UNIT 1 MAINTENANCE MANAGEMENT AND TEROTECHNOLOGY: AN OVERVIEW

Objectives

After studying this unit, you will be able to:

- understand the scope of maintenance management,
- appreciate the role of maintenance in lifecycle profits of a plant,
- understand the concept of terotechnology,
- understand basic elements of a maintenance management system.

Structure

1.1 INTRODUCTION

Production organizations are usually concerned with converting inputs such as raw materials, labor and processes into finished products of higher value at minimum cost satisfying the customer needs. Increased competition for timely delivery of high quality products has forced manufacturers to adopt automation. This has resulted in very high investments in plant and equipment. In order to achieve maximum return on investments the production systems will have to minimize plant downtime, increase productivity, improve quality and deliver orders to customers in a timely fashion. This has brought to the forefront the role of maintenance as a key function in any production system.

Maintenance is a combination of science, art and philosophy. Its execution relies on science, art of maintenance depends on individual aptitude and its philosophy should fit to the operation or organization it serves.

The focus of the maintenance function is to insure that all company assets meet and continue to meet the design function of the asset. Maintenance involves a combination of activities by which equipment or system is kept in, or restored to, a state in which it can perform its designated functions. It is an important factor in product quality and can be used as a strategy for successful competition. Many companies consider maintenance as a necessary evil, an expense to the organization, or a non-value-added function. More progressive companies view maintenance as a way to reduce costs of producing their product or providing their services. They are using this cost advantage to lower prices and increase their life cycle profits.

Maintenance management is the management of all the assets owned by a production organization, based on maximizing the return on investment in the assets. This is achieved by applying general management principles of planning, scheduling, organizing and controlling to the maintenance function.

1.2 PLANT MAINTENANCE AND LIFE CYCLE PROFITS

Life cycle costs are total costs from inception to disposal for equipment and plant.

It is the sum of all costs incurred during the lifetime of an item, that is, the total procurement and ownership costs. It is the total cost of ownership. A typical cost element structure is as follows**:**

Cost categories

a) **Acquisition costs**

- Research and development
  - Management
  - Engineering
- Design and prototyping
  - Engineering design
  - Fabrication
  - Testing and evaluation
- Production
  - Manufacturing
  - Plant facilities and overhead
  - Marketing and distribution

b) **Operations and support costs**

- Operations
  - Facilities
  - Operators
  - Consumables (energy and fuel)
  - Downtime
- Support
  - Repair resources
  - Supply resources
  - Repairables
  - Expendables
  - Tools, test, and support equipment
  - Failure costs
  - Training
  - Technical data

c) **Phase out**

- Salvage value
- Disposal costs

Life cycle cost = Acquisition costs + operation costs + failure Cost + support cost – net salvage value

Where, Net salvage value = salvage value – disposal cost

To discount monetary values over time, all revenues and costs can be expressed in present day equivalent values

If P = present value

f = inflation rate

e = annual return on investment rate

i = real, or effective, discount rate

$i \approx e - f$ for small values of e and f

P_F (i ,d) = present value of a future single payment 'F' at the end of year 'd'

$$= \frac{1}{(1+i)^d} F$$

P_A (i, d) = present value of equal annual payment 'A' over 'd' years

$$= \frac{[(1+i)^d - 1]}{[i(1+i)^d]} A = \frac{1-(1+i)^{-d}}{i} A$$

In case Cu = Unit acquisition cost

N = Number of identical units to be procured

F_o = Fixed cost of operating

C_o = Annual operating cost per unit

F_s = Fixed support cost

C_s = Annual support cost per unit

C_f = Cost per failure

t_o = Operating hours per year per unit

t_d = Design life (in years)

S = Unit salvage value (a negative value is interpreted as disposal cost)

$$\textit{Life Cycle Cost} = C_u N + [F_o + P_A(i, t_d) C_o N] + [P_A(i, t_d) C_f \frac{t_o}{MTTF}.N] + [F_s + P_A(i, t_d)\, C_s N] - [P_F(i, t_d)\, S N]$$

Where $\frac{t_0}{MTTF}$ is the expected number of failures per year

And C_f is Cost per failure may be a repair cost, replacement cost, or a warranty cost. Our objective is maximization of life cycle profits, which can be defined as:

Life Cycle Profit = Revenue Generated – Life Cycle Costs

Figure 1.1 illustrate the expected variation of profit during the life cycle as a difference between achieved revenue and the sum of operation, maintenance, downtime and capital costs. The factors affecting life-cycle profitability are given in Table 1.1.

Table 1.1 : Factors affecting life-cycle profitability

1.	Acquisition Costs	Capital cost Installation cost and Time Commissioning cost and time
2.	Sustaining costs	Production costs Maintenance costs Energy costs
3.	Output factors	Useful Life Plant Performance Product Quality Plant Availability
4.	Outside Factors	Product Demand Product Price Obsolescence

Activity A

Visit a manufacturing unit. Take an audit of few machines and calculate their life cycle cost.

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Figure 1.1 : The Life Cycle Profit

Investment in the plant occurs from its conception to its commissioning. It all goes well the return on the investment begins when the plant comes into use and continues until the plant is finally disposed off. The management objective is to maximize life cycle profits within the constraints imposed by the need for safe operation. The nature of maintenance activity is determined by the manner in which plant and equipment is designed, selected, installed, commissioned, operated, removed and replaced. Best time to influence maintenance and unavailability costs is before the plant comes into use.

The specification for the new plant should include reliability and maintainability (availability) requirements in addition to performance, cost and safety requirements. As far as possible the expected, or useful life of the plant should also be specified. To support this the equipment manuals, drawings, spares needed, spares security of supply and training needs should be specified and included in the contract.

During the design stage in addition to performance due consideration should also be made for reliability, maintainability and useful life. Design stage considerations of reliability and maintainability can also affect the duration and cost of commissioning.

At the installation stage, maintainability continues to be an important consideration as it is at this stage that the multidimensional nature of many of the maintenance problem become clear. Similarly many design faults are known and designed out at the commissioning stage of the plant. Failure to do this may cause serious maintenance problems and high unavailability in the beginning of the operational life. Operating equipment past its useful life stage will result in low availability and high maintenance cost.

The total costs to the user throughout the lifetime of the plant can often be many times the initial capital costs. It is essential that the costs of owning plant and equipment are minimized over its working life. To achieve this objective it is necessary to lower the traditional barrier between design, maintenance, operation, finance and other functions. Terotechnology embraces both the aims of life cycle cost optimization and the multifunctional approach to achieve it.

1.3 TEROTECHNOLOGY

The name Terotechnology is based on the Greek word 'terein', which means to guard or look after. It is defined as -

" A combination of management, financial, engineering and other practices applied to physical assets in pursuit of economic life cycle costs. Its practice is concerned with the specification and design for reliability and maintainability of plant , machinery, equipment , buildings and structures, with their installation and replacement, and with the feedback of information on design, performance and costs."

Terotechnology is a multidisciplinary concept and its aim is to achieve the economic life cycle costs. This can only be achieved by a coordinated consideration of reliability, maintainability and performance aspects from the design stage. Terotechnology is concerned with the provisioning and subsequent management of physical assets. Asset-Management is a cradle-to-grave strategy that commences with engineering studies prior to investment and proceeds through design and construction, and ends with operation, maintenance and discarding. During the period of use, operation and maintenance strategies will be applied to give the best performance at least costs.

Activity B

Elaborate the meaning of Terotechnology in respect of your maintenance department. Explain how does it help in optimizing the life cycle cost?

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1.4 PRESENT STATUS OF MAINTENANCE IN INDIAN INDUSTRY

In today's global economy, only those nations that lead in technology will lead the world. India is embarking on a modernization process in which it dreams of becoming an economic an information superpower. Maximum utilization of all forms of assets is an important pre-requisite of this challenge.

Corrosion phenomenon, which is only a moderate fraction of all failure of plants and equipments, costs India in the region of Rs.24,000/- crores in a year. Recent survey of maintenance, condition monitoring and safety engineering practices of different sectors of Indian Industry by National Productivity Council has indicated that 50% of the maintenance work performed was reactive, 35% preventive periodic, 10% predictive and very few proactive or root-causes based. Average availability of plant and equipment in many industrial sectors range from 40% to 80%, whereas the international best practice benchmark for plant availability is more than 95%. Similarly, capacity utilization figures of some of our core sector industry hover around 60% to 80%, as compared to a world-class level of 85% to 95%.

Role of maintenance becomes significant, as for large systems or pieces of equipment maintenance and support account for as much as 60% to 75% of their overall lifecycle costs. The maintenance has grown from the symbolic spanner and tool-box of the technician to an integrated plant engineering encompassing management systems, human relations, diagnostic engineering techniques, safety engineering etc. The challenge of this millennium would be to harness and further develop this integration so that we can achieve greater results.

Activity C

Visit a manufacturing set up. Examine its maintenance functions and the extent of integration among all the functions.

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1.5 SYSTEMATIC APPROACH TO MAINTENANCE MANAGEMENT

A maintenance system can be viewed as a simple input-output model. The inputs to such a model are labor, management, tools, spares, equipments, plans and schedules; and the output is the equipment that is up, reliable and well configured to achieve the planned operation of the plant. This helps to optimize the resources for maximizing the output of a maintenance system. A typical maintenance system is shown in Figure 1.2.

The basics of preventive maintenance form the foundation of a maintenance management system. Once the preventive maintenance foundation is in place, inventory, work-orders, computerized maintenance management systems, and training of maintenance manpower form the next level. Involving the operator for routine maintenance, along with the predictive and Reliability Centered Maintenance (RCM) techniques, build on this foundation. With the availability of sufficient plant data, the organization can focus on its asset management strategy by Total Productive Maintenance (TPM) and maximize its life cycle profits. Once this level is achieved, the organization should strive for continuous improvement and bench marking.

Activity D

Visit a manufacturing department. Analyze its maintenance system as input-process-output model. Categorize the inputs that undergo maintenance processes and finally list out the tangible outputs.

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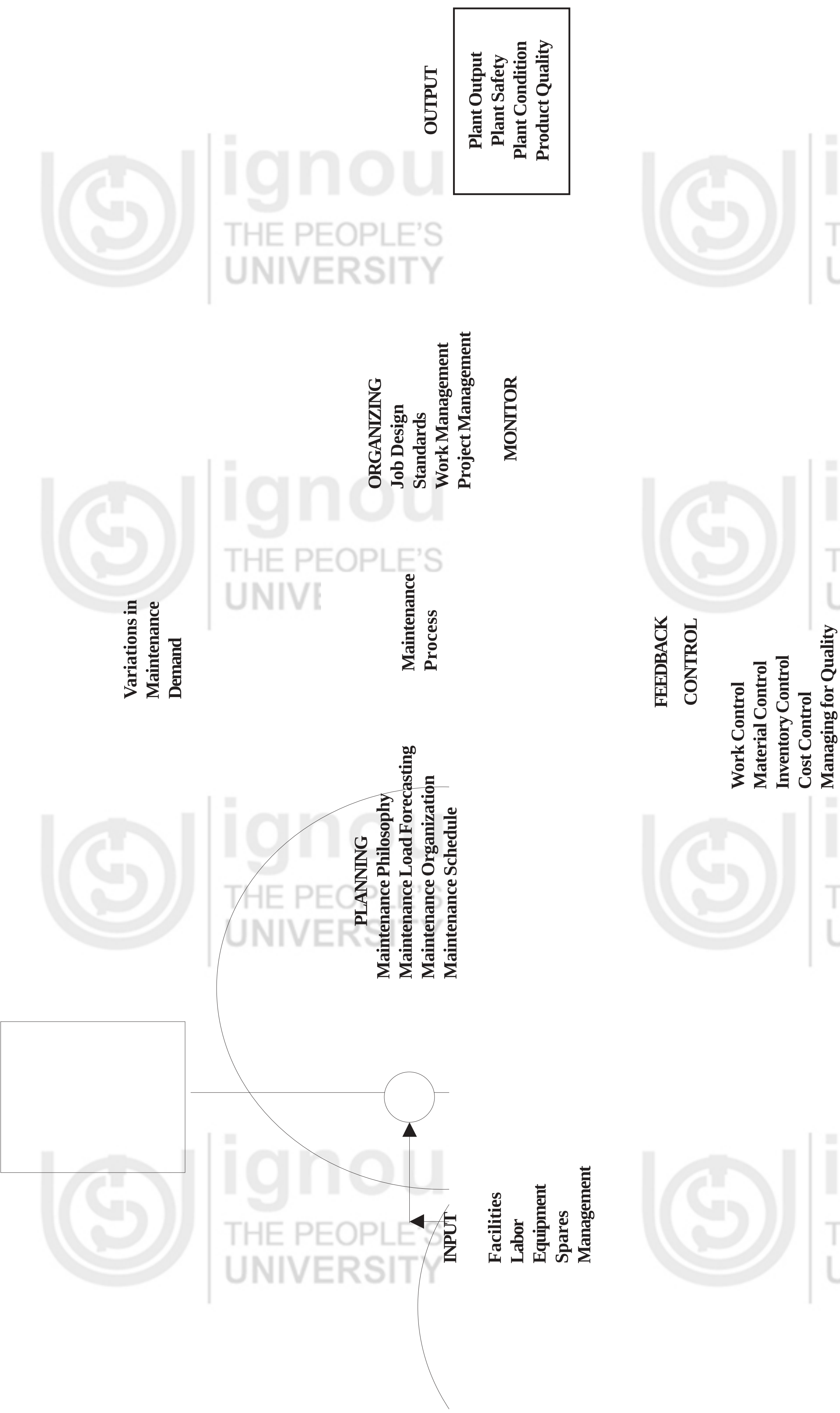

Figure 1.2 : Typical Maintenance Systems

1.6 SUMMARY

With increased automation and very high investments in plant and equipment maintenance has become a key function in the present day production systems. The focus of maintenance function is to ensure that all company assets meet and continue to meet the design function of an asset. Maintenance management is the management of all the assets owned by a production organization, based on maximizing the return on investment in the asset. The nature of maintenance activity is determined by the manner in which plant and equipment is designed, selected, installed, commissioned, operated, removed and replaced. It plays an important role in maximizing the life cycle profits for equipment and plant. Terotechnology is a multidisciplinary concept and its aim is to achieve economic life cycle costs. Role of maintenance has become significant for Indian industry for maximum utilization of all kinds of assets and to face the challenges of the open economy. A systematic approach to maintenance management will help to optimize the resources for maximizing the output of the maintenance system.

1.7 KEY WORDS

Life Cycle Cost: Total costs from inception to disposal for equipment and plant.

Maintenance: It is a combination of activities by which equipment or system is kept in, or restored to, a state in which it can perform its designated functions.

Maintenance Management: It is the management of all assets owned by a production organization, based on maximizing the return on investment in the asset.

Terotechnology: A combination of management, financial, engineering and other practices applied to physical assets in pursuit of economic life cycle costs. Its practice is concerned with the specification for design for reliability and maintainability of plant, machinery, equipment, buildings and structures, with their installation and replacement, and with the feedback of information on design, performance and costs.

1.8 SELF ASSESSMENT QUESTIONS

1) Define maintenance and its function?

2) What are the life cycle cost components for any plant?

3) Which are the factors affecting life cycle profits of any industrial plant?

4) How can maintenance affect the life cycle profits of any equipment and plant?

5) Explain what do you understand by terotechnology?

6) What are the main components of a maintenance system?

1.9 BIBLIOGRAPHY AND SUGGESTED READINGS

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