
3. Using External Consultants without involvement.
4. Neglecting to obtain top management's involvement.
5. Developing a system that does not represent what actually occurs.

DOCUMENTATION

In every organization, the quality system must be documented properly. The documentation of the system can be seen as a hierarchical format as shown.

1. POLICY
2. PROCEDURES
3. PRACTICES
4. PROOFS

7. QUALITY AUDITING

- The term Audit refers to a regular examination and checking of accounts or financial records, settlement or adjustment of accounts.
- It also refers to checking, inspection and examination of Production Processes.

PURPOSE OF QUALITY AUDIT:

- To establish the adequacy of the system.
- To determine the effectiveness of the system.

- To afford opportunities for system analysis.
- To help in problem solving.
- To make decision making easier etc.

TYPES OF QUALITY AUDIT:

1. First – Party Audit.
2. Second – Party Audit.
3. Third – Party Audit.

Quality audit can also be classified on the basis of the area taken into account for the audit such as

- System Audit
- Process Audit
- Product Audit
- Adequacy Audit
- Compliance audit

Test after completion

1. The ISO 9000 series is:

A. a set of instructions for preparing control charts

B. a set of guidelines for quality

C. a set of forms and procedures to ensure quality

D. an international standard that describes a recommended quality system

2. Which of the following is typically viewed to lie between fully vertically integrated firms?

A. Supply chain management
B. Production chain management
C. Value chain management
D. Demand chain management

3. The ability of a product to be used for different purposes at different capacities and under different conditions determines its:

A. Usability
B. Flexibility
C. Operability
D. Availability

4. Financial compensation is the primary motivational tool for which of the following management theories or programs?

A. Zero Defects program
B. Theory X management
C. Theory Y management
D. Quality Control Circles

5. Some organizations emphasizes the use of quality tools but failed to do which of the following?

A. Focus on what is truly important to the distributors
B. Incorporate continuous improvement efforts
C. Make fundamental changes in their processes and culture
D. Focus on what is truly important to the customer

Conclusion

ISO/TS 16949 standard is proven to help deliver tangible commercial improvements such as:

- Enhanced corporate reputation – by demonstrating compliance with industry and legal Requirements.
- Improved customer satisfaction – through delivery of products that consistently meet Customer requirements.
- Ability to win more business – via easier access to global markets and new business and investment prospects.
- Improved operational processes and greater efficiency – through implementation of a Single management system and reduced audit requirements.
- Improved risk management – through greater consistency and traceability of products and services.

Demo Videos

http://youtube.com/watch?v=wBIxVRoPcv0

References

6. DALE H.BESTERFILED, ET AL., "Total Quality Management", Pearson Education, Inc. 2003. (Indian Reprint 2004). ISBN 81-297-0260-6.
7. Feigenbaum. A.V. "Total Quality Management", McGraw-Hill, 1991.
8. ZEIRI, "Total Quality Management for Engineers", Wood Head Publishers, 1991.

Answers to the assignments with full explanation
Assignment 9

1. **Internal Audits**

Objectives – determine actual performance, initiate corrective action, fol ow up, provide continuous improvement through feedback, Auditor – trained profs, ASQ updates training, written and oral comm., honesty, unbiased etc., Techniques – Examine, Observe and interviews. Procedure – check list, documentation procedure, priority list etc.,

2. **Basic Requirements of ISO 9001**

- Procedure to cover al processes in the business
- Monitoring process to ensure effectiveness
- Keeping adequate record
- Defect verification and appropriate correction
- Regular review of individual processes
- Facilitating continual improvement

3. **Benefits of ISO Registration**

1. Increase in internal quality – reduction of scrap, rework etc
2. Production reliability – measure of breakdowns, time and shift management etc
3. External quality – acceptance by customers, less claims, return of goods
4. Time performance – marketing, delivery, production time etc
5. Cost of poor quality – scraps and rework

4. Registration – Selecting a Registrar - ASQ member, Registrar Accreditation Board RAB.

1. Qualification and Experience – Track record, client list, industry specific
2. Certificate of Recognition – authenticity of the registrar, reference, customer check
3. Registration process – structured process, help quality and productivity, efficiency
4. Time and cost constraints – period of the process, additional fees etc
5. Auditor qualifications – know the industry standard, types of process, knowledge. Interest etc

5. Documentation

1. Policy
2. Procedure
3. Work instructions
4. Records
5. Document Development

Course Material

Name of the Course : **Total Quality Management**

Name of the Unit : **Quality systems**

Name of the Topic : Introduction to the ISO 14000.

- Objectives: To adopt the quality systems.

1. Outcomes: **Upon successful completion, the student should be able to Practice the Quality Management Systems in a different organization Environment.**

2. Pre-requisites: **To have a basic knowledge of Production Planning and Control.**

1. If variability of a product decreases, its quality _____

A. remains unchanged

B. decreases

C. increases

D. may increase or decrease

2. The key process input variables (KPIV) and key process output variables are developed during the _____ phase.

A. Define
B. Analyze
C. Measure
D. Improve

3. Which of the following statement is false:

A. Important step of strategic quality management is identification of those dimensions in which the organization will compete
B. Selection of suppliers should be based on quality, schedule, and cost, rather than on cost alone
C. All of the individuals in the organization must have an understanding of the basic tools of quality improvement

D. Manufacturing Unit should be the unit focusing on Quality Improvement among all units in an organization

4. Effective quality improvement can be instrumental in:

A. Increasing productivity
B. Reducing cost
C. Both a and b
D. None of the above

5. Typically in a cause and effect diagram, the _____ is used for classification of causes in the service industry.

A. 5Ms
B. 8Ps
C. 5Ss
D. 6Ps

6. Service Assurance is

A. Confidence with customer
B. Customer has trust
C. Employee has knowledge
D. All of the above

7. EMS stands for

A. Environmental management system
B. Employees management system
C. Engineering management system
D. Equipment management system

8. Which of the following is for Environment management?

A. ISO-9000
B. ISO-14000
C. ISO-26000
D. ISO-31000

9. ISO - 14001 gives stress on

A. Plan - Do -check -Act
B. Environmental protection
C. Prevention rather than detection
D. All of the above

10. As one of its goal the project organization has quality to specified performance measures. When compared with the functional organization, the project organization _____.

A. achieves higher levels of quality
B. is always tailored to meet the specific quality goals
C. is less disciplined in the implementation of quality
D. is more disciplined in the implementation of quality

3.ISO 14000 – ENVIRONMENTAL MANAGEMENT SYSTEM

The overall aim of the Environmental Management systems is to provide protection to the environment and to prevent pollution.

- The success of ISO 9000 along with increased emphasis on Environmental issues were instrumental in ISO' decision to develop Environmental Management Standards.
- In 1991, ISO formed the Strategic Advisory Group on the Environment (SAGE) which led to the formation of Technical Committee (TC) 207 in 1992.
- Mission of TC207 is to develop standards for an Environmental Management System (EMS) which was identified as ISO 14000.

TC207 has established six sub-committees

1. Environmental Management System (EMS)
2. Environmental Auditing (EA)
3. Environmental labeling (EL)
4. Environmental Performance Evaluation (EPE)
5. Life-Cycle Assessment (LCA)
6. Terms & Definitions

Environmental Management System (EMS):
EMS has two Evaluation Standards. They are

1. Organization Evaluation Standards
2. Product Evaluation Standards

REQUIREMENT OF ISO 14001

There are six elements

1. GENERAL REQUIREMENTS

EMS should include policy, planning implementation and operation, checking and corrective action, management review.

2. ENVIRONMENTAL POLICY (Should be based on mission)

- The policy must be relevant to the organization's nature.
- Management's Commitment (for continual improvement and preventing Pollution).
- Should be a framework (for Environmental objectives and Targets).
- Must be Documented, Implemented, and Maintained.

3. PLANNING

- Environmental aspects.
- Legal and other requirements.
- Objectives and targets.
- Environmental Management Programs.

4. IMPLEMENTATION & OPERATION

- Structure and responsibility.
- Training, Awareness, and Competency.
- Communication.
- EMS Documentation.
- Document Control.
- Operational Control.
- Emergency Preparedness and Response.

5. CHECKING & CORRECTIVE ACTION

- Monitoring and Measuring.
- Non-conformance and Corrective and Preventive action.
- Records.
- EMS Audit.

6. MANAGENMENT REVIEW

Review of objectives and targets.

Review of Environmental performance against legal and other

Requirement.

Effectiveness of EMS elements.

Evaluation of the continuation of the policy.

4.BENEFITS OF ENVIRONMENTAL MANAGEMENT SYSTEM:

GLOBAL BENEFITS

- Facilitate trade and remove trade barrier.
- Improve environmental performance of planet earth.
- Build consensus that there is a need for environmental management and a common terminology for EMS.

ORGANIZATIONAL BENEFITS

- Assuring customers of a commitment to environmental management.
- Meeting customer requirement.
- Improve public relation.
- Increase investor satisfaction.
- Market share increase.
- Conserving input material and energy.
- Better industry/government relation.
- Low cost insurance, easy attainment of permits and authorization.

Test after completion

1. The products manufactured during 1800s were unique. How quality was ensured in this era?

A. Through renovation

B. Through inspection

C. Through calculation

D. Through repair

2. Big Q is:

A. Quality of services

B. Quality of people

C. Quality of processes

D. All of the above

3. Most quality problems

A. originate in the quality department where the ultimate responsibility for quality rests
B. originate on the shop floor because of waste and product rework
C. are the result of management's lack of attention to potential quality improvement ideas
D. could be eliminated if shop supervisors monitored their workers more closely

4. The primary components of quality management are quality _____.

A. inspections, certifications, and validations
B. philosophy, assurance, and control
C. form, fit, and function
D. reliability, maintainability, and availability

5. What was the primary concern of managers during 1980s?

A. Detection
B. Strategic impact
C. Control
D. Coordination

Conclusion

- ISO 14000 is Product and Process oriented.
- Determines environmental impacts of products and services; establish, maintain and evaluate EMS.
- ISO 14000 is Process NOT a Performance standard.

- ISO 14000 / EMAS / BS 7750 are all standards of implementation of EMS
- ISO 14000 entails five aspects:
    - Environmental Management System
    - Environmental Auditing and related investigations
    - Environmental Labels and Declarations
    - Environmental Performance Evaluation
    - Life Cycle Analysis & Terms and Definitions.

Demo Videos

http://youtube.com/watch?v=ppcR-R6AhNc

References

1. DALE H.BESTERFILED, ET AL., "Total Quality Management", Pearson Education, Inc. 2003. (Indian Reprint 2004). ISBN 81-297-0260-6.
2. Feigenbaum. A.V. "Total Quality Management", McGraw-Hill, 1991.
3. ZEIRI, "Total Quality Management for Engineers", Wood Head Publishers, 1991.

Answers to the assignments with full explanation
Assignment 10

1. An environmental management system (EMS) is a management structure that allows an organization to assess and control the environmental impact of its activities, products or services.

2. WHY ISO 14000?

- Reduces environmental liability
- Enhances public image and reputation
- Assures customers
- Satisfies investor criteria

- Meets your clients' registration requirements

3. An environmental "Aspect" is any element of an organization's activities, products, or services that can interact with the environment causing impact to the environment, whether adverse or beneficial.

4. An environmental "Objective" is an overall environmental goal, arising from the environmental policy, that an organization sets itself to achieve, and which is quantified where practicable.

5. An environmental "Target" is a detailed performance requirement, quantified where practicable, applicable to the organization or parts thereof, that arises from the environmental objectives and that needs to be set and met in order to achieve those objectives.

Course Material for Unit - 5

Name of the Course : **Total Quality Management**

Name of the Unit : **Statistical Process Control (SPC)**

Name of the Topic : Introduction to the seven tools of quality and Statistical fundamentals.

- Objectives: To apply the statistical process control.

1. Outcomes: **Upon successful completion, the student should be able to analyze various TQM parameters with help of statistical tools.**

2. Pre-requisites: **To have a basic knowledge of Production Planning and Control.**

1._____ is not a process tools for TQM systems.

A. Process flow analysis

B. Histograms

C. Plier

D. Control charts

2. Reliability is the degree to which a unit of equipment performs its intended function under _____ for _____ of time.

A. Specified conditions; specified period

B. Any condition; specified period

C. Specified conditions; all periods

D. Any condition; any period

3. DMAIC is _____

A. Develop, multiply, analyze, improve, check

B. Define, multiply, analyze, improve, control

C. Define, measure, analyze, improve, control

D. Define, manufacture, analyze, improve, control.

4. Check sheet is used during _____ stage of DMAIC.

A. Define

B. Measure

C. Analyze

D. Improve

5. For a given sample size (n) and number of defects acceptable ©, the Average Total Inspection (of units) should _____ with increase in N (lot size).

A. Increase

B. Decrease

C. Remain Constant

D. None of the above

6.Apart from Poisson distribution, another distribution that can be applied to events data is:

A. Normal Distribution

B. Geometric Distribution

C. Lognormal Distribution

D. Continuous Distribution

7.The probability distribution function corresponding to tossing of a coin will be a:

A. Probability Density function

B. Probability Mass function

C. Probability Measurement function

D. Probability Cumulative Function

8.If variability of a product decreases, its quality _____

A. Remains unchanged

B. Decreases

C. Increases

D. May increase or decrease

9. If only _____ causes of variation are present, the output of a process forms a distribution that is table over time and is predictable.

A. Assignable

B. Non-Random

C. Natural

D. Cannot be said.

10._____ diagram is used for identifying potential relationship between two variables.

(A) Pareto

(B) Ishikawa

(C) Histogram

(D) Scatter

3**.QUALITY CONTROL**

DEFINITION OF QUALITY:

- The meaning of "Quality" is closely allied to cost and customer needs. "Quality" may simply be defined as fitness for purpose at lowest cost.
    - The component is said to possess good quality, if it works well in the equipment for which it is meant. Quality is thus defined as fitness for purpose.
- Quality is the 'totality of features and characteristics' both for the products and services that can satisfy both the explicit and implicit needs of the customers.
- "Quality" of any product is regarded as the degree to which it fulfills the requirements of the customer.
- "Quality" means degree of perfection. Quality is not absolute but it can only be judged or realized by comparing with standards. It can be determined by some

characteristics namely, design, size, material, chemical composition, mechanical functioning, workmanship, finish and other properties.

MEANING OF CONTROL

- Control is a system for measuring and checking (inspecting) a phenomenon.
- It suggests when to inspect, how often to inspect and how much to inspect.
- In addition, it incorporates a feedback mechanism which explores the causes of poor quality and takes corrective action.
- Control differs from 'inspection', as it ascertains quality characteristics of an item, compares the same with prescribed quality standards and separates defective items from non-defective ones.
- Inspection, however, does not involve any mechanism to take corrective action.

4.MEANING OF QUALITY CONTROL

- Quality Control is a systematic control of various factors that affect the quality of the product.
- The various factors include material, tools, machines, type of labour, working conditions, measuring instruments, etc.
- Quality Control can be defined as the entire collection of activities which ensures that the operation will produce the optimum Quality products at minimum cost.
- As per A.Y. Feigorbaum Total Quality Control is: "An effective system for integrating the quality development, Quality maintenance and Quality improvement efforts of the various groups in an organization, so as to enable production and services at the most economical levels which allow full customer satisfaction"
- In the words of Alford and Beatly, "Quality Control" may be broadly defined as that "Industrial management technique means of which products of uniform accepted quality are manufactured." Quality Control is concerned with making things right rather than discovering and rejecting those made wrong.

In short, we can say that quality control is a technique of management for achieving required standards of products.

FACTORS AFFECTING QUALITY

In addition to men, materials, machines and manufacturing conditions there are some other factors which affect the product quality. These are:

- Market Research i.e. in-depth into demands of purchaser.

- Money i.e. capability to invest.
- Management i.e. Management policies for quality level.
- Production methods and product design.

Modern quality control begins with an evaluation of the customer's requirements and has a part to play at every stage from goods manufactured right through sales to a customer, who remains satisfied.

OBJECTIVES OF QUALITY CONTROL

- To decide about the standard of quality of a product that is easily acceptable to the customer and at the same time this standard should be economical to maintain.
- To take different measures to improve the standard of quality of product.
- To take various steps to solve any kind of deviations in the quality of the product during manufacturing.

FUNCTIONS OF QUALITY CONTROL DEPARTMENT

- Only the products of uniform and standard quality are allowed to be sold.
- To suggest method and ways to prevent the manufacturing difficulties.
- To reject the defective goods so that the products of poor quality may not reach to the customers.
- To find out the points where the control is breaking down and to investigate the Causes of it.
- To correct the rejected goods, if it is possible. This procedure is known as Rehabilitation of defective goods.

ADVANTAGES OF QUALITY CONTROL

- Quality of product is improved which in turn increases sales.
- Scrap rejection and rework are minimized thus reducing wastage. So the cost of manufacturing reduces.
- Good quality product improves reputation.
- Inspection cost reduces to a great extent.
- Uniformity in quality can be achieved.
- Improvement in manufacturer and consumer relations.

6.STATISTICAL QUALITY CONTROL (S.Q.C):

- Statistics: Statistics means data, a good amount of data to obtain reliable results.
- The science of statistics handles this data in order to draw certain conclusions.
- S.Q.C: This is a quality control system employing the statistical techniques to control quality by performing inspection, testing and analysis to conclude whether the quality of the product is as per the laid quality standards.
- Using statistical techniques, S.Q.C. collects and analyses data in assessing and controlling product quality. The technique of S.Q.C. was though developed in 1924 by Dr.WalterA.Shewartan American scientist; it got recognition in industry only second world war. The technique permits a more fundamental control.

"Statistical quality control can be simply defined as an economic & effective system of maintaining & improving the quality of outputs throughout the whole operating process of specification, production & inspection based on continuous testing with random samples." -YA LUN CHOU

"Statistical quality control should be viewed as a kit of tools which may influence decisions to the functions of specification, production or inspection. -EUGENE L. GRANT

The fundamental basis of S.Q.C. is the theory of probability. According to the theories of probability, the dimensions of the components made on the same machine and in one batch (if measured accurately) vary from component to component. This may be due to inherent machine characteristics or the environmental conditions. The chance or condition that a sample will represent the entire batch or population is developed from the theory of probability.

Relying itself on the probability theory, S.Q.C. evaluates batch quality and controls the quality of processes and products. S.Q.C. uses three scientific techniques, namely;

- Sampling inspection
- Analysis of the data, and
- Control charting

ADVANTAGES OF S.Q.C

S.Q.C is one of the tool for scientific management, and has following main advantages over 100 percent inspection:

Reduction in cost: Since only a fractional output is inspected, hence cost of inspection is greatly reduced.

Greater efficiency: It requires lesser time and boredom as compared to the 100 percent inspection and hence the efficiency increases.

Easy to apply: Once the S.Q.C plan is established, it is easy to apply even by man who does not have extensive specialized training.

Accurate prediction: Specifications can easily be predicted for the future, which is not possible even with 100 percent inspection.

Can be used where inspection is needs destruction of items: In cases where destruction of product is necessary for inspecting it, 100 percent inspection is not possible (which will spoil all the products), sampling inspection is resorted to.

Early detection of faults: The moment a sample point falls outside the control limits, it is taken as a danger signal and necessary corrective measures are taken. Whereas in 100 percent inspection, unwanted variations in quality may be detected after large number of defective items have already been produced. Thus by using the control charts, we can know from graphic picture that how the production is proceeding and where corrective action is required and where it is not required.

7.THE SEVEN TOOLS OF QUALITY CONTROL

1. Cause and effect analysis
2. Flowcharts
3. Checklists
4. Control techniques including Statistical quality control and control charts.
5. Scatter diagram
6. Pareto analysis which means identification of vital few from many at a glance. This is used for fixing the priorities in tackling a problem.
7. Histograms.

Cause-and-Effect Diagrams

- **Cause-and-effect diagrams** are charts that identify potential causes for particular quality problems. They are often called fishbone diagrams because they look like the bones of a fish. A general cause-and-effect diagram is shown in Figure 5-8.
- The “head” of the fish is the quality problem, such as damaged zippers on a garment or broken valves on a tire. The diagram is drawn so that the “spine” of

the fish connects the “head” to the possible cause of the problem.

- These causes could be related to the machines, workers, measurement, suppliers, materials, and many other aspects of the production process.
- Each of these possible causes can then have smaller “bones” that address specific issues that relate to each cause. For example, a problem with machines could be due to a need for adjustment, old equipment, or tooling problems.
- Similarly, a problem with workers could be related to lack of training, poor supervision, or fatigue.
- Cause-and-effect diagrams are problem-solving tools commonly used by quality control teams. Specific causes of problems can be explored through brainstorming.
- The development of a cause-and-effect diagram requires the team to think through all the possible causes of poor quality.

Flowcharts

- A flowchart is a schematic diagram of the sequence of steps involved in an operation or process.
- It provides a visual tool that is easy to use and understand.
- By seeing the steps involved in an operation or process, everyone develops a clear picture of how the operation works and where problems could arise.

Checklists

- A checklist is a list of common defects and the number of observed occurrences of these defects.
- It is a simple yet effective fact-finding tool that allows the worker to collect specific information regarding the defects observed.
- The checklist in Figure 5-7 shows four defects and the number of times they have been observed.
- It is clear that the biggest problem is ripped material. This means that the plant needs to focus on this specific problem—for example, by going to the source of supply or seeing whether the material rips during a particular production process.
- A checklist can also be used to focus on other dimensions, such as location or time.
- For example, if a defect is being observed frequently, a checklist can be developed that measures the number of occurrences per shift, per machine, or per operator. In this fashion we can isolate the location of the particular defect and then focus on correcting

the problem.

Control Charts

- Control charts are a very important quality control tool. We will study the use of control charts at great length in the next chapter.
- These charts are used to evaluate whether a process is operating within expectations relative to some measured value such as weight, width, or volume.
- For example, we could measure the weight of a sack of flour, the width of a tire, or the volume of a bottle of soft drink.
- When the production process is operating within expectations, we say that it is "in control."
- To evaluate whether or not a process is in control, we regularly measure the variable of interest and plot it on a control chart.
- The chart has a line down the center representing the average value of the variable we are measuring.
- Above and below the center line are two lines, called the upper control limit (UCL) and the lower control limit (LCL).
- As long as the observed values fall within the upper and lower control limits, the process is in control and there is no problem with quality. When a measured observation falls outside of these limits, there is a problem.

Scatter Diagrams

- Scatter diagrams are graphs that show how two variables are related to one another.
- They are particularly useful in detecting the amount of correlation, or the degree of linear relationship, between two variables.
- For example, increased production speed and number of defects could be correlated positively; as production speed increases, so does the number of defects.
- Two variables could also be correlated negatively, so that an increase in one of the variables is associated with a decrease in the other.
- For example, increased worker training might be associated with a decrease in the number of defects observed.
- The greater the degree of correlation, the more linear are the observations in the scatter diagram.
- On the other hand, the more scattered the observations in the diagram, the less correlation exists between the variables.
- Of course, other types of relationships can also be observed on a scatter diagram,

such as an inverted. This may be the case when one is observing the relationship between two variables such as oven temperature and number of defects, since temperatures below and above the ideal could lead to defects.

Pareto Analysis

- Pareto analysis is a technique used to identify quality problems based on their degree of importance.
- The logic behind Pareto analysis is that only a few quality problems are important, whereas many others are not critical.
- The technique was named after Vilfredo Pareto, a nineteenth-century Italian economist who determined that only a small percentage of people controlled most of the wealth.
- This concept has often been called the 80–20 rule and has been extended too many areas.
- In quality management the logic behind Pareto's principle is that most quality problems are a result of only a few causes. The trick is to identify these causes.
- One way to use Pareto analysis is to develop a chart that ranks the causes of poor quality in decreasing order based on the percentage of defects each has caused.
- For example, a tally can be made of the number of defects that result from different causes, such as operator error, defective parts, or inaccurate machine calibrations.
- Percentages of defects can be computed from the tally and placed in a chart like those shown in Figure 5-7.We generally tends to find that a few causes account for most of the defects.

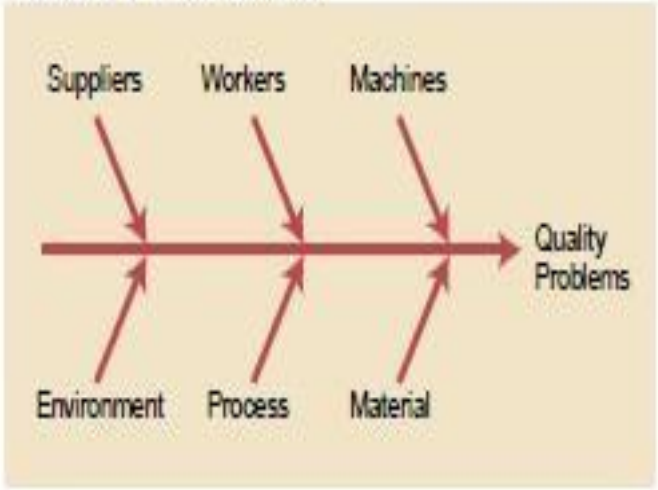
Histograms

- A **histogram** is a chart that shows the frequency distribution of observed values of a variable.
- We can see from the plot what type of distribution a particular variable displays, such as whether it has a normal distribution and whether the distribution is symmetrical.
- In the food service industry the use of quality control tools is important in

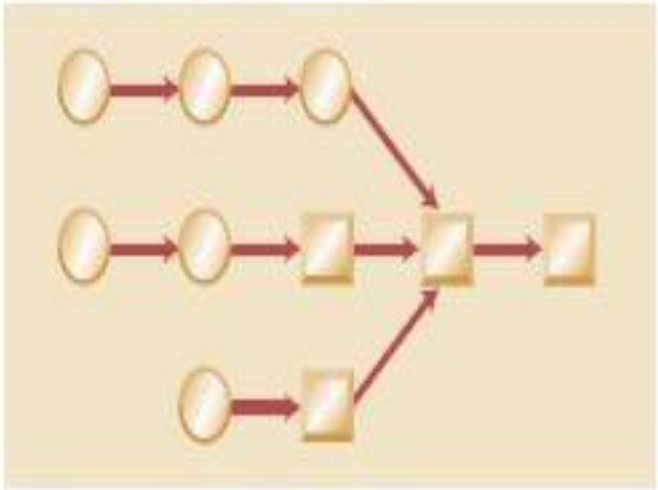
identifying quality problems.

- Grocery store chains, such as Kroger and Meijer, must record and monitor the quality of incoming produce, such as tomatoes and lettuce.
- Quality tools can be used to evaluate the acceptability of product quality and to monitor product quality from individual suppliers.
- They can also be used to evaluate causes of quality problems, such as long transit time or poor refrigeration.
- Similarly, restaurants use quality control tools to evaluate and monitor the quality of delivered goods, such as meats, produce, or baked goods.

1. Cause-and-Effect Diagram



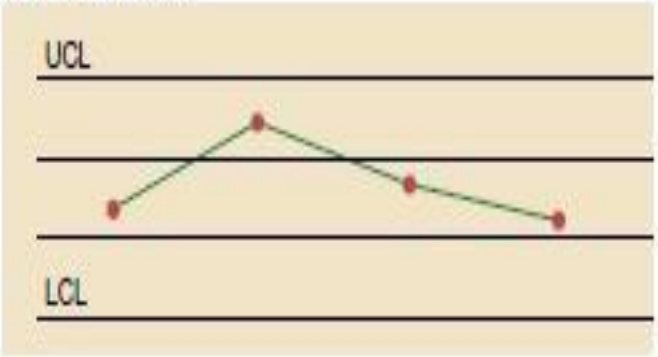
2. Flowchart



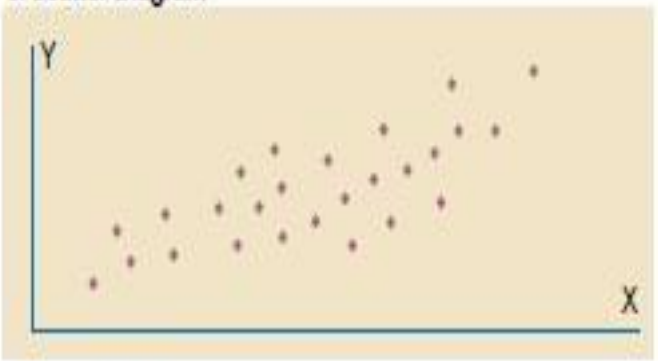
3. Checklist

Defect Type	No. of Defects	Total
Broken zipper	✓✓✓	3
Ripped material	✓✓✓✓✓✓✓	7
Missing buttons	✓✓✓	3
Faded color	✓✓	2

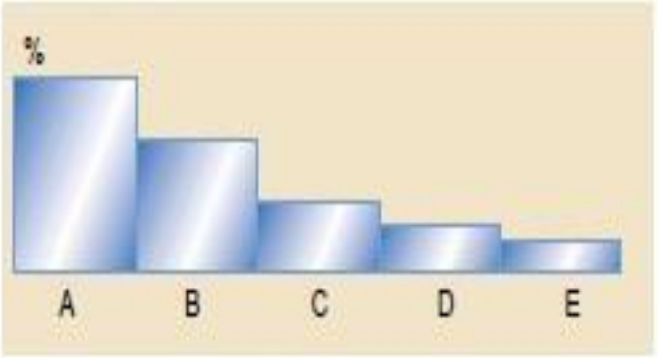
4. Control Chart



5. Scatter Diagram



6. Pareto Chart



7. Histogram

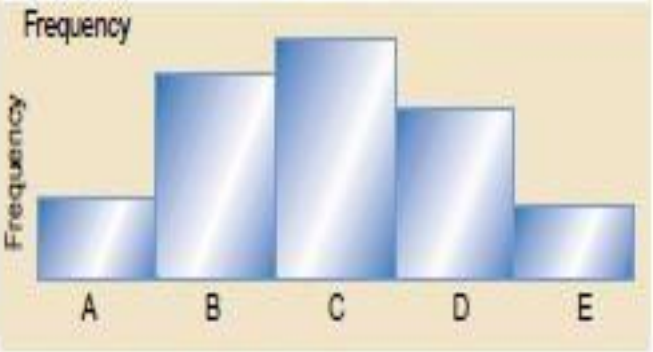


FIGURE 5-7

The seven tools of quality control

Test after completion

1. Machine wear and tear is _____ source of variation.

A. Random

B. Natural

C. Assignable

D. Cannot be determined

2. Apart from Poisson distribution, another distribution that can be applied to events data is:

A. Normal Distribution
B. Geometric Distribution
C. Lognormal Distribution
D. Continuous Distribution

3. The dimension of reliability is concerned with:

A. How easy it is to repair the product
B. How long does the product last
C. Will the product do the intended job
D. How often does the product fail

4. Average Total Inspection is defined as:

A. Average of rejected lots and accepted lots
B. Average number of units inspected per lot
C. Average of rejected Lots
D. Average of accepted Lots

5. Bias reflects the:

A. The differences in observed accuracy and/or precision experienced over the range of measurements made by the system.

B. The difference between observed measurements and a "true" value obtained from a master or gold standard

C. Different levels of variability in different operating regimes, resulting from warm-up effects, environmental factors, inconsistent operator performance

D. None of the above

Conclusion

1. The most important thing in improving quality is to start somewhere, doing something. As you begin using the Pareto chart to decide where your problems are, you will discover many things about your processes and will come because you will know where to improve.
2. Improvement requires knowledge. The more information we have about our processes the better we are at improving them. Cause-and-effect diagrams are one quality tool that is simple yet very powerful in helping us better understand our processes.
3. Histogram is simple tools that allow the user to identify and interpret the variation found in a set of data points. It is important to remember that histograms do not give solutions to problems.
4. Scatter diagrams allow the user to graphically identify correlations that could exist between a quality characteristic and a factor that might be driving it. It is a quality tool that is simple, easy to communicate to others, and generally easy to interpret.
5. Flow charts can be used to describe a single process, parts of a process, or a set of processes. There is no right or wrong way to draw a flow chart. The true test of a flow chart is how well those who create and use it can understand it.

Demo Videos

http://youtube.com/watch?v=NYTYgv0cP5s

References

1. DALE H.BESTERFILED, ET AL., "Total Quality Management", Pearson Education, Inc. 2003. (Indian Reprint 2004). ISBN 81-297-0260-6.
2. Feigenbaum. A.V. "Total Quality Management", McGraw-Hill, 1991.
3. ZEIRI, "Total Quality Management for Engineers", Wood Head Publishers, 1991.

Answers to the assignments with full explanation
Assignment 11

1. Statistics is a mathematical science pertaining to the col ection, analysis, interpretation or explanation, and presentation of data. It is applicable to a wide variety of academic disciplines, from the natural and social sciences to the humanities, government and business.

2. Pareto Principle: The Pareto concept was developed by the describing the frequency distribution of any given characteristic of a population. Also called the 20-80 rule, he determined that a small percentage of any given group (20%) account for a high amount of a certain characteristic (80%).

3. Cause-and-Effect Diagrams - 1943 by Mr. Kaoru Ishikawa at the University of Tokyo. **Purpose:** One important part of process improvement is continuously striving to obtain more information about the process and its output. Cause-and-effect diagrams allow us to do not just that, but also can lead us to the root cause, or causes, of problems.

4. Purpose of Histograms: To determine the spread or variation of a set of data points in a graphical form. It is always a desire to produce things that are equal to their design values. **Histograms:** A histogram is a tool for summarizing, analyzing, and displaying data. It provides the user with a graphical representation of the amount of variation found in a set of data.

5.Scatter Diagrams: A scatter diagram is a nonmathematical or graphical approach for identifying relationships between a performance measure and factors that might be driving it. This graphical approach is quick, easy to communicate to others, and general y easy to interpret. **Interpreting the Results**: Once all the data points have been plotted onto the scatter diagram, you are ready to determine whether there exists a relation between the two selected items or not. When a strong relationship is present, the change in one item will automatically cause a change in the other. If no relationship can be detected, the change in one item will not effect the other item. There are three basic

types of relationships that can be detected to on a scatter diagram:

1. Positive relationship
2. Negative relationship
3. No relationship

Course Material

Name of the Course : **Total Quality Management**

Name of the Unit : **Statistical Process Control (SPC)**

Name of the Topic : Introduction to the Control charts for variables and attributes.

- Objectives: To apply the statistical process control.

1. Outcomes: **Upon successful completion, the student should be able to analyze various TQM parameters with help of statistical tools.**

2. Pre-requisites: **To have a basic knowledge of Production Planning and Control.**

1. The pattern of continuous movement in one direction in a control chart is termed as:

A. Mixture

B. Cyclic Pattern

C. Trend

D. Stratification

2. For a point in the control chart to be out of control, it must lie

A. Above UCL or Below LCL

B. Between Central Line and LCL

C. Between Central Line and UCL

D. None of the above.

3. X bar should never be interpreted when:

A. R chart shows out of control points

B. X bar chart shows out of control points

C. The process mean is not known

D. None of the above.

4. A major assumption for p chart is that all units produced are _____

A. Independent

B. Dependent

C. None of the above

D. Cannot be determined

5. R charts are used for controlling _____ of a process.

A. Central Tendency

B. Dispersion

C. None of the above

D. Both A and B.

6. The x bar chart monitors:

A. Between sample variability

B. Within sample variability

C. Instantaneous variability

D. Natural variability

7. In case someone is interested in process standard deviation, he should construct the _____ chart.

A. X bar

B. R chart

C. S chart

D. None of the above.

8. A company wants to measure the length of a fan as a part of its quality control exercise. The type of data collected will be:

A. Variable

B. Attribute

C. Cannot be determined

D. None of the above

9. The g chart is the control chart for:

A. Average number of events

B. Total number of events

C. Mean number of events

D. None of the above

10. Lots for acceptance sampling should be _____ and _____.

A. Homogeneous, Large

B. Heterogeneous, Small

C. Homogeneous, Small

D. Heterogeneous, Large

3. PROCESS CONTROL

- Under this the quality of the products is controlled while the products are in the process of production.
- The process control is secured with the technique of control charts.
- Control charts are also used in the field of advertising, packing etc.
- They ensure that whether the products confirm to the specified quality standard or not.
- Process Control consists of the systems and tools used to ensure that processes are well defined, performed correctly, and maintained so that the completed product conforms to established requirements.
- Process Control is an essential element of managing risk to ensure the safety and reliability of the Space Shuttle Program.
- It is recognized that strict process control practices will aid in the prevention of process escapes that may result in or contribute to in-flight anomalies, mishaps, incidents and non-conformances.

The five elements of a process are:

- People – skilled individuals who understand the importance of process and change control.
- Methods/Instructions – documented techniques used to define and perform a process.
- Equipment – tools, fixtures, facilities required to make products that meet requirements.
- Material – both product and process materials used to manufacture and test products.
- Environment – environmental conditions required to properly manufacture and test products.

4. PROCESS CONTROL SYSTEMS FORMS

Process control systems can be characterized as one or more of the following forms:

Discrete – Found in many manufacturing, motion and packaging applications. Robotic assembly, such as that found in automotive production, can be characterized as discrete process control.

Most discrete manufacturing involves the production of discrete pieces of product, such as metal stamping.

Batch – Some applications require that specific quantities of raw materials be combined in specific ways for particular durations to produce an intermediate or end result.

One example is the production of adhesives and glues, which normally require the mixing of raw materials in a heated vessel for a period of time to form a quantity of end product.

Other important examples are the production of food, beverages and medicine. Batch processes are generally used to produce a relatively low to intermediate quantity of product per year (a few pounds to millions of pounds).

Continuous – Often, a physical system is represented through variables that are smooth and uninterrupted in time.

The control of the water temperature in a heating jacket, for example, is an example of continuous process control.

Some important continuous processes are the production of fuels, chemicals and plastics.

Continuous processes in manufacturing are used to produce very large quantities of product per year (millions to billions of pounds).

5. STATISTICAL PROCESS CONTROL (SPC)

- SPC is an effective method of monitoring a process through the use of control charts.
- Much of its power lies in the ability to monitor both process center and its variation about that center.
- By collecting data from samples at various points within the process, variations in the process that may affect the quality of the end product or service can be detected and corrected, thus reducing waste as well as the likelihood that problems will be passed on to the customer.
- It has an emphasis on early detection and prevention of problems.

6. CONTROL CHARTS

- Since variations in manufacturing process are unavoidable, the control chart tells when to leave a process alone and thus prevent unnecessary frequent adjustments.
- Control charts are graphical representation and are based on statistical sampling theory, according to which an adequate sized random sample is drawn from each lot.
- Control charts detect variations in the processing and warn if there is any departure from the specified tolerance limits.
- These control charts immediately tell the undesired variations and help in detecting the cause and its removal.
- In control charts, where both upper and lower values are specified for a quality characteristic, as soon as some products show variation outside the tolerances, a review of situation is taken and corrective step is immediately taken.
- If analysis of the control chart indicates that the process is currently under control (i.e. is stable, with variation only coming from sources common to the process) then data from the process can be used to predict the future performance of the process.
- If the chart indicates that the process being monitored is not in control, analysis of the chart can help determine the sources of variation, which can then be eliminated to bring the process back into control.
- A control chart is a specific kind of run chart that allows significant change to be differentiated from the natural variability of the process.
- The control chart can be seen as part of an objective and disciplined approach that enables correct decisions regarding control of the process, including whether or not to change process control parameters.
- Process parameters should never be adjusted for a process that is in control, as this will result in degraded process performance.

In other words, control chart is:

- A device which specifies the state of statistical control,

- A device for attaining statistical control,
- A device to judge whether statistical control has been attained or not.

PURPOSE AND ADVANTAGES:

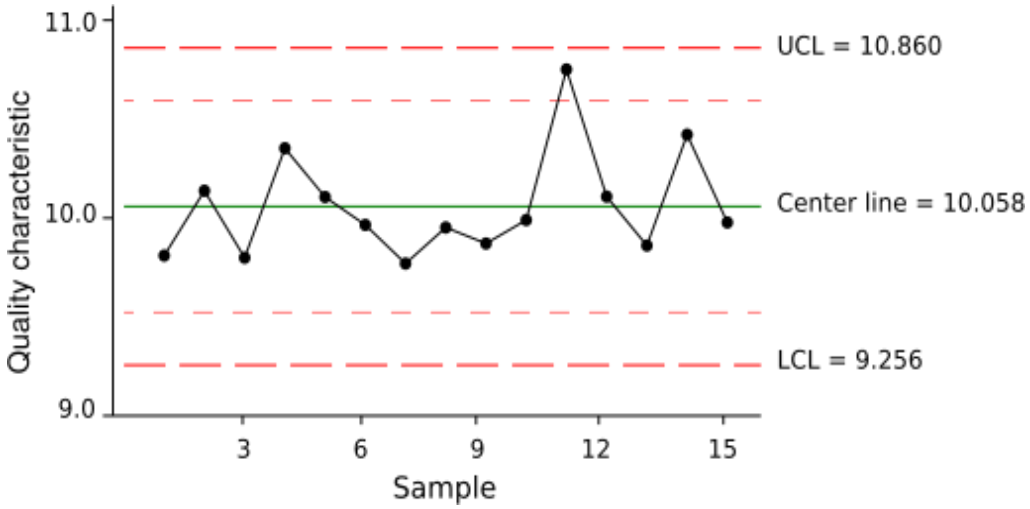
1. A control charts indicates whether the process is in control or out of control.
2. It determines process variability and detects unusual variations taking place in a process.
3. It ensures product quality level.
4. It warns in time, and if the process is rectified at that time, scrap or percentage rejection can be reduced.
5. It provides information about the selection of process and setting of tolerance limits.
6. Control charts build up the reputation of the organization through customer's satisfaction.

A control chart consists of:

- Points representing a statistic (e.g., a mean, range, proportion) of measurements of a quality characteristic in samples taken from the process at different times [the data].
- The mean of this statistic using all the samples is calculated (e.g., the mean of the means, mean of the ranges, mean of the proportions).
- A centre line is drawn at the value of the mean of the statistic.
- The standard error (e.g., standard deviation/sqrt(n) for the mean) of the statistic is also calculated using all the samples.
- Upper and lower control limits (sometimes called "natural process limits") that indicate the threshold at which the process output is considered statistically 'unlikely' are drawn typically at 3 standard errors from the centre line.

The chart may have other optional features, including:

- Upper and lower warning limits, drawn as separate lines, typically two standard errors above and below the center line.
- Division into zones, with the addition of rules governing frequencies of observations in each zone.
- Annotation with events of interest, as determined by the Quality Engineer in charge of the process's quality.



TYPES OF CONTROL CHARTS

1. Control charts

a. Variables or Measurement Charts

X (bar) Chart

R Chart

b. Attribute Charts

p chart

np Chart

C chart

- Control charts can be used to measure any characteristic of a product, such as the weight of a cereal box, the number of chocolates in a box, or the volume of bottled water.
- The different characteristics that can be measured by control charts can be divided into two groups: **variables** and **attributes.**

- A **control chart for variables** is used to monitor characteristics that can be measured and have a continuum of values, such as height, weight, or volume.
- A soft drink bottling operation is an example of a variable measure, since the amount of liquid in the bottles is measured and can take on a number of different values.
- Other examples are the weight of a bag of sugar, the temperature of a baking oven, or the diameter of plastic tubing.

✓ A **control chart for attributes**, on the other hand, is used to monitor characteristics that have discrete values and can be counted.

✓ Often they can be evaluated with a simple yes or no decision. Examples include color, taste, or smell.

✓ The monitoring of attributes usually takes less time than that of variables because a variable needs to be measured (e.g., the bottle of soft drink contains 15.9 ounces of liquid).

✓ An attribute requires only a single decision, such as yes or no, good or bad, acceptable or unacceptable (e.g., the apple is good or rotten, the meat is good or stale, the shoes have a defect or do not have a defect, the lightbulb works or it does not work) or counting the number of defects (e.g., the number of broken cookies in the box, the number of dents in the car, the number of barnacles on the bottom of a boat).

CONTROL CHARTS FOR VARIABLES VS. CHARTS FOR ATTRIBUTES

A comparison of variable control charts and attribute control charts are given below:

- Variables charts involve the measurement of the job dimensions and an item is accepted or rejected if its dimensions are within or beyond the fixed tolerance limits; whereas as attribute chart only differentiates between a defective item and a non-defective item without going into the measurement of its dimensions.
- Variables charts are more detailed and contain more information as compared to attribute charts.
- Attribute charts, being based upon go and no go data (which is less effective as compared to measured values) require comparatively bigger sample size.

- Variables charts are relatively expensive because of the greater cost of collecting measured data.
- Attribute charts are the only way to control quality in those cases where measurement of quality characteristics is either not possible or it is very complicated and costly to do so—as in the case of checking colour or finish of a product, or determining whether a casting contains cracks or not. In such cases the answer is either yes or no.

ADVANTAGES OF ATTRIBUTE CONTROL CHARTS

- Attribute control charts have the advantage of allowing for quick summaries of various aspects of the quality of a product, that is, the engineer may simply classify products as acceptable or unacceptable, based on various quality criteria.
- Thus, attribute charts sometimes bypass the need for expensive, precise devices and time-consuming measurement procedures.
- Also, this type of chart tends to be more easily understood by managers unfamiliar with quality control procedures; therefore, it may provide more persuasive (to management) evidence of quality problems.

ADVANTAGES OF VARIABLE CONTROL CHARTS

- Variable control charts are more sensitive than attribute control charts.
- Therefore, variable control charts may alert us to quality problems before any actual "unacceptables" (as detected by the attribute chart) will occur.
- Montgomery (1985) calls the variable control charts *leading indicators* of trouble that will sound an alarm before the number of rejects (scrap) increases in the production process.

COMMONLY USED CHARTS

1. (X-Bar) and R charts, for process control.
2. P chart, for analysis of fraction defectives

3. C chart, for control of number of defects per unit.

Mean (x-Bar) ( ) Charts

A mean control chart is often referred to as an x-bar chart. It is used to monitor changes in the mean of a process. To construct a mean chart we first need to construct the center line of the chart. To do this we take multiple samples and compute their means. Usually these samples are small, with about four or five observations. Each sample has its own mean. The center line of the chart is then computed as the mean of all sample means, where _ is the number of samples:

1. It shows changes in process average and is affected by changes in process variability.
2. It is a chart for the measure of central tendency.
3. It shows erratic or cyclic shifts in the process.
4. It detects steady progress changes, like tool wear.
5. It is the most commonly used variables chart.
6. When used along with R chart:
    a. It tells when to leave the process alone and when to chase and go for the causes leading to variation;
    b. It secures information in establishing or modifying processes, specifications or inspection procedures;
    c. It controls the quality of incoming material.
7. X-Bar and R charts when used together form a powerful instrument for diagnosing quality problems.

Range (R) charts

These are another type of control chart for variables. Whereas x-bar charts measure shift in the central tendency of the process, range charts monitor the dispersion or variability of the process.

The method for developing and using R-charts are the same as that for x-bar charts.

The center line of the control chart is the average range, and the upper and lower control limits are computed.

The R chart is used to monitor process variability when sample sizes are small (n<10), or to simplify the calculations made by process operators. This chart is called the R chart because the statistic being plotted is the sample range.

1. It controls general variability of the process and is affected by changes in process variability.
2. It is a chart for measure of spread.
3. It is generally used along with X-bar chart.

Plotting of $\bar{X}$ and R charts:

A number of samples of component coming out of the process are taken over a period of time.

Each sample must be taken at random and the size of sample is generally kept as 5 but 10 to15 units can be taken for sensitive control charts.

For each sample, the average value $\bar{X}$ of all the measurements and the range R are calculated.

$$\bar{\bar{x}} = \frac{\bar{x}_1 + \bar{x}_2 + \cdots + \bar{x}_m}{m}$$

$$\bar{R} = \frac{R_1 + R_2 + \cdots + R_m}{m}$$

Variablcs Data ($\bar{x}$ and R Control Charts)

$\bar{x}$ Control Chart

$$UCL = \bar{\bar{x}} + A_2\bar{R}$$

$$LCL = \bar{\bar{x}} - A_2\bar{R}$$

$$CL = \bar{\bar{x}}$$

R Control Chart

$$UCL = \bar{R}\,D_4$$

$$LCL = \bar{R}\,D_3$$

$$CL = \bar{R}$$

Here the factors A_2, D_4 and D_3 depend on the number of units per sample. Larger the number, the close the limits. The value of the factors A_2, D_4 and D_3 can be obtained from S.Q.C tables. However for ready reference these are given below in tabular form:

n	A_2	D_3	D_4	d_2
2	1.880	0.000	3.267	1.128
3	1.023	0.000	2.574	1.693
4	0.729	0.000	2.282	2.059
5	0.577	0.000	2.114	2.326
6	0.483	0.000	2.004	2.534
7	0.419	0.076	1.924	2.704
8	0.373	0.136	1.864	2.847
9	0.337	0.184	1.816	2.970
10	0.308	0.223	1.777	3.078

Notation:

n or m= sample size

Example

Piston for automotive engine are produced by a forging process. We wish to establish statistical control of inside diameter of the ring manufactured by this process using *x* and *R* charts.

Twenty-five samples, each of size five, have been taken when we think the process is in control. The inside diameter measurement data from these samples are shown in table.

Sample Number	Observations					$\bar{x}_i$	R_i
1	74.030	74.002	74.019	73.992	74.008	74.010	0.038
2	73.995	73.992	74.001	74.011	74.004	74.001	0.019
3	73.988	74.024	74.021	74.005	74.002	74.008	0.036
4	74.002	73.996	73.993	74.015	74.009	74.003	0.022
5	73.992	74.007	74.015	73.989	74.014	74.003	0.026
6	74.009	73.994	73.997	73.985	73.993	73.996	0.024
7	73.995	74.006	73.994	74.000	74.005	74.000	0.012
8	73.985	74.003	73.993	74.015	73.988	73.997	0.030
9	74.008	73.995	74.009	74.005	74.004	74.004	0.014
10	73.998	74.000	73.990	74.007	73.995	73.998	0.017
11	73.994	73.998	73.994	73.995	73.990	73.994	0.008
12	74.004	74.000	74.007	74.000	73.996	74.001	0.011
13	73.983	74.002	73.998	73.997	74.012	73.998	0.029
14	74.006	73.967	73.994	74.000	73.984	73.990	0.039
15	74.012	74.014	73.998	73.999	74.007	74.006	0.016
16	74.000	73.984	74.005	73.998	73.996	73.997	0.021
17	73.994	74.012	73.986	74.005	74.007	74.001	0.026
18	74.006	74.010	74.018	74.003	74.000	74.007	0.018
19	73.984	74.002	74.003	74.005	73.997	73.998	0.021
20	74.000	74.010	74.013	74.020	74.003	74.009	0.020
21	73.982	74.001	74.015	74.005	73.996	74.000	0.033
22	74.004	73.999	73.990	74.006	74.009	74.002	0.019
23	74.010	73.989	73.990	74.009	74.014	74.002	0.025
24	74.015	74.008	73.993	74.000	74.010	74.005	0.022
25	73.982	73.984	73.995	74.017	74.013	73.998	0.035
						$\Sigma = 1850.028$	0.581
						$\bar{\bar{x}} = 74.001$	$\bar{R} = 0.023$

So,

X = 74.001

R = 0.023

From S.Q.C tables (Fig.3) for sample size 5

A2=0.58, D4=2.11 and D3= 0

UCL = X + A2 R

= 74.001+ 0.58(0.023)

= 74.01434

LCL = X --

= 74.001- 0.58(0.023)

= 73.98766

UCL (R chart) =

= 2.11*0.023

= 0.04853

LCL (R chart) =

= 0*0.023

= 0

Now $\bar{X}$ and R charts are plotted on the plot as shown in Fig.1 and Fig.2

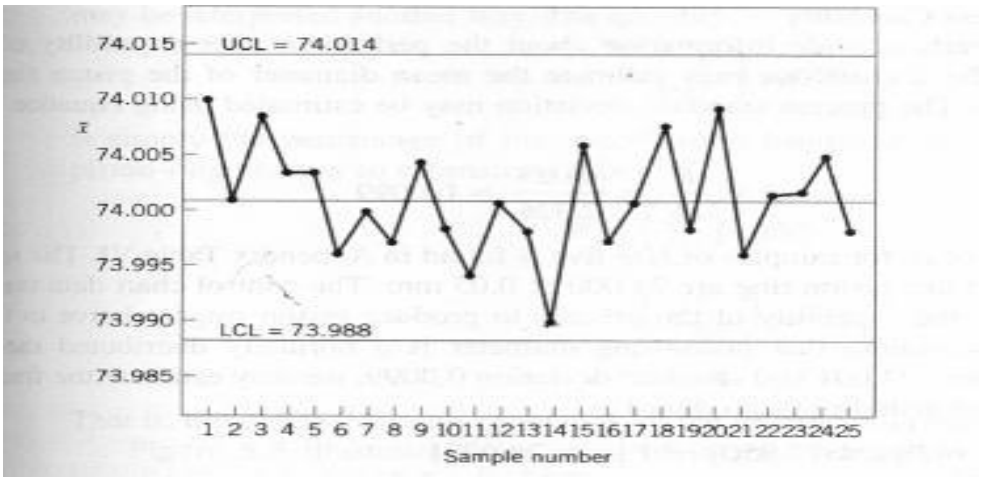


Fig.1: $\bar{X}$ Chart

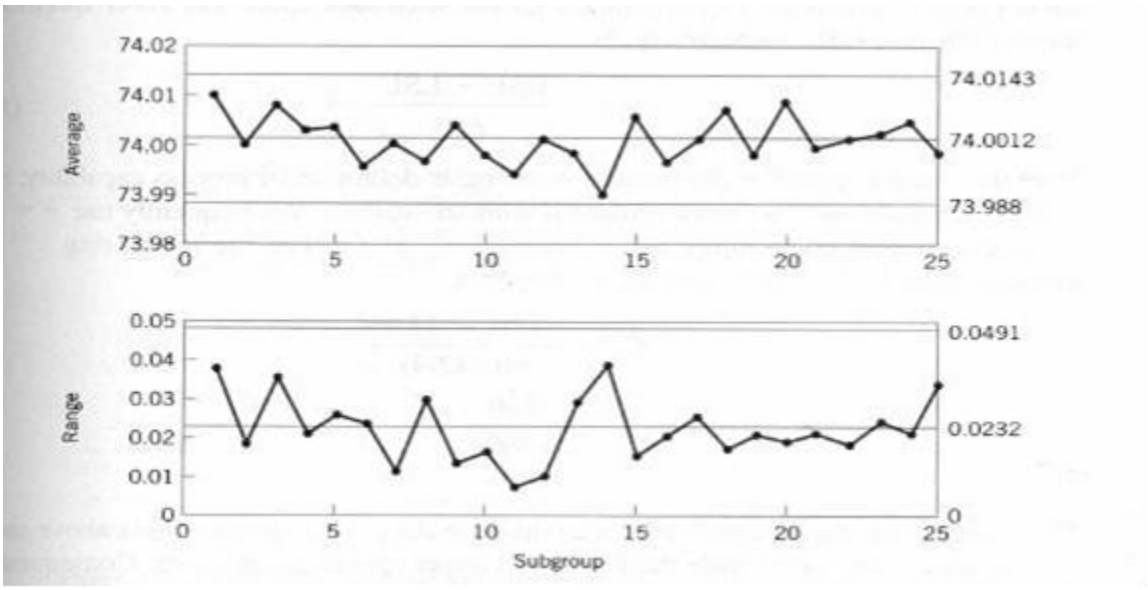


Fig.2: R Chart

Inference:

$\bar{X}$ In the $\bar{X}$ chart, all of the time the plotted points representing average are well within the control limits but if some samples fall outside the control limits then it means something has probably gone wrong or is about to go wrong with the process and a check is needed to prevent the appearance of defective products.

Observations in Sample, n	Chart for Averages: Factors for Control Limits A	A_2	A_3	Chart for Standard Deviations: Factors for Center Line c_4	$1/c_4$	Factors for Control Limits B_3	B_4	B_5	B_6	Chart for Ranges: Factors for Center Line d_2	$1/d_2$	Factors for Control Limits d_3	D_1	D_2	D_3	D_4
2	2.121	1.880	2.659	0.7979	1.2533	0	3.267	0	2.606	1.128	0.8865	0.853	0	3.686	0	3.267
3	1.732	1.023	1.954	0.8862	1.1284	0	2.568	0	2.276	1.693	0.5907	0.888	0	4.358	0	2.574
4	1.500	0.729	1.628	0.9213	1.0854	0	2.266	0	2.088	2.059	0.4857	0.880	0	4.698	0	2.282
5	1.342	0.577	1.427	0.9400	1.0638	0	2.089	0	1.964	2.326	0.4299	0.864	0	4.918	0	2.114
6	1.225	0.483	1.287	0.9515	1.0510	0.030	1.970	0.029	1.874	2.534	0.3946	0.848	0	5.078	0	2.004
7	1.134	0.419	1.182	0.9594	1.0423	0.118	1.882	0.113	1.806	2.704	0.3698	0.833	0.204	5.204	0.076	1.924
8	1.061	0.373	1.099	0.9650	1.0363	0.185	1.815	0.179	1.751	2.847	0.3512	0.820	0.388	5.306	0.136	1.864
9	1.000	0.337	1.032	0.9693	1.0317	0.239	1.761	0.232	1.707	2.970	0.3367	0.808	0.547	5.393	0.184	1.816
10	0.949	0.308	0.975	0.9727	1.0281	0.284	1.716	0.276	1.669	3.078	0.3249	0.797	0.687	5.469	0.223	1.777
11	0.905	0.285	0.927	0.9754	1.0252	0.321	1.679	0.313	1.637	3.173	0.3152	0.787	0.811	5.535	0.256	1.744
12	0.866	0.266	0.886	0.9776	1.0229	0.354	1.646	0.346	1.610	3.258	0.3069	0.778	0.922	5.594	0.283	1.717
13	0.832	0.249	0.850	0.9794	1.0210	0.382	1.618	0.374	1.585	3.336	0.2998	0.770	1.025	5.647	0.307	1.693
14	0.802	0.235	0.817	0.9810	1.0194	0.406	1.594	0.399	1.563	3.407	0.2935	0.763	1.118	5.696	0.328	1.672
15	0.775	0.223	0.789	0.9823	1.0180	0.428	1.572	0.421	1.544	3.472	0.2880	0.756	1.203	5.741	0.347	1.653
16	0.750	0.212	0.763	0.9835	1.0168	0.448	1.552	0.440	1.526	3.532	0.2831	0.750	1.282	5.782	0.363	1.637
17	0.728	0.203	0.739	0.9845	1.0157	0.466	1.534	0.458	1.511	3.588	0.2787	0.744	1.356	5.820	0.378	1.622
18	0.707	0.194	0.718	0.9854	1.0148	0.482	1.518	0.475	1.496	3.640	0.2747	0.739	1.424	5.856	0.391	1.608
19	0.688	0.187	0.698	0.9862	1.0140	0.497	1.503	0.490	1.483	3.689	0.2711	0.734	1.487	5.891	0.403	1.597
20	0.671	0.180	0.680	0.9869	1.0133	0.510	1.490	0.504	1.470	3.735	0.2677	0.729	1.549	5.921	0.415	1.585
21	0.655	0.173	0.663	0.9876	1.0126	0.523	1.477	0.516	1.459	3.778	0.2647	0.724	1.605	5.951	0.425	1.575
22	0.640	0.167	0.647	0.9882	1.0119	0.534	1.466	0.528	1.448	3.819	0.2618	0.720	1.659	5.979	0.434	1.566
23	0.626	0.162	0.633	0.9887	1.0114	0.545	1.455	0.539	1.438	3.858	0.2592	0.716	1.710	6.006	0.443	1.557
24	0.612	0.157	0.619	0.9892	1.0109	0.555	1.445	0.549	1.429	3.895	0.2567	0.712	1.759	6.031	0.451	1.548
25	0.600	0.153	0.606	0.9896	1.0105	0.565	1.435	0.559	1.420	3.931	0.2544	0.708	1.806	6.056	0.459	1.541

For $n > 25$.

$$A = \frac{3}{\sqrt{n}} \qquad A_3 = \frac{3}{c_4\sqrt{n}} \qquad c_4 \cong \frac{4(n-1)}{4n-3}$$

$$B_3 = 1 - \frac{3}{c_4\sqrt{2(n-1)}} \qquad B_4 = 1 + \frac{3}{c_4\sqrt{2(n-1)}}$$

$$B_5 = c_4 - \frac{3}{\sqrt{2(n-1)}} \qquad B_6 = c_4 + \frac{3}{\sqrt{2(n-1)}}$$

PROCESS OUT OF CONTROL

- After computing the control limits, the next step is to determine whether the process is in statistical control or not.
- If not, it means there is an external cause that throws the process out of control.
- This cause must be traced or removed so that the process may return to operate under stable statistical conditions.

The various reasons for the process being out of control may be:

1. Faulty tools
2. Sudden significant change in properties of new materials in a new consignment
3. Breakout of lubrication system
4. Faults in timing of speed mechanisms.

PROCESS IN CONTROL

If the process is found to be in statistical control, a comparison between the required specifications and the process capability may be carried out to determine whether the two are compatible.

7. CONTROL CHARTS FOR ATTRIBUTES

- Control charts for attributes are used to measure quality characteristics that are counted rather than measured.
- Attributes are discrete in nature and entail simple yes-or-no decisions. For example, this could be the number of nonfunctioning light bulbs, the proportion of broken eggs in a carton, the number of rotten apples, the number of scratches on a tile, or the number of complaints issued.
- Two of the most common types of control charts for attributes are p-charts and c-charts.
- **P-charts** are used to measure the proportion of items in a sample that are defective. Examples are the proportion of broken cookies in a batch and the proportion of cars produced with a misaligned fender.
- P-charts are appropriate when both the number of defectives measured and the size of the total sample can be counted.

A proportion can then be computed and used as the statistic of measurement.

1. It can be a fraction defective chart.
2. Each item is classified as good (non-defective) or bad (defective).
3. This chart is used to control the general quality of the component parts and it checks if the fluctuations in product quality (level) are due to chance alone.

<u>Plotting of P-charts</u>:

- By calculating, first, the fraction defective and then the control limits.
- The process is said to be in control if fraction defective values fall within the control limits.
- In case the process is out of control an investigation to hunt for the cause becomes necessary.

The mean proportion defective ($\bar{p}$):

$$\bar{p} = \frac{\text{Total Number of Defectives}}{\text{Total Number Inspected}}$$

The standard deviation of p:

$$\sigma_{\bar{p}} = \sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

where n = sample size.

Control Limits are:

$$UCL = \bar{p} + Z*\sigma_{\bar{p}} \qquad LCL = \bar{p} - Z*\sigma_{\bar{p}}$$

or

$$UCL = \bar{p} + Z*\sqrt{\frac{\bar{p}(1-\bar{p})}{n}} \qquad LCL = \bar{p} - Z*\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

- Usually the Z value is equal to 3 (as was used in the X and R charts), since the variations within three standard deviations are considered as natural variations.
- However, the choice of the value of Z depends on the environment in which the chart is being used, and on managerial judgment.

  - **C-charts** count the actual number of defects. For example, we can count the number of complaints from customers in a month, the number of bacteria on a petri dish, or the number of barnacles on the bottom of a boat.
  - However, we cannot compute the proportion of complaints from customers, the proportion of bacteria on a petri dish, or the proportion of barnacles on the bottom of a boat.

Defective items vs. individual defects

The literature differentiates between defect and defective, which is the same as differentiating between nonconformity and nonconforming units. This may sound like splitting hairs, but in the interest of clarity let's try to unravel this man-made mystery.

Consider a wafer with a number of chips on it. The wafer is referred to as an "item of a product". The chip may be referred to as "a specific point". There exist certain specifications for the wafers. When a particular wafer (e.g., the item of the product) does not meet at least one of the specifications, it is classified as a nonconforming item. Furthermore, each chip, (e.g., the specific point) at which a specification is not met becomes a defect or nonconformity.

So, a nonconforming or defective item contains at least one defect or nonconformity. It should be pointed out that a wafer can contain several defects but still be classified as conforming. For example, the defects may be located at noncritical positions on the wafer. If, on the other hand, the number of the so-called "unimportant" defects becomes alarmingly large, an investigation of the production of these wafers is warranted.

Control charts involving counts can be either for the total number of nonconformities (defects) for the sample of inspected units, or for the average number of defects per inspection unit.

Defect vs. Defective

- 'Defect' – a single nonconforming quality characteristic.

- 'Defective' – items having one or more defects.

C charts can be plotted by using the following formulas:

$$UCL = \bar{c} + 3 \sqrt{\bar{c}}$$

$$\bar{c} = \frac{\text{total number of defects}}{\text{total number of samples}}$$

$$LCL = c - 3\sqrt{\bar{c}}$$

THE PRIMARY DIFFERENCE BETWEEN USING A P-CHART AND A C-CHART IS AS FOLLOWS.

- A P-chart is used when both the total sample size and the number of defects can be computed.
- A C-chart is used when we can compute *only* the number of defects but cannot compute the proportion that is defective.

Test after completion

1. X bar charts are used to control the _____ of a process.

A. Dispersion

B. Central tendency

C. None of the above

D. Both A and B.

2. The average run length can be defined as:

A. The beta risk for an x bar chart
B. The expected number of samples taken before any shift in process quality is detected
C. The number of samples used in the construction of x bar chart
D. The number of items per sample

3. Which of the following is not true regarding when to select a p, c or u chart:

A. The process is a complex assembly operation and product quality is measured in terms of the occurrence of nonconformities, successful or unsuccessful product function, and so forth.
B. Process control is necessary, but measurement data cannot be obtained.
C. A historical summary of process performance is necessary.
D. Destructive testing (or such other expensive testing procedures) is required.

4. The standard normal distribution has mean= _____ and standard deviation= _____.

A. 1,0
B. 0,1
C. 0,0
D. 1,1

5. If the Average outgoing Quality is plotted against the Incoming Fraction Defective, the Average Outgoing Quality Limit is the _____ point.

A. Highest
B. Lowest
C. Middle
D. Cannot be determined

Conclusion

When to use a control chart?

1. Controlling ongoing processes by finding and correcting problems as they occur.
2. Predicting the expected range of outcomes from a process.
3. Determining whether a process is stable (in statistical control).
4. Analysing patterns of process variation from special causes (non-routine events) or Common causes (built into the process).
5. Determining whether the quality improvement project should aim to prevent specific Problems or to make fundamental changes to the process.

Demo Videos

http://youtube.com/watch?v=ccReTaolqHo

References

1. DALE H.BESTERFILED, ET AL., "Total Quality Management", Pearson Education, Inc. 2003. (Indian Reprint 2004). ISBN 81-297-0260-6.
2. Feigenbaum. A.V. "Total Quality Management", McGraw-Hill, 1991.
3. ZEIRI, "Total Quality Management for Engineers", Wood Head Publishers, 1991.

Answers to the assignments with full explanation
Assignment 12

1. **A population** is any entire col ection of people, animals, plants or things from which we may collect data. It is the entire group we are interested in, which we wish to describe or draw conclusions about. In order to make any generalisations about a population, a sample, that is meant to be representative of the population, is often studied. For each population there are many possible samples. A sample statistic gives information about a corresponding population parameter. For example, the sample mean for a set of data would give information about the overall population mean. It is important that the investigator careful y and completely defines the population before collecting the sample, including a description of the members to be included.

2. A sample is a group of units selected from a larger group (the population). By studying the sample it is hoped to draw valid conclusions about the larger group. A sample is general y selected for study because the population is too large to study in its entirety. The sample should be representative of the general population. This is often best achieved by random sampling. Also, before collecting the sample, it is important that the researcher careful y and completely defines the population, including a description of the members to be included.

3. Control Charts

When the quality controls have to focus on a quality characteristic hard or expensive to measure on a numerical scale, the control chart for attributes are a useful alternative.

Attributes concern quality characteristics which are able to be classified in two types, conform and not conform to specifications. What is called nonconforming means that the unit controlled is not conformed to standard on one or more of examined quality characteristics.

4. The goal of control charts for variable is still to control mean and variability of a process but here, we focus of number of nonconforming units or nonconformities in a population. Three types of charts exist. Their use depends on the production (which quality characteristic to control, how many to examine), the characteristic of controls (constant or variable sample size):

- The p-chart: it is a control chart for fraction nonconforming
- The c-chart: it is a control chart for number of defects or nonconformities
- The u-chart: it is a control chart for number of nonconformities per unit

It is so to choose the best adapted control chart to the production.

5. **Measure Central Tendency**

The arithmetic mean is found by adding the numbers and dividing the sum by the number of numbers in the list. This is what is most often meant by an average. The median is the exact middle number. Place them in order from least to greatest and see which number is in the middle. The mode is the most frequently occurring value on the list.

Course Material

Name of the Course	:	**Total Quality Management**
Name of the Unit	:	**Statistical Process Control (SPC)**
Name of the Topic	:	Introduction to the Concept of six sigma and New Seven Management tools.

- Objectives: To apply the statistical process control.

1. Outcomes: **Upon successful completion, the student should be able to analyze various TQM parameters with help of statistical tools.**

2. Pre-requisites: **To have a basic knowledge of Production Planning and Control.**

1. Processes that operate with "six sigma quality" over the short term are assumed to produce long-term defect levels below _____ defects per million opportunities (DPMO).

A. 2

B. 2.4

C. 3

D. 3.4

2. _____ are used in six sigma

A. Black belt

B. Green belt

C. Both black belt and green belt

D. None of the above.

3. In Six Sigma, a _____ is defined as any process output that does not meet customer specifications.

A. Error

B. Cost

C. Quality

D. Defect

4. While the first generation of Six sigma focused on _____ , the third generation of six sigma focused on _____.

A. Variability reduction, creating value

B. Variability reduction, improved business performance

C. Creating value, improved business performance

D. None of the above.

5. SIPOC diagram, used for understanding the flow in a process is used in _____ Stage of DMAIC.

A. Define
B. Measure
C. Analyze
D. Improve

6. For new product development, the chosen methodology should be

A. DMADV

B. DMAIC

C. Structured Design Methodology

D. DMIE

7. In DMAIC, redesigning of process to either remove bottlenecks or to reduce waste takes place in the _____ stage.

A. Define
B. Measure
C. Improve
D. Control

8. The Operating characteristic curve shows the relationship between the probability of acceptance (on y axis) and _____ (on x axis).

A. Proportion defective

B. Proportion acceptable

C. Number of lots

D. Size of lot

9. While random variability in a system can be removed by _____, non-random variability requires _____.

A. Operator or management action, Improvement in the system
B. Improvement in the system, operator or management action

C. Statistical Quality Control, Quality Checks
D. None of the above

10. The concept of rational sub group means that subgroups or samples be selected such that if assignable causes are present the chances for differences between subgroups will be _____.

A. minimized

B. maximized

C. neutralized

D. optimized

3. ACCEPTANCE SAMPLING

"Acceptance Sampling is concerned with the decision to accept a mass of manufactured items as conforming to standards of quality or to reject the mass as non-conforming to quality. The decision is reached through sampling." - SIMPSON AND KAFKA

- **Acceptance sampling** uses statistical sampling to determine whether to accept or reject a production lot of material.
- It has been a common quality control technique used in industry and particularly the military for contracts and procurement.
- It is usually done as products leave the factory, or in some cases even within the factory. Most often a producer supplies a consumer a number of items and decision to accept or reject the lot is made by determining the number of defective items in a sample from the lot.
- The lot is accepted if the number of defects falls below where the acceptance number or otherwise the lot is rejected
- For the purpose of acceptance, inspection is carried out at many stages in the process of manufacturing.
- These stages may be: inspection of incoming materials and parts, process inspection at various points in the manufacturing operations, final inspection by a manufacturer of his own product and finally inspection of the finished product by the purchaser.
- Inspection for acceptance is generally carried out on a sampling basis.
- The use of sampling inspection to decide whether or not to accept the lot is known as Acceptance Sampling.

- A sample from the inspection lot is inspected, and if the number of defective items is more than the stated number known as acceptance number, the whole lot is rejected.
- The purpose of Acceptance Sampling is, therefore a method used to make a decision as to whether to accept or to reject lots based on inspection of sample(s).

Acceptance sampling is the process of randomly inspecting a sample of goods and deciding whether to accept the entire lot based on the results. Acceptance sampling determines whether a batch of goods should be accepted or rejected.

Acceptance Sampling is very widely used in practice due to the following merits:

1. Acceptance Sampling is much less expensive than 100 percent inspection.
2. It is general experience that 100 percent inspection removes only 82 to 95 percent of defective material. Very good 100 percent inspection may remove at the most 99 percent of the defectives, but still cannot reach the level of 100 percent. Due to the effect of inspection fatigue involved in 100 percent inspection, a good sampling plan may actually give better results than that achieved by 100 percent inspection.
3. Because of its economy, it is possible to carry out sample inspection at various stages.

Inspection provides a means for monitoring quality.

- For example, inspection may be performed on incoming raw material, to decide whether to keep it or return it to the vendor if the quality level is not what was agreed on.
- Similarly, inspection can also be done on finished goods before deciding whether to make the shipment to the customer or not.
- However, performing 100% inspection is generally not economical or practical, therefore, sampling is used instead.
- Acceptance Sampling is therefore a method used to make a decision as to whether to accept or to reject lots based on inspection of sample(s).
- The objective is not to control or estimate the quality of lots, only to pass a judgment on lots.

- Using sampling rather than 100% inspection of the lots brings some risks both to the consumer and to the producer, which are called the consumer's and the producer's risks, respectively. We encounter making decisions on sampling in our daily affairs.

4. Operating Characteristic Curve

The Operating Characteristic Curve (OC Curve) shows you the probability that you will accept lots with various levels of quality. It is the working plan of acceptance sampling.

AQL – Acceptance Quality Level

The AQL (Acceptance Quality Level), the maximum % defective that can be considered satisfactory as a process average for sampling inspection

RQL – Rejectable Quality Level

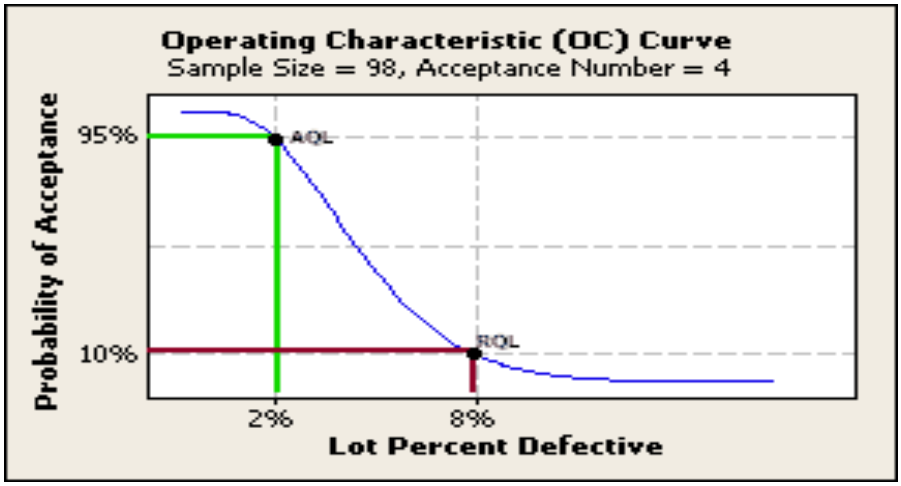
The RQL (Rejectable Quality Level) is the % defective. t is also known as the Lot Tolerance Percent Defective (LTPD).

LTPD – Lot Tolerance Percent Defective

The LTPD of a sampling plan is a level of quality routinely rejected by the sampling plan. It is generally defined as that level of quality (percent defective, defects per hundred units, etc.) which the sampling plan will accept 10% of the time.

Risks in Acceptance sampling

1. Producer's risk-: Sometimes inspite of good quality, the sample taken may show defective units as such the lot will be rejected, such type of risk is known as producer's risk.
2. Consumer's Risk-: Sometimes the quality of the lot is not good but the sample results show good quality units as such the consumer has to accept a defective lot, such a risk is known as consumer's risk.



ACCEPTANCE SAMPLING PLANS

- A sampling plan is a plan for acceptance sampling that precisely specifies the parameters of the sampling process and the acceptance/rejection criteria.
- The variables to be specified include the size of the lot (N), the size of the sample inspected from the lot (n), the number of defects above which a lot is rejected (c), and the number of samples that will be taken.

There are different types of sampling plans.

- Single Sampling (Inference made on the basis of only one sample)
- Double Sampling (Inference made on the basis of one or two samples)
- Sequential Sampling (Additional samples are drawn until an inference can be made) etc.

Single Sampling Plan

- In single sampling plan, the decision regarding the acceptance or rejection is made after drawing a sample from a bigger lot.
- Inspection is done and if the defectives exceed a certain number the lot is rejected. Otherwise, the lot is accepted when the number of defectives is less than the acceptance number.

Double Sampling Plan

- In this, a small sample is first drawn. If the number of defectives is less than or equal to the acceptance number (C1) the lot is accepted.
- If the number of defectives is more than another acceptance number (C2) which is higher, then C1 then the lot is rejected.
- If in case, the number in the inspection lies between C2 and C1, then a second sample is drawn.
- The entire lot is accepted or rejected on the basis of outcome of second inspection.

Sequential Sampling Plan

- Sequential sampling plan is used when three or more samples of stated size are permitted and when the decision on acceptance or rejection must be reached after a stated number of samples.
- A first sample of n1 is drawn, the lot is accepted if there are no more than c1 defectives, the lot is rejected if there are more than r1 defectives.
- Otherwise a second sample of n2 is drawn. The lot is accepted if there are no more than c2 defectives in the combined sample of n1 + n2.
- The lot is rejected if there are more than r2 defectives in the combined sample of n1 + n2. The procedure is continued in accordance with the table below.

Sample	*Sample Size*	*Size*	*Acceptance Number*	*Rejection Number*
First	n_1	n_1	c_1	r_1
Second	n_2	$n_1 + n_2$	c_2	r_2
Third	n_3	$n_1 + n_2 + n_3$	c_3	r_3
Fourth	n_4	$n_1 + n_2 + n_3 + n_4$	c_4	r_4
Fifth	n_5	$n_1 + n_2 + n_3 + n_4 + n_5$	c_5	$c_5 + 1$

- If by the end of fourth sample, the lot is neither accepted nor rejected, a sample n5 is drawn. The lot is accepted if the number of defectives in the combined sample of n1 + n2 + n3 + n4 + n5 does not exceed c5. Otherwise the lot is rejected.
- A sequential sampling plan involves higher administrative costs and use of experienced inspectors.

5. Six Sigma

- Six Sigma is a set of tools and strategies for process improvement originally developed by Motorola in 1985.
- Six Sigma became well known after Jack Welch made it a central focus of his business strategy at General Electric in 1995, and today it is used in different sectors of industry.
- Six Sigma seeks to improve the quality of process outputs by identifying and removing the causes of defects (errors) and minimizing variability in manufacturing and business processes.
- It uses a set of quality management methods, including statistical methods, and creates a special infrastructure of people within the organization ("Champions", "Black Belts", "Green Belts", "Orange Belts", etc.) who are experts in these very complex methods.
- Each Six Sigma project carried out within an organization follows a defined sequence of steps and has quantified value targets, for example; process cycle time reduction, customer satisfaction, reduction in pollution, cost reduction and/or profit increase.
- The term *Six Sigma* originated from terminology associated with **manufacturing**, specifically terms associated with statistical modeling of manufacturing processes.
- The maturity of a manufacturing process can be described by a *sigma* rating indicating its yield or the percentage of defect-free products it creates.

- A six sigma process is one in which 99.99966% of the products manufactured are statistically expected to be free of defects (3.4 defects per million), although, as discussed below, this defect level corresponds to only a 4.5 sigma level.
- Motorola set a goal of "six sigma" for all of its manufacturing operations, and this goal became a byword for the management and engineering practices used to achieve it.

Methods

Six Sigma projects follow two project methodologies inspired by Deming's Plan-Do-Check-Act Cycle. These methodologies, composed of five phases each, bear the acronyms DMAIC and DMADV. [11]

- DMAIC is used for projects aimed at improving an existing business process.
- DMADV is used for projects aimed at creating new product or process designs.

DMAIC

The DMAIC project methodology has five phases:

- Define the problem, the voice of the customer, and the project goals, specifically.
- Measure key aspects of the current process and collect relevant data.
- Analyze the data to investigate and verify cause-and-effect relationships. Determine What the relationships are, and attempt to ensure that all factors have been considered. Seek out root cause of the defect under investigation.
- Improve or optimize the current process based upon data analysis using techniques such as design of experiments, poka yoke or mistake proofing, and standard work to create a new, future state process. Set up pilot runs to establish process capability.
- Control the future state process to ensure that any deviations from target are corrected before they result in defects. Implement control systems such as statistical process control, production boards, visual workplaces, and continuously monitor the process.

Some organizations add a ***R****ecognize* step at the beginning, which is to recognize the right problem to work on, thus yielding an RDMAIC methodology.

DMADV or DFSS

The DMADV project methodology, known as DFSS ("**D**esign **F**or **S**ix **S**igma"),features five phases:

- ***D****efine* design goals that are consistent with customer demands and the enterprise strategy.
- ***M****easure* and identify CTQs (characteristics that are **C**ritical **T**o **Q**uality), product capabilities, production process capability, and risks.
- ***A****nalyze* to develop and design alternatives
- ***D****esign* an improved alternative, best suited per analysis in the previous step
- ***V****erify* the design, set up pilot runs, implement the production process and hand it over to the process owner(s).

6. THE SIX STEPS TO SIX SIGMA.

STEP #1 - IDENTIFY THE PRODUCT YOU CREATE OR THE SERVICE YOU PROVIDE

In other words ... WHAT DO YOU DO?

STEP #2 - IDENTIFY THE CUSTOMER(S) FOR YOUR PRODUCT OR SERVICE, AND DETERMINE WHAT THEY CONSIDER IMPORTANT I.E. CUSTOMER REQUIREMENTS

In other words ... WHO USES YOUR PRODUCT AND SERVICES?

STEP #3 - IDENTIFY YOUR NEEDS (TO PROVIDE PRODUCT/SERVICE SO THAT IT SATISFIES THE CUSTOMER)

In other words ... WHAT DO YOU NEED TO DO YOUR WORK?

STEP #4 - DEFINE THE PROCESS FOR DOING YOUR WORK

In other words ... HOW DO YOU DO YOUR WORK?

STEP #5 - MISTAKE-PROOF THE PROCESS AND ELIMINATE WASTED EFFORTS USING...

In other words ... HOW CAN YOU DO YOUR WORK BETTER?

Step #6 - Ensure continuous improvement by measuring, analyzing and controlling the improved process using control charts.

7. Seven New Management and Planning Tools

In 1976, the Union of Japanese Scientists and Engineers (JUSE) saw the need for tools to promote innovation, communicate information and successful y plan major projects.

A team researched and developed the seven new quality control tools, often called the seven management and planning (MP) tools, or simply the seven management tools. Not all the tools were new, but their collection and promotion were.

The seven MP tools, listed in an order that moves from abstract analysis to detailed planning, are:

1. Affinity diagram: organizes a large number of ideas into their natural relationships.
2. Relations diagram: shows cause-and-effect relationships and helps you analyze the natural links between different aspects of a complex situation.
3. Tree diagram: breaks down broad categories into finer and finer levels of detail, helping you move your thinking step by step from generalities to specifics.
4. Matrix diagram: shows the relationship between two, three or four groups of information and can give information about the relationship, such as its strength, the roles played by various individuals, or measurements.
5. Matrix data analysis: a complex mathematical technique for analyzing matrices, often replaced in this list by the similar prioritization matrix. One of the most rigorous, careful and time-consuming of decision-making tools, a prioritization matrix is an L-shaped matrix that uses pairwise comparisons of a list of options to a set of criteria in order to choose the best option(s).
6. Arrow diagram: shows the required order of tasks in a project or process, the best schedule for the entire project, and potential scheduling and resource problems and their solutions.
7. Process decision program chart (PDPC): systematical y identifies what might go wrong in a plan under development.

Affinity Diagram

- This tool takes large amounts of disorganized data and information and enables one to organize it into groupings based on natural relationships.

- It was created in the 1960s by Japanese anthropologist Jiro Kawakita.

Interrelationship Diagraph

- This tool displays all the interrelated cause-and-effect relationships and factors involved in a complex problem and describes desired outcomes.
- The process of creating an interrelationship diagraph helps a group analyze the natural links between different aspects of a complex situation.

Tree Diagram

- This tool is used to break down broad categories into finer and finer levels of detail.
- It can map levels of details of tasks that are required to accomplish a goal or task.
- It can be used to break down broad general subjects into finer and finer levels of detail.
- Developing the tree diagram helps one move their thinking from generalities to specifics.

Prioritization Matrix

- This tool is used to prioritize items and describe them in terms of weighted criteria.
- It uses a combination of tree and matrix diagraming techniques to do a pair-wise evaluation of items and to narrow down options to the most desired or most effective.

Matrix Diagram

- This tool shows the relationship between items. At each intersection a relationship is either absent or present.
- It then gives information about the relationship, such as its strength, the roles played by various individuals or measurements.
- Six differently shaped matrices are possible: L, T, Y, X, C and roof-shaped, depending on how many groups must be compared.

Process Decision Program Chart (PDPC)

- A useful way of planning is to break down tasks into a
- hierarchy, using a Tree Diagram.
- The PDPC extends the tree diagram a couple of levels to identify risks and countermeasures for the bottom level tasks.
- Different shaped boxes are used to highlight risks and identify possible countermeasures (often shown as 'clouds' to indicate their uncertain nature).
- The PDPC is similar to the Failure Modes and Effects Analysis (FMEA) in that both identify risks, consequences of failure, and contingency actions; the FMEA also rates relative risk levels for each potential failure point.

Activity Network Diagram

- This tool is used to plan the appropriate sequence or schedule for a set of tasks and related subtasks.
- It is used when subtasks must occur in parallel.
- The diagram enables one to determine the critical path (longest sequence of tasks). (See also PERT diagram.)

Test after completion

1. The _____ diagram starts with one item which then branches of into two or more items. This diagram is used to breakdown broad categories into finer levels of detail.

A. Affinity
B. Tree
C. Relations
D. Matrix

2. Lot tolerance percent defective (LTPD) is a level of lot quality specified by the _____.

A. Consumer
B. Producer
C. Supplier
D. Sampling Plan

3. For a process which is six sigma complaint, the percentage of products within specifications is:

A. 95.20%
B. 99.73%
C. 99.10%
D. 96.78%

4. For a double sampling plan the probability of acceptance on the combined samples is calculated as:

A. Maximum of probability of acceptance of first and second sample
B. Product of probability of acceptance of first and second sample
C. Average of probability of acceptance of first and second sample
D. Sum of probability of acceptance of first and second sample

5. Process capability ratio is expressed as:

A. USL+LSL/6σ
B. USL-LSL/6σ
C. USL-LSL/3σ
D. USL-LSL/σ

Conclusion

Six Sigma identifies several key roles for its successful implementation:-

- Executive Leadership, includes the CEO and other members of top management. They are responsible for setting up a vision for Six Sigma implementation.
- Champions, take responsibility for Six Sigma implementation across the organization in an integrated manner.
- Master Black Belts, identified by champions, act as in-house coaches on Six Sigma. They devote 100% of their time to Six Sigma. They assist champions and guide Black Belts and Green Belts.

- Black Belts, operate under Master Black Belts to apply Six Sigma methodology to specific projects.
- Green Belts, are the employees who take up Six Sigma implementation along with their other job responsibilities, operating under the guidance of Black Belts.

Demo Videos

http://youtube.com/watch?v=DxNicBRCPi4

References

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Answers to the assignments with full explanation
Assignment 13

1. **Six Sigma** has evolved over the last two decades and so has its definition. Six Sigma has literal, conceptual, and practical definitions. Features that set Six Sigma apart from previous quality improvement initiatives include –

- A clear focus on achieving measurable and quantifiable financial returns from any project.
- An increased emphasis on strong and passionate management leadership and support.
- A special infrastructure of "Champions," "Master Black Belts," "Black Belts," etc. to lead and implement the Six Sigma approach.
- A clear commitment to making decisions on the basis of verifiable data, rather than assumptions and guesswork.

2. **Six Sigma as a Methodology**

As Six Sigma has evolved, there has been less emphasis on the literal definition of 3.4 DPMO, or counting defects in products and processes. Six Sigma is a business improvement methodology that focuses an organization on:

- Understanding and managing customer requirements
- Aligning key business processes to achieve those requirements
- Utilizing rigorous data analysis to minimize variation in those processes
- Driving rapid and sustainable improvement to business processes

3. DMAIC - The basic methodology consists of the following five steps:
    - Define process improvement goals that are consistent with customer demands and the enterprise strategy.
    - Measure key aspects of the current process and col ect relevant data.
    - Analyze the data to verify cause-and-effect relationships. Determine what the relationships are, and attempt to ensure that al factors have been considered.
    - Improve or optimize the process based upon data analysis using techniques like Design of Experiments.
    - Control to ensure that any deviations from target are corrected before they result in defects. Set up pilot runs to establish process capability, move on to production, set up control mechanisms and continuously monitor the process.

4. DMADV

The basic methodology consists of the following five steps:

- Define design goals that are consistent with customer demands and the enterprise strategy.
- Measure and identify CTQs (characteristics that are Critical To Quality), product capabilities, production process capability, and risks.
- Analyze to develop and design alternatives, create a high-level design and evaluate design capability to select the best design.
- Design details, optimize the design, and plan for design verification. This phase may require simulations.
- Verify the design, set up pilot runs, implement the production process and hand it over to the process owners.

5. Six Sigma as a Metric

The term "Sigma" is often used as a scale for levels of "goodness" or quality. Using this scale, "Six Sigma" equates to 3.4 Defects Per Mil ion Opportunities (DPMO). Six Sigma started as a defect reduction effort in manufacturing and then applied to other business processes for the same purpose. Taking the 1.5 sigma shift into account, short-term sigma levels correspond to the fol owing long-term

DPMO values (one-sided):

- One Sigma = 690,000 DPMO => efficiency 31%
- Two Sigma = 308,000 DPMO => efficiency 69.2%
- Three Sigma = 66,800 DPMO => efficiency 93.32%
- Four Sigma = 6,210 DPMO => efficiency 99.379%
- Five Sigma = 230 DPMO => efficiency 99.977%
- Six Sigma = 3.4 DPMO => efficiency 99.9997%