TEROTECHNOLOGY

Terotechnology

1.1 Introduction

Terotechnogy is the process of optimising the life cycle cost of physical assets. **Life cycle cost** is the sum of all costs incurred during the life time of an asset that is, the total of procurement and ownership costs. Life cycle costs are categorised as: cost of acquisition, cost of use, and cost of administration. Life Cycle Cost (LCC) of any physical asset is influenced by the plant reliability and plant maintainability.

Maintainability is the action taken during the design and development of assets to include features that will increase ease of maintenance and will ensure that when used in the field the asset will have minimum downtime and Life-cycle support costs i.e. its serviceability, reparability, and cost-effectiveness of maintenance are increased.

Reliability is the probability that an item will carry out its stated function adequately for the specified time interval when operated according to the designed conditions, i.e. to define reliability of any equipment:

- We must state the planned working life e.g. a new car might be very reliable if we only expect it to last for 5 years; less reliable over a period of 10 years; and completely unreliable if we are expecting a useful life of say 40 years.
- Similarly we shall need to know the intended conditions of use, and the routine maintenance which is required, e.g. if a car engine seizes because there is no water in the radiator this is a failure of maintenance rather than a failure of reliability; if a car is driven carelessly and fails this is a misuse failure.

Mean Time between Failures (MTBF) and Mean Time to Repair (MTTR): The Mean Time between Failures (MTBF) tells us how long on average, equipment operates before it fails, and this we want to be as long as possible. MTBF, therefore, depends **on reliability.** The Mean Time To Repair (MTTR) tells us how long on average, it takes to put the equipment right after it has failed, and this we want to be as short as possible. MTTR, therefore, depends on maintainability.

1.2 Product Quality

1.2.1 Definition of Quality

Broadly defined, **quality** refers to the ability of a product or service to consistently meet or exceed customers' needs and expectations. However, quality can be defined in various ways, depending on the perspective of the user. Quality is:

- Conformance to applicable specifications and standards.
- Fitness for use.
- Satisfaction of customer wants, need and expectations at the competitive cost.

Conformance - Quality of conformance refers to the extent to which the product complies with the specifications, standards, and workmanship criteria imposed upon its manufacture. A product, manufactured to specification and in conformance with the control limits of the production processes should satisfy the customer provided that the specifications have correctly translated the customer's requirements (and that pertinent reliability aspects were considered in design). The difference between quality of design and quality of conformance is illustrated by the following example:
Two electrical freezers are made to the same design, specifications, procedures, and standards i.e. they both have the same quality of design. One of them is unable to carry its cooling load as advertised; it therefore does not conform to the specification, and the two units differ in their quality of conformance.

Fitness for use - All human institutions (industrial companies, schools, hospitals etc.) are engaged in providing products or services to human beings. This relationship is constructive only if the goods and services respond to the overall needs of the user in price, delivery date, and fitness for use. If the goods and services do respond to these overall needs, they are said to possess marketability. Among these overall needs, the extent to which the product successfully serves the purpose of the user, during usage, is called its "**fitness for use".** Fitness for use is determined by those features of the product that the user can recognize as beneficial to him/her, e.g. clear reception of TV programs, timeliness of bus service, life of shoes etc. Fitness for use is judged as seen by the user, not by the manufacturer.

Customer Satisfaction at the Competitive Price: Another definition for Quality says that product or service quality is the producer's ability to satisfy customer needs while still being able to realize a profit. This definition has both a customer and a manufacturer orientation. While the customer is the reason for the organization's existence, the product manufacturer and service producer must still make a profit. This definition focuses on satisfying the customer at the competitive price. Many customers will not purchase a product or service unless it is reasonably priced.

1.2.2 Types of Quality

There are three types of quality that are normally considered - quality of design, quality of conformance, and quality of performance.

i) Quality of design has to do with intentional differences between goods and services with the same basic purpose. A given level of design quality may satisfy some consumers and may not satisfy others. Designing quality into a product or service is extremely important. A good product design will prevent problems in manufacturing and will result in satisfied customers. The product design will specify a set of tolerances (specifications) that must be met if the product is to operate/perform acceptably. **[This is the Design Stage].**

ii) Quality of conformance has to do with the ability of a process (for instance, a manufacturing process) to meet the specifications set forth by the design. The types and quality of raw materials, the design and efficiency of the production process, the amount of training given to workers, the care and attention paid by workers and the extent to which quality control practices are employed will all affect the ability to meet the design specifications. **[This is the Process Stage].**

iii) Quality of performance has to do with how well the product or service actually performs in the marketplace. The quality of performance in the marketplace will determine the ultimate market share of the product or service. Quality of performance studies can reveal two kinds of quality problems. A quality problem will exist when the product design (the set of quality characteristics and specifications set forth in the design) does not exceed the needs of the consumer. However, even if the product design is well conceived, a quality problem will exist if the production process produces quality characteristics that exhibit too much variation. **[This is the Operation/Performance Stage].**

1.2.3 Objectives of Quality Control and Quality Control Steps

Quality control is the engineering and management activity by which we measure the quality characteristics of the product, compare them with specifications or requirements, and take appropriate remedial action whenever there is a difference between actual performance and the standard.

The objective of the quality-control department is not to eliminate all variability of the items produced - which would be an impossible task - but to constrain this variability to economically feasible limits. The basic quality control plan should provide for the control of the product throughout its development and production cycle.

Control is impossible unless objectives and targets are clearly defined, and it is also impossible if objectives and policies change with every passing whim. For example, we cannot control a design or process without setting quality standards, and we cannot control research and technology without setting quality targets. There are six steps to control the quality, which is shown in figure 1 below. This is the basic philosophy of control, and control only takes place when the loops shown in figure 2 are followed. If this is done with respect to clearly defined quality objectives, it is quality control. Also control can be exercised effectively if **statistical methods** are used skilfully at each of the above stages. This is statistical control. When exercised with respect to quality, it is called **Statistical Quality Control** (SQC).

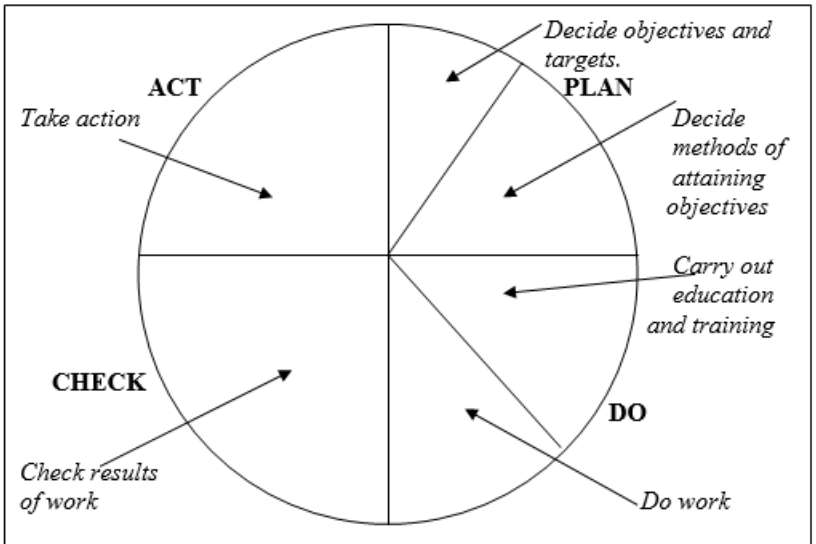

Fig. 1: The Six Control Steps: Plan-Do-Check-Act (PDCA) cycle is also known as Deming Cycle

Statistical Quality Control can be divided into **acceptance sampling** and **statistical process control**. Acceptance sampling involves testing a random sample of existing goods and deciding whether to accept an entire lot based on the quality of the random sample. Statistical process control involves testing a random sample of output from a process to determine whether the process is producing items within a pre-selected range. When the tested output exceeds that range, it is a signal to adjust the production process to force the output back into the acceptable range. This is accomplished by adjusting the process itself. Acceptance sampling is frequently used in a purchasing or receiving situation, while process control is used in a production situation of any type.

Quality control for both acceptance sampling and process control measures either attributes or variables. Goods or services may be observed to be either good or bad, or functioning or malfunctioning. For example, a lawnmower either runs or it doesn't; it attains a certain level of torque and horsepower or it doesn't. This type of measurement is known as **sampling by attributes**. Alternatively, a lawnmower's torque and horsepower can be measured as an amount of deviation from a set standard. This type of measurement is known as **sampling by variables**.

1.2.4 Quality Assurance

The purpose of quality control is to assure that processes are performing in an acceptable manner. This is accomplished by monitoring process output using statistical techniques. If the results are acceptable, no further action is required; unacceptable results call for corrective action.

The best companies emphasize designing quality into the process, thereby greatly reducing the need for inspection or control efforts. **Quality assurance** that relies primarily on inspection after production is referred to **acceptance sampling**. Quality assurance efforts that occur during production are referred to as **statistical process control**.