

★ Lean and JIT Quality philosophy:-

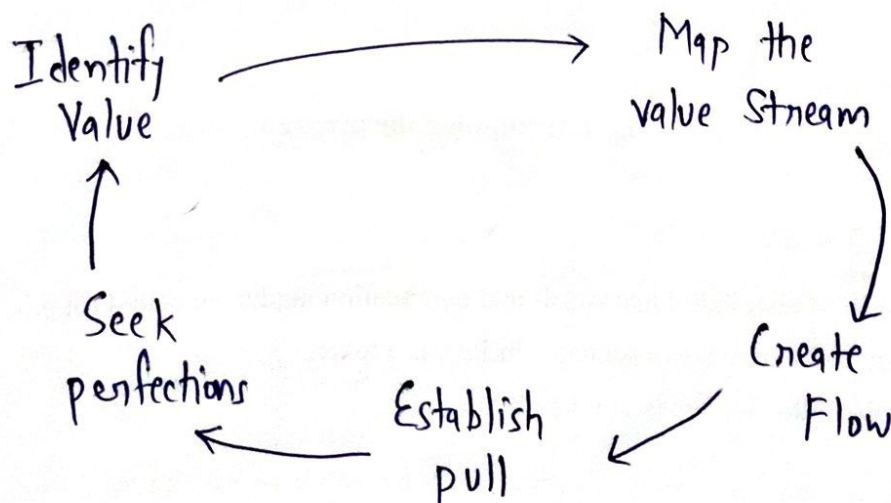
Lean :- Lean was originally created by Toyota to eliminate waste and inefficiency in its manufacturing operations.

→ QM topics like Six Sigma, DMAIC and Jidoka are important in the context of lean manufacturing because the ultimate goal is to eliminate waste in the value stream and one of the most common types of waste is connection waste.

→ Connection waste happens when it is necessary to work around poor quality in components from suppliers or it is necessary to repair, rework or scrap defective product units.

So lean can improve how a team works together, inventory management, and even client interaction.

→ 5 key Principles of lean thinking:-



JIT Quality Philosophy:-

Just in time (JIT) is not just a manufacturing technique but a philosophy of manufacturing that influences a company's relationship with its suppliers, customers and employees.

→ The two basic underpinnings of the philosophy are [elimination of anything that does not add value for the customer and continuous improvement of productivity.]

- JIT
- A set of techniques to increase productivity, improve quality and reduce cost of an operations.
 - A management philosophy to promote elimination of waste and continuous improvement of productivity.

[Right Material + Right place + At the right time
||
(Just In time)]

⇒ We can't achieve JIT without reducing these 7 wastes:-

- Waste of over production
- Waste of waiting
- Waste of Transportation
- Waste of over processing
- Waste of inventory
- Waste of Motion
- Waste of making defective products

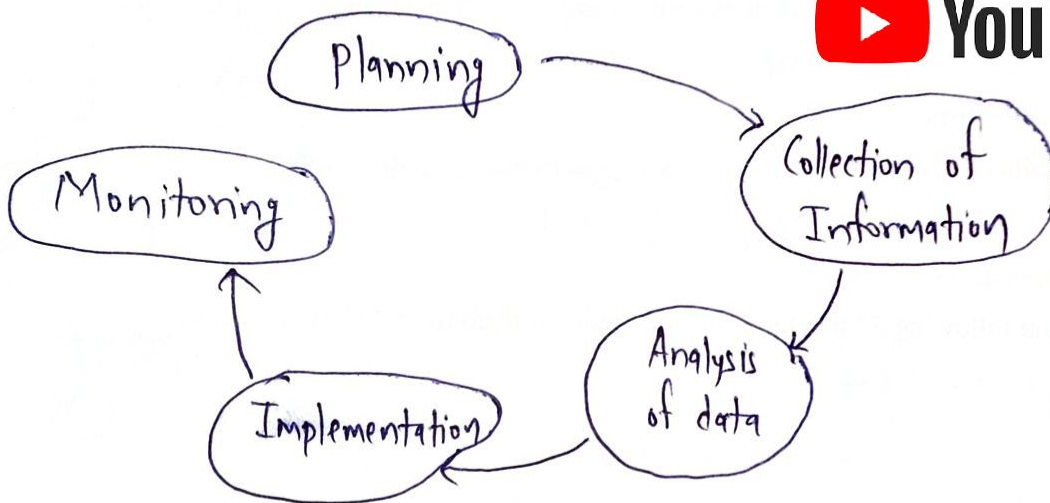
Benchmarking:-

Benchmarking is the process of comparing the cost, cycle time, productivity or quality of a specific process or method to another that is widely considered to be an industry or best practice.

- "Benchmarking is quality by comparison for achieving better."
- Benchmarking provides a snapshot of the performance of your business.

process of benchmarking:-

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(i) Planning:- Identify the product, service or process to be benchmarked.

(ii) Collection of information:- Information can be divided in sub texts of primary and secondary data.

primary data → directly from benchmarked company.

Secondary data → gathered from press, publication or websites.

(iii) Analysis of data:- Compare the current performance and benchmarked data & analyse the difference.

(iv) Implementation:- It becomes mandatory to walk the talk and at the time we improve quality and fulfill the difference b/w current & benchmarked data.

(V) Monitoring:- In order to reap the maximum benefits of the benchmarking process, a systematic evolution should be carried out on a regular basis.

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PFMEA (Process Failure Mode and Effect Analysis):-

PFMEA is a structured analytical tool used by an organization, business unit or cross-functional team to identify and evaluate the potential failure of a process.

It can

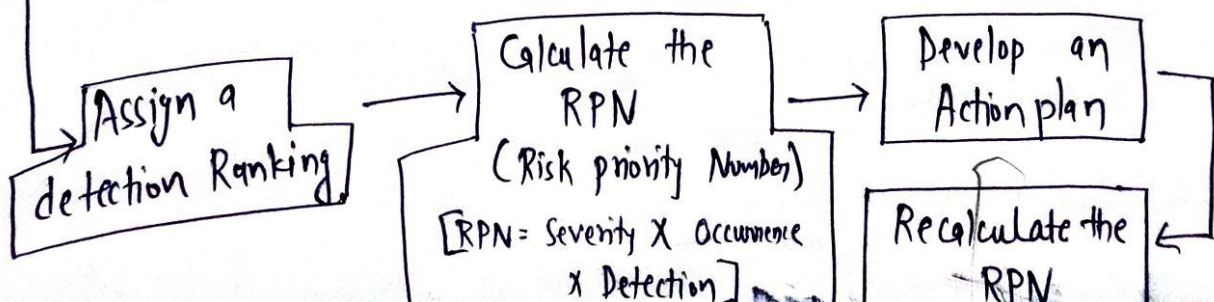
- Identifies design or process related failure modes before they happen.
- Determines the effect & Severity of those failure modes.
- Identifies the causes and probability of occurrence of failure modes.
- Quantifies & prioritizes the Risks associated with the failure modes.

Type of failures in FMEA:-

→ System FMEA, → Design FMEA, → Process FMEA

Process of FMEA:-

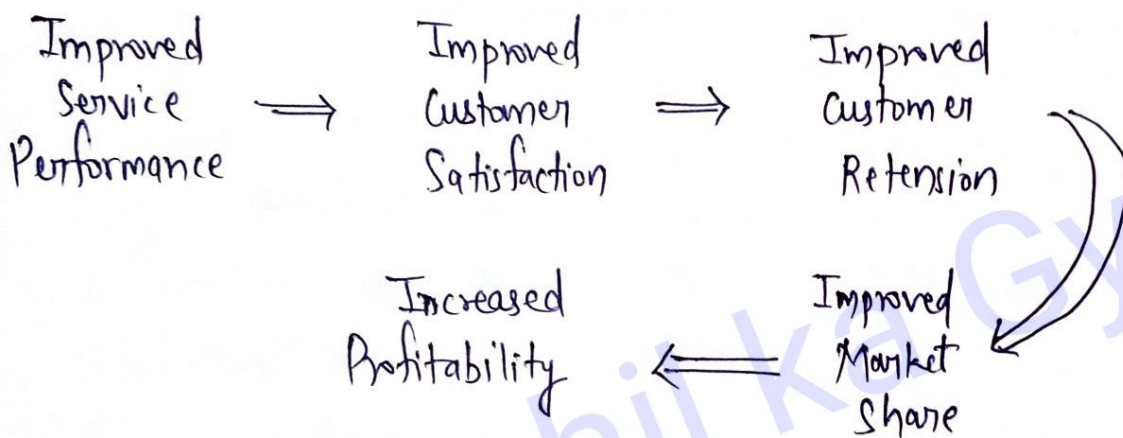
Review the process → Potential failure Mode → Effects of failure
Cause of failure
Assign a Severity Ranking
Assign an occurrence Ranking



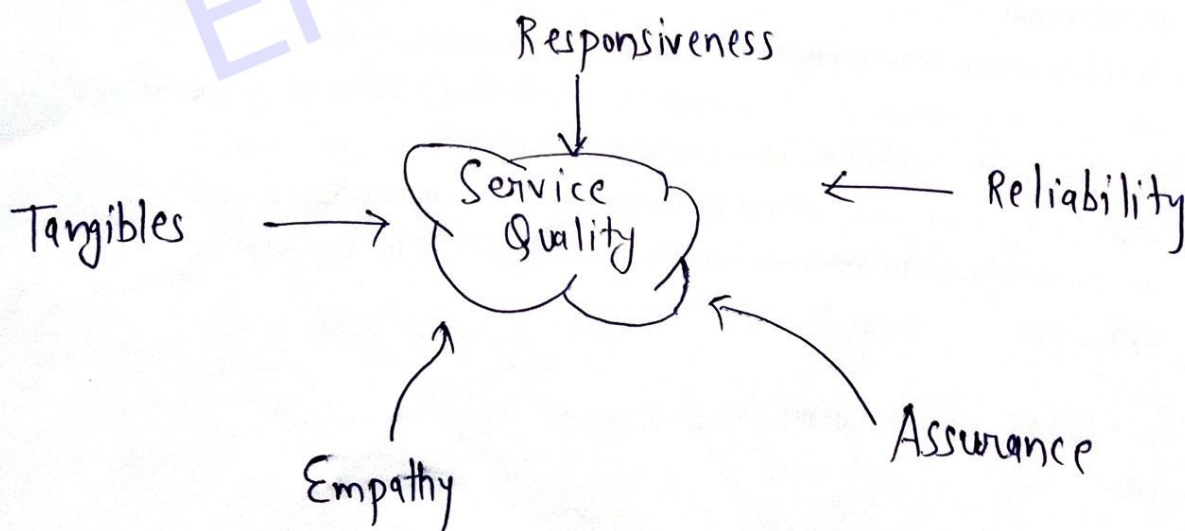
Service Quality:- It generally refers to a customer's comparison of service expectations as it relates to a company's performance.

A business with a high level of service quality is likely capable of meeting customer needs while also remaining economically competitive in their respective industry.

Purpose of SQ:-



Dimensions of SQ:-



★★ Six Sigma for Process Improvement:-

Six Sigma is a business process that guides companies to produce high Quality products, reduce costs and improve efficiency.

DFSS Concepts can be included into an existing product development process or can be used to create a new product development process within an organization.

Six Sigma aims at improving process and increasing customer satisfaction. The concept behind this approach is to reduce the variation in processes.

- A systematic approach to process improvement.
- Processes can be related to design, manufacturing and administrative functions.
- It involves the use of statistical tools and techniques to analyse & improve process.

Six-Sigma process detailed below is a 5-step process:-

- (i) Define: Customer requirements, the problems, goals & project scope.
- (ii) Measure: The current product or process capability.
- (iii) Analyze: What is wrong and identify possible root causes.
- (iv) Improve: Find and test the possible Solutions.
- (v) Control:- Implement, monitor and sustain the optimal solution

* ISO 9000 Series :-

- It is defined as a set of international standards on quality management and Quality assurance developed to help companies effectively document the quality system elements needed to maintain an efficient quality system.
- It is a series, or family, of quality management standards.

* ISO 9001:2015 : QMS - Requirements

ISO 9000:2015 : QMS - Fundamentals & Vocabulary

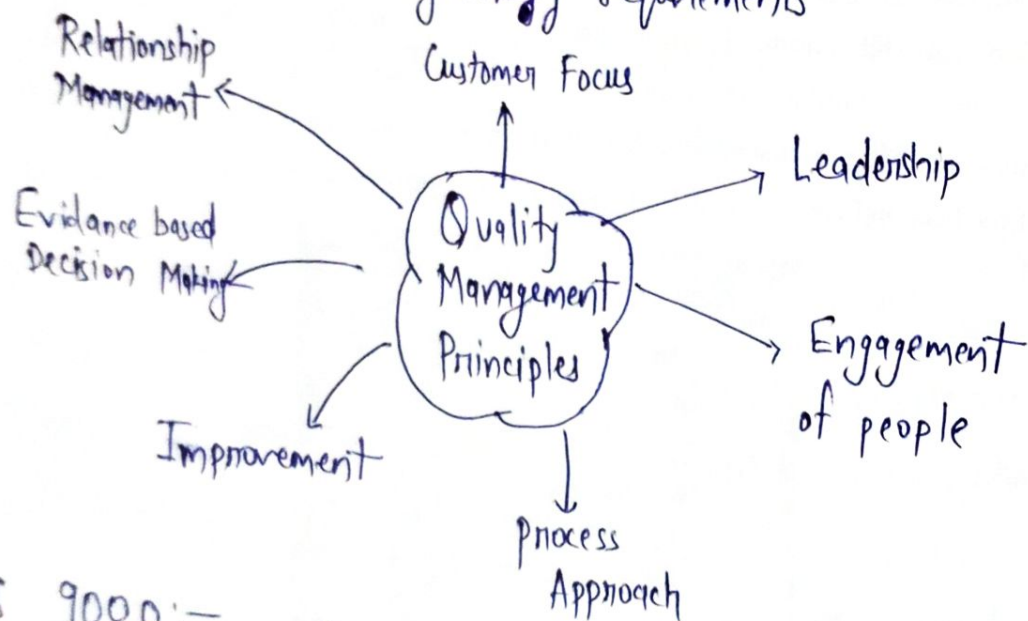
ISO 9004:2018 : Quality Management - Quality of an Organization

ISO 19011:2018 : Guidelines for Auditing Management Systems

→ ISO 9000:2015 and ISO 9001:2015 standards are based on 7 Quality Management Principles that senior management can apply to promote organizational improvement.

ISO 9001:2015

ISO 9001 is defined as the international standard that specifies requirements for quality management System (QMS). Organizations use the standard to demonstrate the ability to consistently provide products and services that meet customer and regulatory requirements.



QS 9000:-

QS 9000 is a company level certification based on quality system requirements related specifically to the automotive industry. These standards were deployed by larger automotive companies.

QS 9000 applied to companies who supplied automotive production materials, productions and service parts, heat treatment, painting, plating & others finishing services. All suppliers of the automotive industry were not required to be certified to QS-9000 Standards.

1. Customer focus

- Understand the needs of existing and future customers
- Align organizational objectives with customer needs and expectations
- Meet customer requirements
- Measure customer satisfaction
- Manage customer relationships
- Aim to exceed customer expectations
- Learn more about the customer experience and customer satisfaction

2. Leadership

- Establish a vision and direction for the organization
- Set challenging goals
- Model organizational values
- Establish trust
- Equip and empower employees
- Recognize employee contributions
- Learn more about leadership

3. Engagement of people

- Ensure that people's abilities are used and valued
- Make people accountable
- Enable participation in **continual improvement**
- Evaluate individual performance
- Enable learning and knowledge sharing
- Enable open discussion of problems and constraints
- Learn more about **employee involvement**

4. Process approach

- Manage activities as processes
- Measure the capability of activities
- Identify linkages between activities
- Prioritize improvement opportunities
- Deploy resources effectively

5. Improvement

- Improve organizational performance and capabilities
- Align improvement activities
- Empower people to make improvements
- Measure improvement consistently
- Celebrate improvements
- Learn more about approaches to [continual improvement](#)

6. Evidence-based decision making

- Ensure the accessibility of accurate and reliable data
- Use appropriate methods to analyze data
- Make decisions based on analysis
- Balance data analysis with practical experience
- See [tools for decision making](#)

7. Relationship management

- Identify and select suppliers to manage costs, optimize resources, and create value
- Establish relationships considering both the short and long term

Quality Audit :-

Quality Audit is the process of systematic examination of a quality system carried out by an internal or external quality

auditor or an audit team.

It is a key element in ISO Quality System Standard, ISO 9001.

Types of Quality Audit :-

- (i) Process Audit
- (ii) Product Audit
- (iii) System Audit

An audit may also be classified as internal or external

↓
performed by
employees of
organization

↓
outside agent
(third party)

(i) Process Audit:- A verification that processes are working within ~~established~~ established limits. It evaluates an operation or method against predetermined instructions or standards to measure conformance to these standards and effectiveness of the instructions.

(ii) Product Audit:- A verification that processes are working within established limits.

Check conformance to defined requirements such as time, accuracy, temperature, pressure, composition, responsiveness, amperage, examine the resource, environment & methods.

(iii) System Audit:- An audit conducted on a management system.

Conformance to company policies, contract commitments & regulatory requirements, environment management system by environment system audit, food safety ———, Safety management ———.

Quality Circles:-

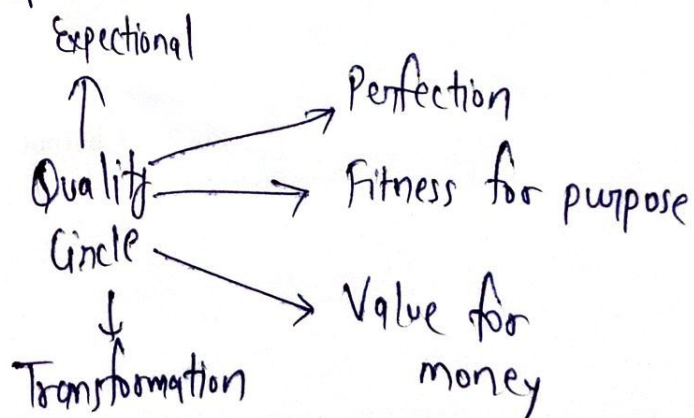
A quality circle or quality control circle is a group of workers who do the same similar work, who meet regularly to identify, analyze and solve work-related problems. It consists of minimum three and maximum 12 members in number.

Objective of QC:-

- Improvement in quality of product, in methods of production
- Development of employee participating in QC.
- Promoting morale of employees.
- Respect humanity & Create a happy work place worthwhile to work.

Main features of QC :-

- (i) Voluntary Groups
- (ii) Small Size
- (iii) Regular Meeting
- (iv) Independent Agenda
- (v) Quality focused



Process :-

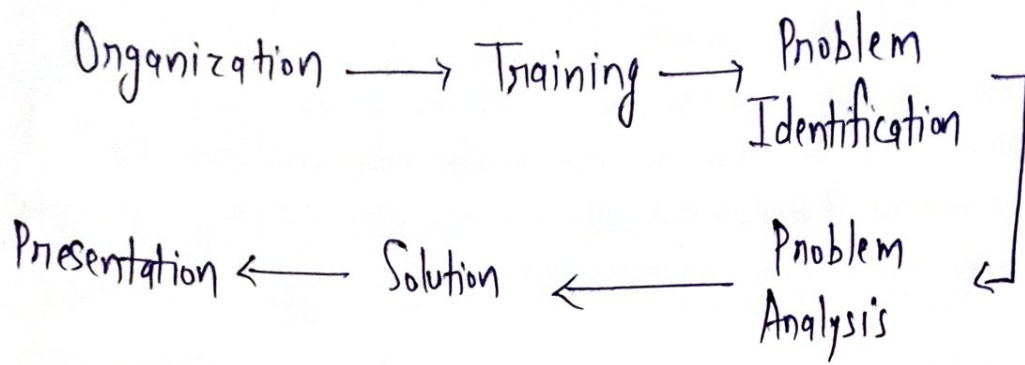


Fig:- Quality Circle Processes

Adv:-

- Promotion of teamwork
- Develops employee positive attitude
- Positive working environment
- Increased Quality & Productivity

DisAdv:-

- (i) Employees not sure for purpose.
- (ii) Not Enough relevant training.
- (iii) Participating not Voluntary
- (iv) Little or no management Support.
- (v) Quality Circles are not empowered to make decisions.

Chapter - (4)

Product Quality Improvement

Quality Function Deployment:-

→ QFD is a comprehensive methodology used to translate the customer requirements (voice of customer) to design characteristics and build a quality product after benchmarking against the competition.

OR

QFD is a structured approach to defining customer needs or requirements and translating them into specific plans to produce products to meet those needs.

Basic Steps of QFD product Quality improvement process:-

- (i) Identify the voice of customer (VOC).
- (ii) Define your process elements based on VOC.
- (iii) Relationship b/w WHAT's and HOW's
- (iv) Customer benchmarking
- (v) Solution benchmarking
- (vi) Trade-off between different HOW's
- (vii) Set up Integrated Matrix.
- (viii) Define Specifications.

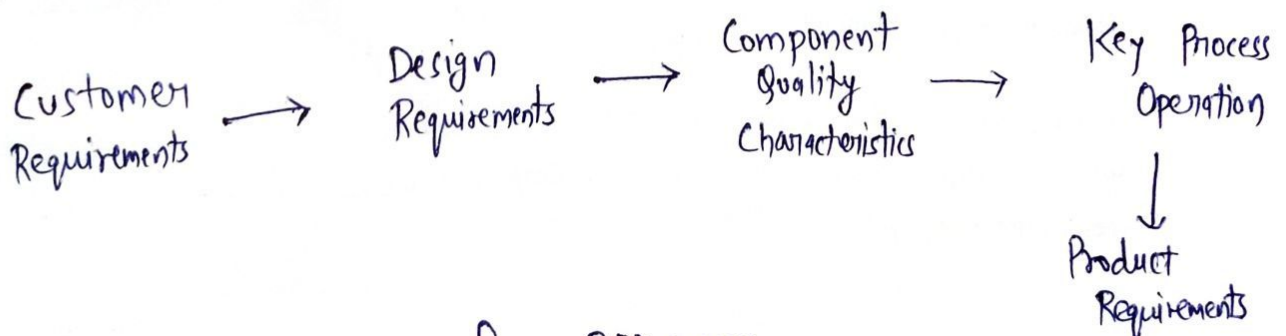


Fig:- QFD process

The Voice of customer is captured in a variety of ways: direct discussion or interviews, surveys, focus groups, customer specifications etc.

This understanding of the customer needs is then summarized in a product planning matrix or "house of Quality".

These matrices are used to translate higher level

"what's" [sic] or needs into lower level

"how's" [sic] - product requirements or technical characteristics to satisfy these needs.

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Robust Design and Taguchi Method:-

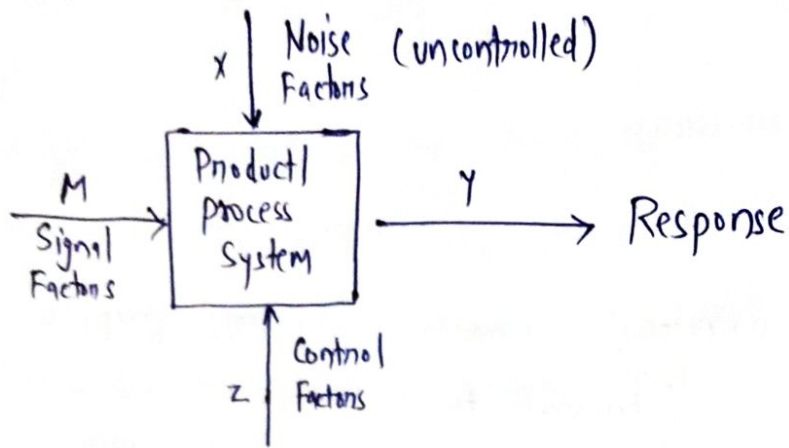
Robust Design (RD) means the design of a product that causes no problem under any case. RD signifies designing of a product which can work properly under different circumstances.

Taguchi Method is a powerful technique to optimize performance of the products or process.

- Taguchi's main purpose is to reduce the variability around the target value of product properties via a systematic application of statistical experimental design which is called robust design.
- Taguchi simplified the usage of orthogonal arrays to setup experimental design.
- Taguchi proposed the usage of S/N ratio in order to measure the effects of factors on the performance characteristics.

→ Robust Design Method, also called the Taguchi Method, pioneered by Dr. Genichi Taguchi greatly improves engineering productivity.

→ The Robust design method prescribes a systematic procedure for minimizing design sensitivity and it is called Parameter Design.



P-Diagram

Noise factors:-

- External Noise factors: temperature, Humidity
- Internal Noise factors: Wearing of parts, Manufacturing imperfections.
- Unit to Unit or Variational Noise factors: It indicates the difference b/w individual products, which are produced to same specifications.

→ Taguchi's work includes 3 principal contributions to Statistics:-

- (i) A specific loss functions.
- (ii) The philosophy of offline Quality Control
- (iii) Innovations in design of experiments.

→ Steps involve in Taguchi Method:-

- (i) Identify the main function and its side effects.
- (ii) Identify the noise factors, testing condition & Quality characteristics.
- (iii) Identify the objective function to be optimized.

- (iv) Identify the control factors & their levels.
- (v) Select a suitable orthogonal Array & Construct the Matrix.
- (vi) Conduct the matrix experiment.
- (vii) Examine the data; predict the optimum Control factor levels and its performance.
- (viii) Conduct the verification experiment.

Design Method

The design of experiment (DOE) is explained by Lye, as a methodology for systematically applying statistics to experimentations.

- In DOE, a sequence of tests is designed in which powerful vary the input factors of product or process to examine the reasons of variation in the output response.

By the end of 20th century, DOE was no longer viewed as merely a stand-alone tool, because it was packaged together with a structured initiative for business improvement known as Six-sigma.

Adv:-

- A good amount of data can be obtained with lesser resources.
- Systematic way to estimate the interactions b/w process factors

The estimates of effect of each factors on response are more precise.

Taguchi Method

We assume that we are designing an engineering system it might be a machine that performs some intended function or it might be a production process.

- We use knowledge of fundamental about system & process parameters for efficient experimentation.

- We can skip all extra effort that might have gone into investigating interactions. By this, we can decrease the no. of factors.

- Taguchi categorize the factors in 2 sets:-

(i) Control factors, which are under our control.

(ii) Noise factors, which are not under our control, except during experiments.

Adv.

- The foundation of DOE in TM is orthogonal Array design that is very simple method for analysing the outputs.
- The key step of TM is to increasing the quality level with less affecting the cost factors.
- TM provides the optimal settings for processes which can improve quality, and these settings attained from TM are also insensitive to the variation of noise factors.

Design Failure

Failure Modes and Effect Analysis is a step by step approach for identifying all possible failures in a design, a manufacturing or assembly process or product.

→ A design failure is a design that is low value or that destroys value. It is common for such failures to damage results, reputation, brand image & quality of life.

Types of design failure in QM:-

- Value Proposition
- Accidental Complexity
- Naive Design
- Less is a Bore
- Feature Fatigue
- Architecture
- Context of use
- Error defect
- Design for failure
- Style
- Efficiency
- Balance
- Color Scheme

~~DFMEA~~ DFMEA:- DFMEA is a methodological approach used for identifying potential risks introduced in a new or changed design of product/Service.

→ The design ~~FMEA~~ FMEA initially identifies design function, failure modes and their effects on the customer with corresponding severity ranking / danger of the effect.

→ The design FMEA also tracks improvements through Risk Priority Number (RPN) reductions. By comparing the before & after the RPN.

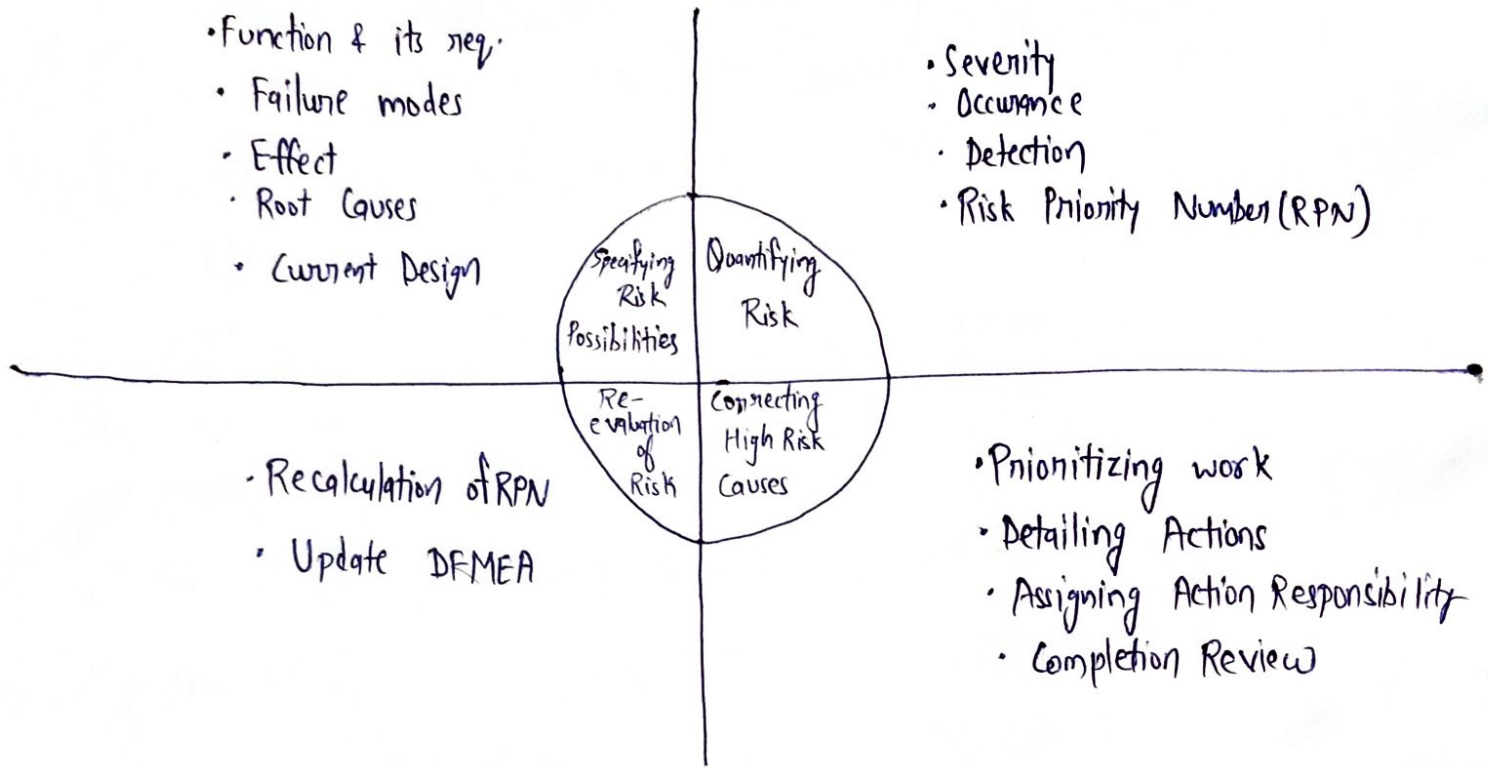
Failure Modes:- It means the ways or modes, in which something might fail. Failures are any errors or defects, especially ones that effect the customer.

Effect Analysis:- Effects analysis refers to studying the consequences of those failures.

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Design failure can be -

- No functioning (100% not working)
- Partial functioning (partially working)
- Intermediate functioning (Stop for short time & then start again: Repeat)



Product Reliability Analysis: - The purpose of reliability analysis is to indicate the probability of success for a specified time. This probability is called the reliability and it is always associated with a given time.

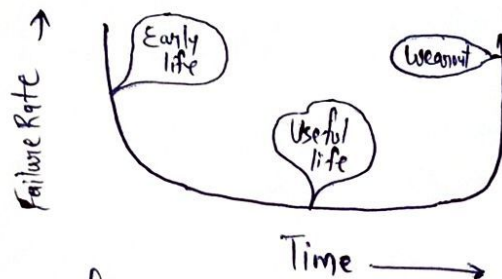
→ Product Reliability is defined as the probability that a device will perform its required function, subjected to stated conditions, for a specific period of time.

→ PR is quantified as MTBF (Mean time between failures) for repairable product and MTTF (Mean time to failure) for non-repairable product.

We can measure it or better it and predict it by the famous BathTub Curve.

Famous BathTub Curve :-

Instantaneous failure rate vs time



(i) Early life :- If we follow the slope from the leftmost slot to where it begins to flatten out this can be considered the first period. The first period is characterised by a decreasing failure rate. It is what occurs during the "early life" of a population of units. The weaker units fail leaving a population that is more rigorous.

(ii) Useful life :- The next period is the flat bottom portion of the graph. It is called the "Useful life" period. Failures occur more in a random sequence during this time. It is difficult to predict which failure mode will occur but the rate of failure is predictable. Notice the constant slope.

(iii) Wearout :- The third period begins at the point where the slope begins to increase & extends to the rightmost end of graph. This is what happens when units become old & begin to fail at an increasing rate. It is called "wearout" period.

Mean time Between failure (MTBF) = T/R

T = total time

R = no. of failures

Mean time to failure (MTTF) = T/N

T = total time

N = No. of Units Under Test

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