Quality and Quality Control

INSPECTION

Inspection is the most common method of attaining standardisation, uniformity and quality of workmanship. It is the cost art of controlling the product quality after comparison with the established standards and specifications. It is the function of quality control. If the said item does not fall within the zone of acceptability it will be rejected and corrective measure will be applied to see that the items in future conform to specified standards.

Inspection is an indispensable tool of modern manufacturing process. It helps to control quality, reduces manufacturing costs, eliminate scrap losses and assignable causes of defective work.

Objectives of Inspection

1. To collect information regarding the performance of the product with established standards for the use of engineering production, purchasing and quality control etc.
2. To sort out poor quality of manufactured product and thus to maintain standards.
3. To establish and increase the reputation by protecting customers from receiving poor quality products.
4. Detect source of weakness and failure in the finished products and thus check the work of designer.

Purpose of Inspection

1. To distinguish good lots from bad lots
2. To distinguish good pieces from bad pieces.
3. To determine if the process is changing.
4. To determine if the process is approaching the specification limits.
5. To rate quality of product.
6. To rate accuracy of inspectors.
7. To measure the precision of the measuring instrument.
8. To secure products – design information.
9. To measure process capability.

Stages of Inspection

1. Inspection of incoming material
2. Inspection of production process
3. Inspection of finished goods.
(1) **Inspection of incoming materials.** It is also called receiving inspection. It consists of inspecting and checking of all the purchased raw materials and parts that are supplied before they are taken on to stock or used in actual manufacturing. Inspection may take place either at supplier's end or at manufacturer's gate. If the incoming materials are large in quantity and involve huge transportation cost it is economical to inspect them at the place of vendor or supplier.

(2) **Inspection of production process.** The work of inspection is done while the production process is simultaneously going on. Inspection is done at various work centres of men and machines and at the critical production points. This had the advantage of preventing wastage of time and money on defective units and preventing delays in assembly.

(3) **Inspection of finished goods.** This is the last stage when finished goods are inspected and carried out before marketing to see that poor quality product may be either rejected or sold at reduced price.

**Inspection Procedures**

There are three ways of doing inspection. They are Floor inspection, Centralised inspection and Combined inspection.

**Floor Inspection**

It suggest the checking of materials in process at the machine or in the production time by patrolling inspectors. These inspectors moves from machine to machine and from one to the other work centres. Inspectors have to be highly skilled. This method of inspection minimise the material handling, does not disrupt the line layout of machinery and quickly locate the defect and readily offers field and correction.

**Advantages**

1. Encourage co-operation of inspector and foreman.
2. Random checking may be more successful than batch checking.
3. Does not delay in production.
4. Saves time and expense of having to more batches of work for inspection.
5. Inspectors may see and be able to report on reason of faculty work.

**Disadvantages**

1. Difficult in inspection due to vibration.
2. Possibility of biased inspection because of worker.
3. Pressure on inspector.
4. High cost of inspection because of numerous sets of inspections and skilled inspectors.

**Suitability**

1. Heavy products are produced.
2. Different work centres are integrated in continuous line layout.

**Centralised Inspection**

Materials in process may be inspected and checked at centralised inspection centre which are located at one or more places in the manufacturing industry.
Advantages
(1) Better quality checkup.
(2) Closed supervision.
(3) Absence of workers pressure.
(4) Orderly production flow and low inspection cost.

Disadvantages
(1) More material handling.
(2) Delays of inspection room causes wastage of time.
(3) Work of production control increases.
(4) Due to non-detection of machining errors in time, there may be more spoilage of work.

Suitability
(1) Incoming materials inspection.
(2) Finished product inspection.
(3) Departmental inspection.
(4) High precision products of delicate products.
(5) Small and less expensive products.

Combined Inspection
Combination of two methods what ever may be the method of inspection, whether floor or central. The main objective is to locate and prevent defect which may not repeat itself in subsequent operation to see whether any corrective measure is required and finally to maintained quality economically.

Methods of Inspection
There are two methods of inspection. They are 100% inspection and Sampling inspection.

100% Inspection
This type will involve careful inspection in detail of quality at each strategic point or stage of manufacture where the test involved is non-destructive and every piece is separately inspected. It requires more number of inspectors and hence it is a costly method. There is no sampling error. This is subjected to inspection error arising out of fatigue, negligence, difficulty of supervision etc. Hence complete accuracy of influence is seldomly attained.

It is suitable only when a small number of pieces are there or a very high degree of quality is required. Example: Jet engines, Aircraft, Medical and Scientific equipment.

Sampling Inspection
In this method randomly selected samples are inspected. Samples taken from different batches of products are representatives. If the sample prove defective. The entire concerned is to be rejected or recovered. Sampling inspection is cheaper and quicker. It requires less number of Inspectors. Its subjected to sampling errors but the magnitude of
sampling error can be estimated. In the case of destructive test, random or sampling inspection is desirable. This type of inspection governs wide currency due to the introduction of automatic machines or equipments which are less susceptible to chance variable and hence require less inspection, suitable for inspection of products which have less precision importance and are less costly.

**Example:** Electrical bulbs, radio bulbs, washing machine etc.

Destructive tests conducted for the products whose endurance or ultimate strength properties are required.

**Example:** Flexible strength, resistance capacity, compressibility etc.

**Drawbacks of Inspection**

1. Inspection adds to the cost of the product but not for its value.
2. It is partially subjective, often the inspector has to judge whether a product passes or not.
   
   **Example:** Inspector discovering a slight burnish on a surface must decide whether it is bad enough to justify rejection even with micrometers a tight or loose fit change measurement by say 0.0006 inches. The inspectors design is important as he enforces quality standards.

3. Fatigue and Monotony may affect any inspection judgement.
4. Inspection merely separates good and bad items. It is no way to prevent the production of bad items.

**Quality**

Different meaning could be attached to the word Quality under different circumstances. The word Quality does not mean the Quality of manufactured product only. It may refer to the Quality of the process (i.e., men, material, machines) and even that of management. Where the quality of manufactured product referred as or defined as “Quality of product as the degree in which it fulfills the requirement of the customer. It is not absolute but it judged or realised by comparing it with some standards”.

It is usually determined by some characteristics namely design, size, material, chemical composition, mechanical functioning workmanship, finish and other properties. In the final analysis the Quality standards for the products are established by the customer.

**Example:** Gear used in sugarcane extracting machine through not of the same material and without possessing good finish, tolerance and accuracy as that of gear used in the hand stock of a teeth may be considered of good quality if it work satisfactory in the juice extracting machine.

Quality begins with the design of a product in accordance with the customer specification further it involves the established measurement standards, the use of proper material, selection of suitable manufacturing process and the necessary tooling to manufacture the product, the performance of the necessary manufacturing operations and the inspection of the product to check on performance with the specifications. Quality characteristics can be classified as follows:

1. Quality of design
2. Quality of conformance with specifications
Control

The process through which the standards are established and met with standards is called control. This process consists of observing our activity performance, comparing the performance with some standard and then taking action if the observed performance is significantly different from the standards.

The control process involves a universal sequence of steps as follows:
1. Choose the control subject.
2. Choose a unit of measure.
3. Set a standard value i.e., specify the quality characteristics
4. Choose a sensing device which can measure.
5. Measure actual performance.
6. Interpret the difference between actual and standard.
7. Taking action, if any, on the difference.

Quality Control

Quality control can be defined as that Industrial Management technique by means of which product of uniform acceptable quality is manufactured.

Factors Affecting Quality

1. Men, Materials and Machines
2. Manufacturing conditions
3. Market research in demand of purchases
4. Money in capability to invest
5. Management policy for quality level
6. Production methods and product design
7. Packing and transportation
8. After sales service

Objectives of Quality Control

1. To decide about the standard of Quality of a product that is easily acceptable to the customer.
2. To check the variation during manufacturing.
3. To prevent the poor quality products reaching to customer.

Statistical Quality Control (SQC)

A Quality control system performs inspection, testing and analysis to conclude whether the quality of each product is as per laid quality standard or not. It’s called “Statistical Quality Control” when statistical techniques are employed to control quality or to solve quality control problem. SQC makes inspection more reliable and at the same time less costly. It controls the quality levels of the outgoing products.

SQC should be viewed as a kit of tools which may influence related to the function of specification, production or inspection.
A successful SQC programme is expected to yield the following results:

(1) Improvement of quality.
(2) Reduction of scrap and rework.
(3) Efficient use of men and machines.
(4) Economy in use of materials.
(5) Removing production bottle-necks.
(6) Decreased inspection costs.
(7) Reduction in cost/unit.
(8) Scientific evaluation of tolerance.
(9) Scientific evaluation of quality and production.
(10) Quality consciousness at all levels.
(11) Reduction in customer complaints.

Tools of SQC

The principle tools of SQC are as follows:

(1) Frequency distribution.
(2) Control charts for measurement and attribute data.
(3) Acceptance sampling techniques.
(4) Regression and correlation analysis.
(5) Tests of significance.
(6) Design of experiments.

QUALITY CHARACTERISTICS

Quality of Design

Quality design is a technical term. It can be regarded as a composite of 3 separate terms or steps in a common progression of activities.

(i) Identification of what constitutes fitness for use to the user (Quality of market research).

(ii) Choice of concept of product or service to be responsible to the identified needs of the user (Quality of concept).

(iii) Translation of the chosen product concept into a detailed set of specifications which is faithfully executed, will then meet the user’s need (Quality of specification).

The total progression composed of these three activities is called “Quality of Design” and it may be said to consist of Quality of market research: Quality of concept and Quality of specification.

Example: All automobiles provide the user with the service of transportation. The various models differ as to size, comfort, appearance, performance, economy, status conferred etc. These differences are in turn the results of intended or designed differences in the size, styling, materials, tolerances, test programs etc. Higher quality of design can be attained only at an increase in costs.
Quality of Conformance

The design must reflect the needs of fitness for use, and the products must also confirm to the design. The extent to which the product does confirm to the design is called “Quality of conformance”. This extent of conformance is determined by variables as:

(i) Choice of process i.e., whether they are able to hold the tolerances.
(ii) Training of the supervision and the work force.
(iii) Degree of adherence to the program of inspect, test, audit etc. motivation for quality.

Higher quality of conformance can be attained with an accompanying reduction in cost.

Example: Two scooters both are produced at the same level of time but one may be 100% according to the drawing and specification of the same design; the second scooter may be 90% according to the drawing and specification and probably a few dimensions may be different from those of drawing. Therefore quality of conformance of 1st scooter is better than the 2nd scooter even though both are of same design.

Quality Costs

Quality costs are the incurring in introducing quality and benefits. This is done by identifying and defining the following categories of costs which are associated with making, finding, repairing or avoiding (preventing) defects.

![Fig. 1.1. Hierarchy of quality cost or Breakdown of quality cost.](image)

**Quality Costs**

- **Direct cost**
  - Failure costs
  - Preventive costs
  - Appraisal costs

- **Indirect cost**
  - Internal
  - External

(A) Failure costs

**Internal failure costs.** These are costs which would disappear if no defects exit in the product prior to shipment to the customer. They include.

- Scrap : The net loss in labour and material resulting from defectives which cannot economically be repaired or used.
- Rework : The cost of correcting defectives to make them fit for use.
- Retest : The cost of inspection and retest of products that have undergone rework or other revision.
- Down time : The cost of idle facilities resulting from defects. **(Example :** Aircraft idle due to unreliability, printing press down due to paper break).
- Yield losses : The cost of process yield lower that might be attainable by improved controls. Includes “overfill” of containers (going to customers) due to variability in filling and measuring equipment.
**External failure costs.** These costs would also disappear if there were no defects. They are disguised from the internal failure costs by the fact that the defects are found at the shipment to the customer. They include:

- **Complaint adjustment:** All costs of investigation and adjustment of justified complaints attributable to defective product or installation.
- **Returned material:** All costs associated with receipts and returned from the field.
- **Warranty charges:** All costs involved in service to customers under warranty contracts.
- **Allowances:** Costs of concessions made to customers due to substandard products being accepted by the customer as is include loss in income due to down grading products for sale as seconds.

**B) Appraisal Costs**

These are costs incurred to discover the conditions of the products, mainly during the “first come through” costs include.

- **Incoming material inspection:** The cost of determining the quality of vendor made products, whether by inspection on receipt or at source or by surveillance method.
- **Inspection and test:** The cost of checking the conformance of the product throughout its progression, in the factory, including final acceptance and check of packing and shipping includes life, environmental and reliability tests. Also includes testing done at customer’s premises prior to giving up the product to the customer.
- **Maintaining accuracy of test equipment:** Includes the cost of operating the system that keeps the measuring instruments and equipment in calibration.
- **Materials and services consumed:** Includes costs of product consumed through destructive tests, materials consumed and services where significant.
- **Evaluation of stock:** Include the costs of testing products in field storage or in stock to evaluate degradation.

**C) Prevention Costs**

These costs are incurred to keep future and appraisal costs at a minimum. It includes:

- **Quality Planning:** This includes the broad array of activities which collectively create quality plan, the inspection plan, reliability plan, data system and numerac specialised plans. It includes also preparation of the manuals and procedures needed to communicate these plans to all concerned.
- **New Product review:** Includes preparation of bid proposals evaluation of new design, preparation of test and experiment programs and other quality activities associated with the launching of new designs.
- **Training:** The costs of preparing training programs for attaining and improving quality performance includes the cost of conducting formal training programs as well.
- **Process control:** Includes that part of process control which is conducted to achieve fitness for use as distinguished from achieving productivity, safety etc.
Quality data acquisition and analysis: This is the work of running the quality of data systems to acquire continuing data on quality performance. It includes analysis of these data to identify the quality troubles, to sound alarms etc.

Quality reporting: Includes the work of summarizing and publishing quality information to the middle and upper management.

Improvement Projects: Includes the work of structuring and carrying out programs for breakthrough to new levels of performance i.e., defective prevention programs, motivation programs etc.

**Total Quality Control**

Total Quality Control defined as an effective system for integrating the quality development, quality maintainance and quality improvement efforts of the various groups in an organization so as to enable production and service at the most economical level which allow for full customer satisfaction.

It may be classified as a “Management Tool” for many industries outstanding improvement in product quality design and reduction in operating costs and losses.

Product quality is defined as “The composite product of engineering and manufacture that determine the degree to which the product in use will meet the expectations of the customer”.

“Control” represents a tool with four steps:

- Setting up of quality standards.
- Appraising conformance to these standards.
- Acting when these standards are exceeded.
- Planning for improvements in these standards.

Quality control emerges as a basic function based on the collection analysis and interpretations of data on all aspects of the enterprise.

Total quality control is an aid for good engineering designs, good manufacturing methods and conscious inspection activity that have always been required for the production of high quality articles.

Quality of any product is effected at many stages of the industrial cycle:

- **Marketing**: Evaluates the level of quality which customers want for which they are willing to pay.
- **Engineering**: Reduces this marketing evaluations to exact specification.
- **Purchasing**: Chooses, contracts with and retains vendors for parts and materials.
- **Manufacturing Engineering**: Select the jigs, tools and processes for production.
- **Manufacturing Supervision and shop operators**: Exert a major quality influence during parts making, sub assembly and final assembly.
- **Mechanical Inspection and function Test**: Check conformance to specifications.
- **Shipping**: Influences the calibre of packaging and transportation.
- **Installation**: Helps ensure proper operations by installing the product according to proper instructions and maintaining it through product service.
In other words, the determination of both quality and quality costs actually takes place throughout the entire industrial cycle.

Quality control is responsible for quality assurance at optimum quality costs. The benefits resulting from Total Quality Control programmes are:

- Improvements in product quality and design
- Reduction in operating costs and losses
- Reduction in production line bottle necks
- Improvement in employee morale
- Improved inspection methods
- Setting time standards for labour
- Definite schedule for preventive maintainance
- Availability of purposeful data for use in co-advertising
- Furnishing of actual basis for cost accounting for standard and for scrap, rework and inspection.