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UNIT I

INTRODUCTION

Every manufacturing organisation is concerned with the quality of its product. While it is important that quality requirements be satisfied and production schedules met. It is equally important that finished products meet established specifications. Because, customer's satisfaction is derived from quality products and services. However, the management looks to achieve customer satisfaction by running its business at the desired economic level. Both these can be attained by properly integrating quality development, quality maintenance and quality improvement of the product.

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 fulfils 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.

The product should have certain abilities to perform satisfactorily in a stated application. These abilities are categorised into the following factors

- Suitability: for specific application.
- Reliability: It should give efficient and consistent performance
- Durability: It should have desired life
- Safe and foolproof workability.
- Affordability: It should be economical
- Maintainability: it should be easy to maintain.
- Aesthetic look: It should look attractive.
- Satisfaction to customers: It should satisfy the customer's requirements.
- Economical: It should have reasonable price
- Versatility: It should serve number of purposes.

A product can be said to possess good quality if all the requirements are properly balanced while manufacturing and designing it.

QUALITY OF DESIGN:

The quality of design of a product is concerned with the tightness of the specifications for manufacture of the product. For example, a part which has a drawing tolerance of ± 0.001mm would be considered to have a better quality of design than another with a tolerance of ± 0.01mm.

A good quality of design must ensure consistent performance over its stipulated life span stated in terms of rated output, efficiency, overload capacity, continued or intermittent operation for specified application or service.

It should consider possible modes of failure due to stress, wear, distortion, corrosion, shocks, and vibrations, high or low temperature, environmental conditions etc.

However, product design and development is a continuous process which results into evaluation, of a product, based on assessed user needs, their feedback after use and development in technology at a given point of time in a given environment.

FACTORS CONTROLLING QUALITY OF DESIGN:

1. Type of customers in the market.

a) For consumer goods the important factor which governs the quality of design, is the type of customers in the market. The study of optimum quality of design involves "market survey".

It is the study of

a) consuming habits of the people

b) the price they are willing to pay for various products and services,

c) the choice of the design of the product which meets the needs of the customers.

For example, variety of vehicles with difference in size, capacity, performance and capabilities are found in the market to suit various applications, e.g., for passenger transport, ambulance for hospitals and vehicles for defence service etc,. The quality of design. thus, depends upon the type of customers rich, middle, poor etc., to provide the intended function with greatest overall economy.

b) For capital goods, the decision is usually governed by such considerations as intended life, environmental conditions, reliability, importance of continuity of service maintainability etc.

2. Profit consideration

From company's point of view, profit is more important. It is not necessary that the company should manufacture 100 percent quality products. The market segment to which management desires to cater should be considered. Profit can be maximised by producing products in different grades to suit different types of customers.

3. Environmental conditions

It also plays an important role in designing quality of design, For example, a car radiator designed for use in equatorial region should be for increased ambient temperature. A well-designed bus body known for its good performance abroad fail to withstand both road conditions and loading pattern in our country.

4. Special requirements of the product:

Generally, greater the requirements for strength, fatigue resistance, life interchangeability of manufacture of item, closer should be the tolerances to give better quality goods.

5. Higher quality of design means higher cost, quite often it also means higher values.

QUALITY OF CONFORMANCE

The quality of conformance is concerned with how well the manufactured product conforms to the quality of design.

When a design has been established, it is the task of all responsible for production planning and manufacture to obtain a high level of quality of conformity, the measure of truthfulness with which the product conforms to the design specifications

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FACTORS CONTROLLING QUALITY OF CONFORMANCE

For good quality of conformance with the design any organisation should ensure that:

- The incoming raw materials are of adequate quality. The machines and tools for the job and the measuring instruments are adequate for their purposes and are adequate for their purposes and are kept at high level of maintenance.
- Proper selection of the process and adequate process control.
- The operators should be well trained, experienced and motivated for quality consciousness.
- Proper care should be taken in shipment and storage of finished goods.
- Inspection programme is such that it gives accurate measure of the efficiency of the whole system and ensures to reduce and sort out defective products from the lot during processing.
- Feedback from both, the internal inspection, and the customers, are obtained regarding quality for corrective action.
- S.Q.C. techniques should be used to control variability in manufacturing process.
- Higher quality of design usually costs more, higher quality of conformance usually costs less, by reducing the number of defective products produced.

QUALITY OF PERFORMANCE

The quality of performance is concerned with how well the manufactured product gives its performance. It depends upon

a) Quality of Design
b) Quality of Conformance

It can be a best design possible, but poor conformance control can cause poor performance, conversely the best conformance control cannot make the product function correctly, if the design is not right.

QUALITY CONTROL

Control

Control can be defined as a process by means of which we observe the actual performance and compare it with some standard. If there is a deviation between the observed performance and the standard performance then it is necessary to take corrective action.

Quality control

Quality control is the process through which we measure the actual quality performance compare it with the standards and take corrective action if there is a deviation.

It is a systematic control of various factors that affect the quality of the product. It depends on Material, tools, Machines, type of labour, working conditions, measuring instruments etc.

Quality control is a powerful productivity technique for effective diagnosis of lack of quality (or conformity to set standards) in any of the materials, processes, machines or end products. It is essential that the end products possess the qualities that the consumer expects of them, for the progress of the industry depends on the successful marketing of products. Quality control ensures this by insisting on quality specifications all along the line from the arrival of materials through each of their processing to the final delivery of goods. Quality control, therefore, covers all the factors and processes of production which may be broadly classified as follows:

- **Quality of materials**: Material of good quality will result in smooth processing there by reducing the waste and increasing the output. It will also give better finish to end products.
- **Quality of manpower**: Trained and qualified personnel will give increased efficiency due to the better quality production through the application of skill and also reduce production cost and waste.
- **Quality of machines**: Better quality equipment will result in efficient working due to lack or scarcity of break downs thus reducing the cost of defectives.
- **Quality of Management**: A good management is imperative for increase in efficiency, harmony in relations, growth of business and markets.

Steps in quality control programme

1. Formulate quality policy
2. Work out details of product requirements, set the standards (specifications) on the basis of customers preference, cost and profit.
3. Select inspection plan and set up procedure for checking.
4. Detect deviations from set standards or specifications.
5. Take corrective action through proper authority and make necessary changes to achieve standards.
6. Decide how the defective parts are disposed of entire scrap or rework.
7. Co-ordination of quality problems.
8. Developing quality consciousness in the organisation.

STATISTICAL QUALITY CONTROL

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 performing inspection, testing and analysis to ensure 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.Walter A. Shewartan American scientist; it got recognition in industry only during 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

BASIC CONCEPTS OF SQC

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

Modern techniques of statistical quality control and acceptance sampling have an important part to play in the improvement of quality, enhancement of productivity, creation of consumer confidence and development of individual economy of the country.

The following statistical tools are generally used for exercising control, improvement of quality, enhancement of productivity, creation of consumer confidence and development of individual economy of the country.

1. **Frequency Distribution:** Frequency distribution is a tabulation or tally of the number of times a given quality characteristic occurs within the samples. Graphic representation of frequency distribution will show:
   i) Average Quality
   ii) Spread of quality
   iii) Comparison with specific requirements
   iv) Process capability
2. **Control chart:** Control chart is a graphical representation of quality characteristics which indicates whether the process is under control or not.
3. **Acceptance sampling**: Acceptance sampling is the process of controlling a portion of the product/material in a lot for the purpose of accepting or rejecting the lot on the basis of conforming or not conforming to a quality specifications. It reduces the time and cost of inspection and exerts more effective pressure on quality improvement than it is possible by 100 percent inspection. It is used when assurance is desired for the quality of

materials/products either produced or received.

4. **Analysis of the data:** It includes special methods, which include such techniques as the analysis of tolerances, correlation, analysis of variance, analysis for engineering design, problem solving technique to eliminate cause of trouble.

Statistical methods can be used inn arriving at proper specification limits of product, in designing the product, in the purchase of raw material, semi-finished products, manufacturing processes, inspection, packing, sales and also after sales service**.**

USES OR BENEFITS OF SQC:

1. The use of SQC ensures rapid and efficient inspection at a minimum cost.
2. It provides a means of detecting error at inspection.
3. It leads to more uniform quality of production.
4. It improves the relationship with the customer.
5. It reduces inspection costs.
6. It reduces the number of rejects and saves the cost of material.
7. It provides a basis for attainable specifications.
8. It points out the bottlenecks and trouble spots.
9. It provides a means of determining the capability of the manufacturing process.
10. It promotes the understanding and appreciation of quality control.

CAUSES OF VARIATION

Chance and assignable causes of variation

Variation in the quality of the manufactured product in the repetitive process in the industry is inherent and inevitable. These variations are broadly classified as being due to two causes viz., (i) chance causes, and (ii) assignable causes.

Chance causes

Some Stable pattern of variation or a constant cause system is inherent in any particular scheme of production and inspection. This pattern results from many minor causes that behave in a random manner. The variation due to these causes is beyond the control of human being and cannot be prevented or eliminated under any circumstance. Such type of variation has got to be allowed within the stable pattern, usually termed as Allowable Variation. The range of such variation is known as natural tolerance of the process.

Assignable causes

The second type of variation attributed to any production process is due to non-random or the so-called assignable causes and is termed as Preventable Variation. The assignable causes may creep in at any stage of the process, right from the arrival of raw materials to the final delivery of the goods.

Some of the important factors of assignable causes of variation are substandard or defective raw material, new techniques or operations, negligence of the operators, wrong or improper handling of machines, faulty equipment, unskilled or inexperienced technical staff and so on. These causes can be identified and eliminated and are to be discovered in a production process before it goes wrong i.e., before the production becomes defective.

By Statistical Quality Control (SQC) we mean the various statistical methods used for the maintenance of quality in a continuous flow of manufactured goods. The main purpose of SQC is to devise statistical techniques which help us in separating the assignable causes from chance causes of variation thus enabling us to take remedial action wherever assignable causes are present. The elimination of assignable causes of erratic fluctuations is described as bringing a process under control. A production process is said to be in a state of statistical control if it is governed by chance causes alone, in the absence of assignable causes of variation.

In the above problem, the main aim is to control the manufacturing process so that the proportion of defective items is not excessively large. This is known as **Process Control**. In another type of problem we want to ensure that lots of manufactured goods do not contain an excessively large proportion of defective items. This is known as **Product or Lot Control**. The process control and product control are two distinct problems, because even when the process is in control, so that the proportion of defective products for the entire output over a long period will not be large, an individual lot of items may not be of satisfactory quality. Process Control is achieved mainly through the technique of **Control Charts** whereas Product Control is achieved through **Sampling Inspection**.

PROCESS CONTROL

Statistical process control (**SPC**) is a method of quality control which employs statistical methods to monitor and control a process. This helps to ensure that the process operates efficiently, producing more specification-conforming products with less waste (rework or scrap). SPC can be applied to any process where the "conforming product" (product meeting specifications) output can be measured.

The main objective in any production process is to control and maintain a satisfactory quality level of the manufactured product. This is done by 'Process Control'. In Process Control the proportion of defective items in the production process is to be minimized and it is achieved through the technique of control charts.

The application of SPC involves three main phases of activity:

1. Understanding the process and the specification limits.
2. Eliminating assignable (special) sources of variation, so that the process is stable.
3. Monitoring the ongoing production process, assisted by the use of control charts, to detect significant changes of mean or variation.

CONTROL CHARTS

A Bell Laboratories engineer named Dr. Walter A. Shewhart introduced the basic concept of control charts in the 1920's. Shewhart was able to identify the importance of the reduction of variation in a process. In order to achieve continuous improvement he stressed the necessity of understanding and reducing this variation. He introduced a control chart as a tool to bring a process into a state of statistical control. These charts are sometimes referred to as Shewhart Charts.

Control charts attempt to differentiate "assignable" ("special") sources of variation from "Chance" ("common") sources. As "Common" sources are an expected part of the process, are of much less concern to the manufacturer than "assignable" sources. Using control charts is a continuous activity, ongoing over time.

In an industry, there are two kinds of problems to be faced, namely

(i) To check whether the process is conforming to its standard level.

(ii) To improve the standard level and reduce the variability.

Shewhart's control charts provide an answer to both. It is a simple technique used for detecting patterns of variations in the data. Control charts are simple to construct and easy to interpret. A typical control charts consists of the following three lines.

(i) Centre Line (CL) indicates the desired standard level of the process.

(ii) Upper Control Limit (UCL) indicates the upper limit of tolerance.

(iii) Lower Control Limit (LCL) indicates the lower limit of tolerance.

If the data points fall within the control limits, then we can say that the process is in control, instead if one or more data points fall outside the control limits, then we can say that the process is out of control.

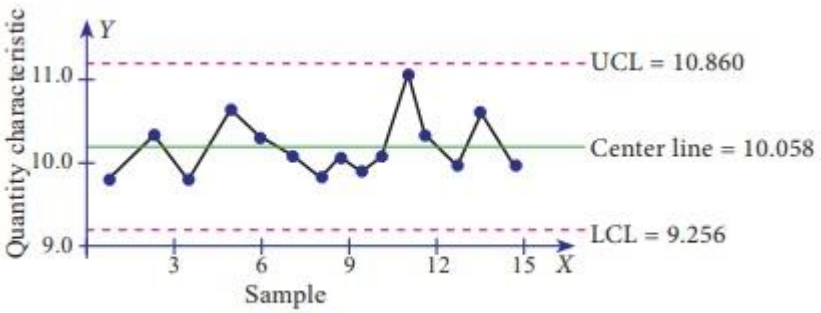

Fig 9.4

For example, the following lines with the data points plotted, diagram shows all the three control limits. since all the points falls within the control limits, we can say that the process is in control.

THREE-SIGMA CONTROL LIMITS

A phenomenon will be said to be controlled when, using past experience, we can predict within limits, how the phenomenon may be expected to behave in the future. Here it is understood that prediction within limits means that we can state, at least approximately, the probability that the observed phenomenon will fall within the given limits.

Three-sigma limits (**3-sigma limits**) is a statistical calculation that refers to data within **three** standard deviations from a mean. **Three-sigma limits** are used to set the upper and lower **control limits** in statistical quality **control charts.**

For an approximately normal data set, the values within one standard deviation of the mean account for about **68%** of the set; while within two standard deviations account for about **95%**; and within three standard deviations account for about **99.7**%.

Control limit equations are based on three sigma limits. It is three sigma limits of what is being plotted. If you are plotting individual values (e.g., the X control chart for the individuals control chart), the control limits are given by:

$$\text{UCL} = \text{Average}(X) + 3*\text{Sigma}(X)$$

$$\text{LCL} = \text{Average}(X) - 3*\text{Sigma}(X)$$

where Average (X) = average of all the individual values and Sigma(X) = the standard deviation of the individual values.

If you are plotting subgroup averages (e.g., the Xbar control chart), the control limits are given by:

$$\text{UCL} = \text{Average}(\bar{X}) + 3*\text{Sigma}(\bar{X})$$

$$\text{LCL} = \text{Average}(\bar{X}) - 3*\text{Sigma}(\bar{X})$$

where $\text{Average}(\bar{X})$ = average of the subgroup averages and

$\text{Sigma}(\bar{X})$ = the standard deviation of the subgroup averages.

If you are plotting range values, the control limits are given by:

$$UCL = Average(R) + 3*Sigma(R)$$

$$LCL = Average(R) - 3*Sigma(R)$$

where Average(R)= average of the range values and Sigma(R) = standard deviation of the range values.