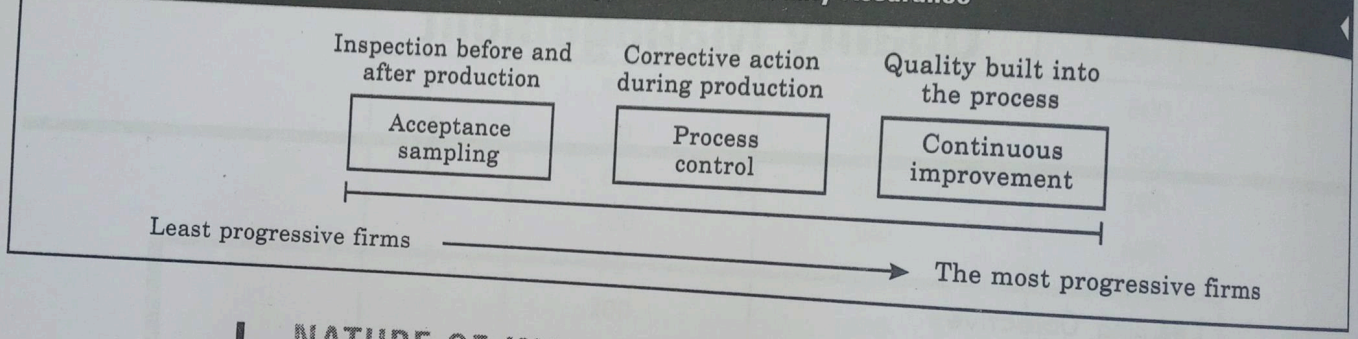
Traditional strategies of business organisations have tended to emphasise cost minimisation or *product differentiation.* But, most companies today focus on *superior quality* and/or time which form the core of their business strategy. Attaining *near-perfect product quality* is seen as a principal means of capturing market share in global competition.

Quality based strategies focus on satisfying the customer by integrating quality into all phases of the organisation. This includes not only the final product or service provided to the customer but also the related *processes* such as product or service design, production and after-sales-service.

The best firms emphasise designing quality *into the process* thereby greatly reducing the need for *inspection* or *quality control* efforts. The least progressive firms rely heavily on inspection. In between the best companies and least progressive firms, there are many other firms which employ some amount of inspection and a great deal of quality control including process control. The highly progressive firms have achieved an inherent level of quality which is sufficiently high that they can avoid inspection totally and even process control activities.

Exhibit 17.1 illustrates the approaches of firms to quality assurance.

Exhibit 17.1 : Approaches to Quality Assurance



I NATURE OF INSPECTION

Inspection: Verification of conformance of goods or services to the design specifications.

Inspection has been defined as a function whose purposes are to interpret specifications, verify conformance to these specifications and communicate the information obtained to those responsible for making necessary corrections in the manufacturing process.

The act of determining conformance or nonconformance of the expected performance is the function of inspection. In other words, the acceptability on non acceptability of parts, sub units and finished products or services is determined by inspection. The basis for inspection is usually a specification which is referred to as *inspection standard* or *quality standard.*

Quality: The sum total features of a product which influences its ability to satisfy a given demand.

What is Quality? Quality may be defined as the sum total of features of a product which influence its ability to satisfy a given demand.

Basically the quality of products and services is not defined or determined by producing firms, it is determined by customers. *"The quality of product or service is a customer's perception of the degree to which the product or service meets his or her expectations.*

Dimensions of Product Quality : Some dimensions of product quality are :

(i) **Performance :** How will the product or service perform and meet the customer's intended use. *For example,* the speed of a sports car.

(ii) **Features :** The special characteristics that appeal to customers. *For example,* the power steering of an automobile.

(iii) **Reliability :** The likelihood of breakdowns, malfunctions, or need for repairs. Higher the reliability lesser will be the likelihood of breakdowns and malfunctions and better will be the quality of the product.

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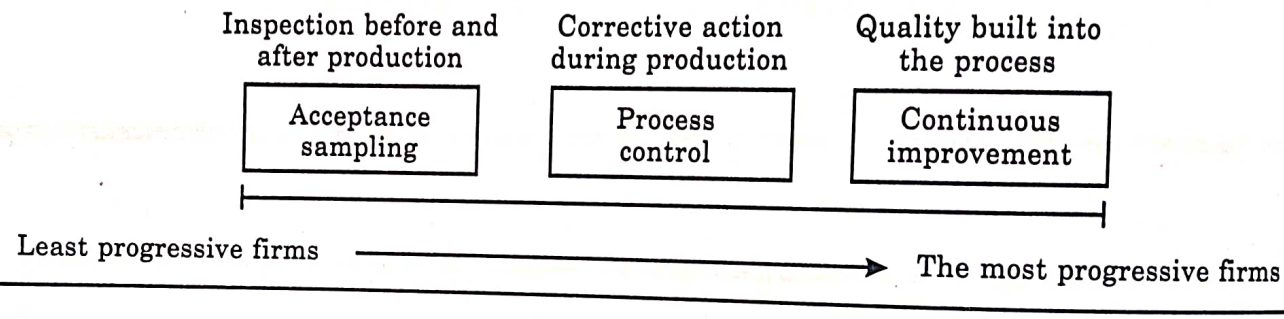

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(g) **Serviceability :** The speed, cost and convenience of repairs and maintenance. Higher the serviceability better will be the quality of the product.

(h) **Appearance :** The effect or human senses, the look, feel, taste, smell or sound.

(i) **Customer Service :** The treatment received by customers before, during and after the sale.

(j) **Safety :** How well the product protects users before, during and after use.

Inspection and Quality Control

Inspection is primarily a comparison with established standards, whereas quality control concerned with any function which contributes to the quality of goods produced.

"Quality control refers to all those functions or activities that must be performed to fill company's quality objectives."

Inspection is a *postmortem* operation carried out after the product is manufactured. It segregates the good from the bad and the defective items may be either rectified or scrapped. spection ensures that defective items are not sent to further stages of manufacture and finished oducts with defects are not despatched to customers or sold.

Inspection is one phase of quality control. It provides information required by other ases of quality control.

Quality control on the other hand, may also include establishment of criteria for the lection of production equipment, tooling and personnel. It often involves statistical analysis ferred to as statistical quality control or SQC).

Quality control aims at investigating the *root cause for defects* identified by inspection d take corrective action to overcome the defects for future production. For instance, a fect observed in a product may be due to defective design, defective machine or defective orkmanship of the worker. The exact reason for the defect is identified and appropriate rrective action is taken.

Inspection does not add to the value or quality of the product. It only ensures that substandard products are not supplied to the customer. Quality control helps to minimise the sts of inspection and rejection. Quality control is an effective system for integrating the ality **development, quality maintenance** and **quality improvement** efforts of the various oups in an organisation so as to enable production and service at the most economical vels which allow for full **customer satisfaction.**

Objectives of Inspection

(i) The major objective of inspection is the prevention of defects.

(ii) Detect defects as they occur in processing.

(iii) Detect trends in the process which might lead to defects.

(iv) Remove defective parts from production to stop further handling and processing costs.

(v) Remove defective parts to prevent poor performance of finished product.

(vi) Inform all levels of management on the performance of manufacturing departments or units.

(vii) Provide records for evaluation of individual machine or worker performance.

Scope of Inspection

There are several stages or levels at which inspection may be performed. These may be referred to in broad categories as : *(i)* receiving inspection, *(ii)* pre-production inspection, *(iii)* production inspection, *(iv)* product tests.

Where to Inspect in a Process

Many operations or processes have many points or stages in the process where inspecti is possible. Because each inspection adds to the cost and not to the value of the product, it necessary to restrict inspection efforts to the points where they are most beneficial manufacturing. Some stages of inspection or inspection points are :

(i) **Raw Materials and Purchased Parts :** which are supplied by outside vendors and hen must be inspected for quantity and quality at the inwards goods stage.

(ii) **Finished Products :** Since passing defective finished products to customers affects custom satisfaction and the credibility or image of the manufacturer, and also the repairing replacing of products sold is much more costly than rectifying the defects at the firm finished products inspection is essential.

(iii) **Before a Costly Operation :** This is to ensure that costly machine time or labour time not wasted by carrying out the operation on an item which is already defective.

(iv) **Before an Irreversible Process :** Certain processes or operations, once carried out on a item, the item if found defective can not be repaired or reworked. Such defective item may have to be scrapped or sold as seconds.

(v) **Before a Surface Finish Operation** such as electroplating or plating which can mask certain objects such as dents, or scratches.

I QUALITY CONTROL

Quality control: An approach to prevent the defects rather than detecting the defects.

Objectives : The ultimate aim of quality control is to provide products which are dependable, satisfactory and economical. A quality control system is designed to ensure economical production of products of uniform quality which is acceptable to the customer. **Quality control aims at preventing the defects rather than detecting the defects.**

Benefits of Quality Control

(i) Minimum scrap or rework due to reduced defectives.
(ii) Reduced cost of labour and material as a result of reduced defectives.
(iii) Uniform quality and reliability of product help in increasing sales turn over.
(iv) Reduced variability resulting in-higher quality and reduced production bottle necks.
(v) Reduced inspection and reduced inspection costs.
(vi) Reduced customer complaints.
(vii) Increased quality consciousness among employees.
(viii) Higher operating efficiency.
(ix) Better utilisation of resources.
(x) Better customer satisfaction and employee satisfaction.

Quality Assurance: Activity of providing adequate confidence that a product or service will satisfy given requirement for quality.

Quality Assurance : Quality assurance is the activity of providing the evidence needed to establish confidence that the quality related activities are being performed effectively. It is defined as "all those planned or systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirement for quality". Quality assurance encompasses **quality planning, quality control, quality improvement, quality audit and reliability.**

Organisation for Quality Control

Quality control is a staff function concerned with the *prevention of defects* in manufacturing so that items may be made **right at the first time** and not to be rejected later.

In order to achieve this end, several activities need to be performed. There must be inspection and control of incoming raw materials to ensure that they meet specifications; there must be planning and control of manufacturing processes to ensure that suitable methods are being used and that machines and equipment are performing satisfactorily; there must be in-process inspection to ensure that items being fabricated meet specifications; there must be final inspection and testing for product performance. In pursuance of these activities, several techniques must be employed.

In order to carry on these functions a separate department is created which is called Quality Control Department or simply, Department of Quality. The person who heads this department carries the title of Manager of Quality Control, Manager of Quality Assurance, or Chief Inspector. The level of quality control in an organisation is influenced by several factors, namely, the quality level of significance (e.g., of utmost importance in aircraft industry), the extent to which high quality represents the company to customers, the seriousness of quality system failures (e.g., food and pharmaceutical industries), the complexity of manufacturing, and the policies of customers. Thus, each company must establish a type of organisation which best fulfils its needs. Frequently, the quality control department is composed of a quality engineering function, an inspection function, and a laboratory function.

It should be stated that quality control is not the responsibility of only the personnel in the quality control department. Everybody in the organisation must be equally responsible to ensure quality of the end product.

Quality involves the members of management who set the **quality policies**, the salesmen who contract to sell products of a certain quality, the design engineers who set the **product specifications**, the buyers who purchase **raw materials** of the **right quality**, and the manufacturing personnel who are responsible for making the product according to the **prescribed specification**. It is only through the wholehearted cooperation of all the people that a sustained quality control programme can be maintained.

Ensuring Quality

Ensuring quality involves action on several fronts. To be specific, quality control involves the following steps :

A. **Control of Engineering Quality**

(i) Assist in the evaluation of customer requirements to arrive at a clear understanding of the product quality objectives.

(ii) Review design documentation for conformance to design standards and practice and for identification of potential quality problems.

(iii) Validate the accuracy and completeness of design proof tests and qualification tests.

(iv) Audit the release and distribution of design documents to assure that all drawings and specifications in use are current and correct.

(v) Provide information on previous quality problems encountered for consideration in new product designs or current product improvements.

B. **Control of Purchased Material Quality**

(i) Assist in the evaluation and selection of potential suppliers or sub-contractors.

(ii) Review purchase orders and sub-contracts for correctness and completeness of quality requirements.

(iii) Assure that purchased material conforms to the requirements of purchase orders and specifications.

(iv) Initiate corrective action with suppliers and subcontractors when purchased material is not of an acceptable quality level.

C. Control of Manufacturing Quality

(i) Evaluate and approve manufacturing equipment, processes, testing, and test equipment.

(ii) Assure that measuring and test equipment is properly calibrated and maintained.

(iii) Establish points of inspection and tests at selected points in the production processes.

(iv) Perform inspection and tests at selected points in the production processes.

(v) Collect and analyse inspection and test data and provide information on process and product quality levels.

(vi) Initiate corrective action on out-of-control conditions and related quality problems.

(vii) Conduct follow-up to assure that corrective action is accomplished in a timely manner.

(viii) Control the handling, preservation, and packaging of material and equipment from receipt through shipment of the final product.

D. Actions Supporting the Product After Delivery

(i) Assure that product service specifications are clear and correct.

(ii) Assure that spare parts conform to quality requirements.

(iii) Assure that repair and modification are performed in accordance with company quality requirements.

(iv) Gather and analyse complaint data from the field to measure the degree of customer satisfaction and initiate appropriate corrective action.

I STATISTICAL QUALITY CONTROL (SQC)

Statistical Quality Control: Application of statistical techniques to accept or reject products already produced or to control the process while it is being carried out.

Statistical Quality Control (SQC) is the application of statistical techniques to accept or reject products already produced, or to control the process and, therefore, product quality while the part is being made. While the latter is called *process control*, the former is named *acceptance sampling*.

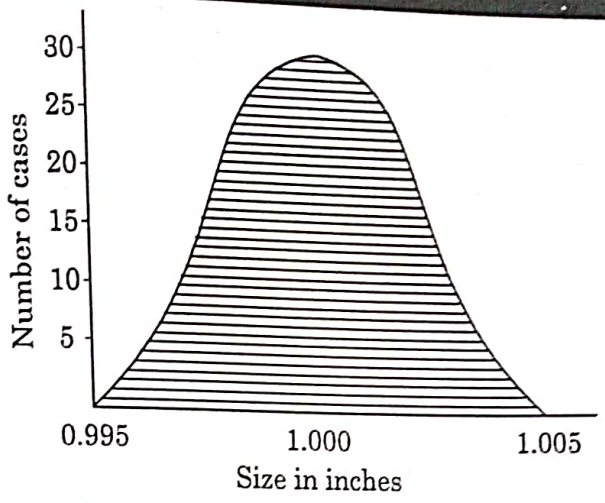
SQC for Process Control

Statistical Process Control (SPC): Statistical evaluation of the output of a process during production.

Mainly, SQC is used for controlling quality during production in mass production industries which produce standard products. SQC for process control is based on probability theory. It is common knowledge that when several identical parts are manufactured, some are a little large and some a little small, but most will be approximately the same. The middle or average will be the most frequent, with smaller and larger sizes as extremes from the average. When the frequency or count of the items by size is plotted with size on the horizontal scale and count on the vertical scale, a normal or bell-shaped curve of the type given in *Exhibit 17.3* is obtained.

Variations in size between 0.995 inch and 1.005 inches, with most measuring 1.000 inch are due to **chance causes**. Chance causes are inherent and cannot be controlled or prevented. Chance causes are ignored because any effort to eliminate them is uneconomical and may be counter-productive too. However, if the size measures beyond 1.005 inches or below 0.995 inch, it is not due to chance causes but because of **assignable causes**. In other words, the part is not normal. Assignable causes include internal temperature and wear and tear of the machine parts, a worn-out tool, improper dimension of raw material, or the setting of the machine being changed unintentionally. When it is known that an improper size is made as a result of an assignable cause, it is possible to stop, detect the cause and rectify it.

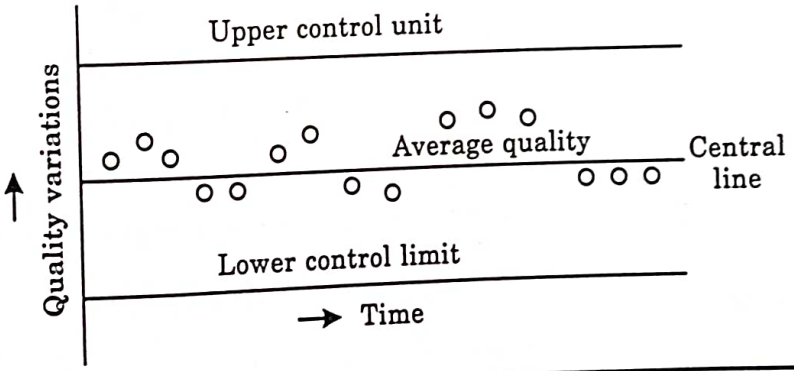
Exhibit 17.3 : Bell Shaped Curve



In practice, SQC for process control manifests through **control charts**. Control charts, st developed by Dr. Walter A. Shewhart of the Bell Telephone Laboratories during the 920s, are horizontal extensions of the bell-shaped curve.

A typical control chart consists of a **central line** corresponding to the average quality at hich the process is to perform and two other lines corresponding to the **upper and lower ontrol limits**, also called the **tolerance limits**. The vertical scale indicates the quality variations nd the horizontal scale has time. Samples of product are taken at specified time intervals, uality checked, measured, averaged and plotted on the chart. If the values plotted are within he control limits, the processing is said to be under control. If the values move away from ontrol limits, the process must be improved. In the *Exhibit 17.4,* values are within control imits. Naturally, process is under control. The control chart technique for process control is iscussed in detail later in this chapter.

Exhibit 17.4 : Control Chart for Process Control



Acceptance Sampling

Acceptance sampling is based on the premise that a sample represents the whole lot from which the former is drawn. In this method samples are taken out and are carefully inspected to detect defects. On the basis of number of defects found, the lot is accepted or rejected. If defects are few, lot is accepted. It is rejected when defects are more. Thus, acceptance sampling is used to take a decision regarding acceptance or rejection of a lot without having to examine the entire lot, thereby providing economy of inspection. It may be used at any point in a plant, but is most often found in incoming inspection and as such it is an important part of the overall quality control programme of a plant. The acceptance sampling technique is discussed in detail later in this chapter.

Acceptance Sampling: A statistical technique used to take a decision regarding acceptance or rejection of a lot without having to examine the entire lot.

Advantages of SQC

SQC offers several advantages to its users. Hence, it is being increasingly used in the industrial field. Some of the advantages of SQC are :

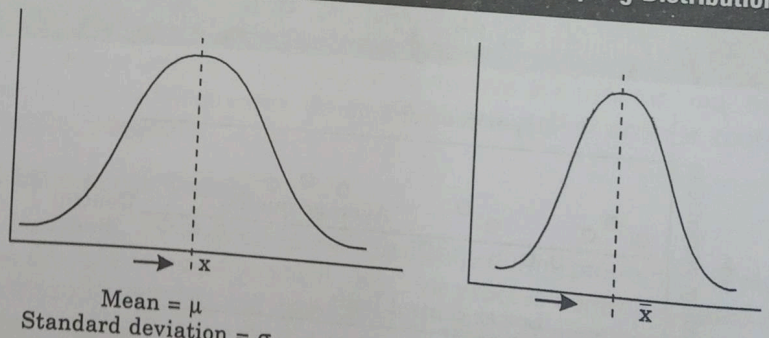
1. It helps prevent defects from occurring. Assignable causes signifying deviations in quality are detected and rectified. Costly rework, rejection, and scrap are avoided.
2. It also helps avoidance of the risk of accepting a bad lot.
3. Emphasising on inspection of only samples, SQC avoids inspection of the entire lot.
4. It ensures the maintenance of high standards of quality and enables the users to build up their goodwill.
5. Another important reason for using SQC is to supply an audit of quality regarding the producers' products. A universally understood measurement is supplied. In addition, the reasonableness of the quality standards established are checked. Frequently, this is a 'free extra' information, but in some cases, quite important information is heeded.

Sampling : It is the process of selecting and measuring (or inspecting) representative units of output termed **sample units**. A set of sample units is termed as **sample**. The sample units are drawn from the lot (universe or population) at random. A random sample is one in which each unit in the lot has an equal chance of being included in the sample and the sample is likely to be representative of the lot.

Central Limit Theorem : This theorem is stated as "Sampling distributions can be assumed to be normally distributed even though the population distribution are not normal".

Exhibit 17.5 compares a population distribution with its sampling distribution of sample means.

Exhibit 17.5 : A Comparison of Population and Sampling Distributions



Mean = μ
Standard deviation = σ_x

Mean = $\bar{\bar{x}} = \mu$

Standard error = $\sigma_{\bar{x}} = \frac{\sigma_x}{\sqrt{n}}$

The following generalizations are made about sampling distributions.

1. The sampling distribution can be assumed to be normally distributed unless the sample size (n) is extremely small (*i.e.*, less than five).
2. The mean of the sampling distribution ($\bar{\bar{x}}$) is equal to the population mean (μ).
3. The standard error of the sampling distribution ($\sigma_{\bar{x}}$) is smaller than the population standard deviation (σ_x) by a factor of $\frac{1}{\sqrt{n}}$.