

# Chapter 1

## Introduction

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**Chapter synopsis:** Maintenance is an integral part of production for optimal achievement of company objectives. This is crux of today's Total Productive Maintenance. After giving the common definitions of the maintenance function, this chapter introduces the purpose and scope of maintenance and outlines the importance, scope and objectives of maintenance. The three dimensions are highlighted.

**Keywords:** Modifier, five M's of input, three dimensions of maintenance, level of technology, mechanization. Primary and secondary functions, objectives and responsibilities, economic and technical dependency, and social change, zero-technology Integrated Maintenance Management System (IMMS), expert system, intelligent system, Maintenance Management System Improvement.

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### 1.1 Dictionary Definitions

The dictionaries define maintenance in several forms as:

- The act of maintaining or the state of being maintained
- A means of support; livelihood
- A modifier of or relating to the maintaining of buildings, machinery, etc., like the maintenance team
- A provision ordered to be made by way of periodical payments or a lump sum, as after a divorce for a spouse
- The correction or prevention of faults in hardware by a programme of inspection and the replacement of parts
- The act of removal of existing faults and the modification of software in response to changes in specification or environment

In the context of maintenance applied to industry, we shall limit our definitions and explanation to the last two meanings.

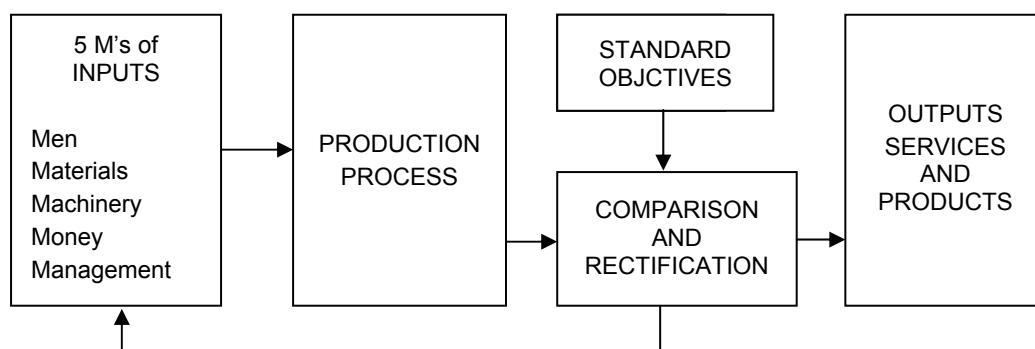
## 1.2 Importance of Maintenance Function

Why does a factory need a maintenance department? The answer to this question is the basis for developing the general concepts, the philosophy, the policies, the techniques and the organization of the maintenance engineering facility. Basically the purpose of having a maintenance facility in an organization is to attend to the day to day problems in keeping and maintaining the machinery and other plant equipments and services in good working condition. Machine failures have far reaching effects and may result in loss of thousands of man hours.

Broadly speaking the term maintenance embraces all the activities involved in keeping the entire production systems or specific equipment in working order and to enhance its reliability. The reliability can be defined as the probability that the production system will function properly or a reasonable length of time after being put into use. The policy objectives from the management point of view are to minimize the total cost of maintaining the system at an optimal level of equipment reliability. In view of its significance, the term reliability and its related terms are discussed in detail in chapter 4.

The trend towards mechanization and automation has already increased the investment in capital goods. To obtain a fair return of the investment, high level of utilization is required, and to achieve this, the equipment must be kept in perpetual operating condition. The extent to which this objective is achieved depends largely upon the maintenance policy.

Manufacturing activities at any level of technology involve the five M's of input, viz, men, materials, money, management and more significantly the machines and tools as illustrated in Fig. 1.1. Obviously every machine cannot work continuously throughout their life time. The mechanization and automating of the manufacturing processes do increase the productivity, but at the same time increase the dependency on proper running of the equipment.



*Fig. 1.1 The 5 M's of input*

The justification for maintenance engineering facility lies in its efforts to ensure the availability of the machines, buildings and services needed by the other wings of the organization for the performance of their functions with optimum return on investment, whether the investment is in term of machinery, materials or men. The maintenance function should be considered an integral and important part of the organization.

Dependence of the operating personnel on the maintenance engineering facility is ever increasing with the complexity of machinery used in modern industry. The cost of maintenance has become a greater part of the total cost of manufacture and the maintenance unit of the industry. Regardless of the tremendous growth of the importance, cost and complexity of the maintenance function, it should be remembered that the function exists because it is an essential part of the whole plant operation, and is not a self sufficient unit. It is one part of the team that can be successful only when function in tandem.

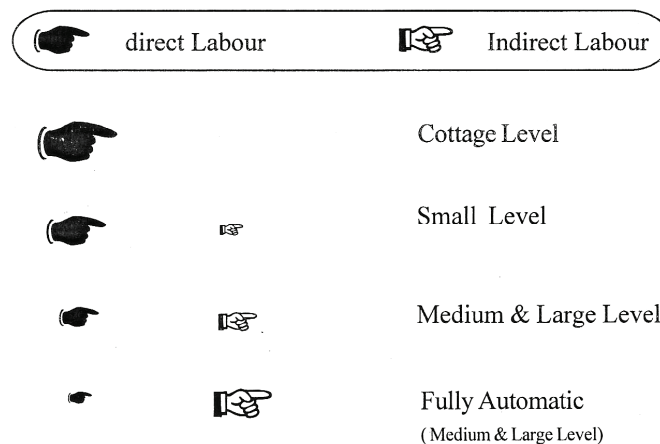
### 1.3 The Three Dimensions of Maintenance

We thus see that preventive maintenance, which is the act of estimating the probability of the possible breakdowns in the future and planning the course of maintenance action before they occur and this system is an integral part of the production function and involves three major dimensions.

- (a) *Level of technology*: Manufacturing is a technical process of physical and chemical transformation of materials. The function and organization of maintenance is obviously determined by the kind of technology (chemical, engineering etc.), and the level of technology (small, medium, large etc.). This relationship is illustrated in Fig. 1.2.
  - *At cottage level*: All members of the family are involved in the manufacturing, using indigenous skills and very simple tools, which were made and maintained by the respective user.
  - *At small industry level*: Technical division of the labor and mechanization is in small scale. Machine operators are relatively experienced and perform a lot of repair work themselves. Yet outside craftsmen with specialized skills in tool making and repair are often called in.
  - *At large scale level*: Highly developed professional specialization exists in designing, tool making, machine operation, maintenance etc.
- (b) *Organization*: Any function of manufacturing industry, including maintenance is based on the technical division of labor. Hence the three C's viz,

- ◆ Communication
- ◆ coordination and
- ◆ cooperation

are essential for the successful preventive maintenance program. The organization patterns that are most suitable for maintenance function are discussed further in chapter 7.



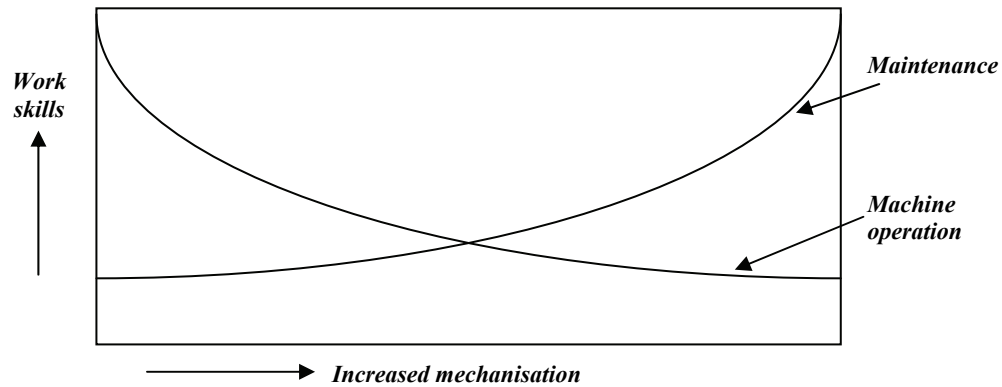
*Fig. 1.2 Maintenance Labor vs. production labor*

(c) *Economy*: Since the profitability of a maintenance program is an essential to an organization, the following economics must be given consideration,

- ◆ economy of time
- ◆ economy of material resources,
- ◆ economy of human recourses.

In other words, we find that, as mechanization increases,

- ◆ Machine operators tend to be less skilled
- ◆ Machine maintenance staff repairing in the respective facility need higher skills with formal specialized training, and
- ◆ In a highly mechanized situation, the cost of breakdown is so high that it is always essential to foresee when a breakdown would occur and set the weakening characters right before the breakdown occur. This is dealt more in details in chapters 3 and 4.



*Fig. 1.3 Maintenance skills increase with increased mechanization*

#### **1.4 Scope of Maintenance Function**

Although in practice, the scope of the activities of a maintenance engineering department is different in different plants and is generally influenced by the plant size, type, company policy, industry category etc. It comprises of plant maintenance, construction, utilities, generation and miscellaneous services for the plant cooperation. While the basic function of the maintenance department is to provide the engineering and support facilities for the uninterrupted, efficient and safe operation of the plant, we can group these activities into two general classifications as *primary functions* that are included in the justification of the department and *secondary functions* most of which are included because of the experience, knowhow, precedence or because there is no logical division of the plant to which these responsibilities can be assigned or delegated to.

*Primary functions:*

1. Engineering, scheduling, execution and control of the planned maintenance and repair of the equipment
2. Condition monitoring of the plant and equipment
3. Maintenance of the building and other facilities of the plant
4. Equipment inspection and lubrication
5. Maintaining and controlling of the workshops
6. Generation and distribution of utilities like power, steam and compressed air
7. New installations and/or alterations to the buildings and equipment
8. Engineering and supervision of the construction and installation projects within the scope of the organization

9. Technical consultation on mechanical problems with the production department
10. Performing all the above functions in a safe and efficient manner.

**Secondary functions:**

1. Storekeeping, generally of maintenance items
2. Plant protection including fire protection
3. Industrial safety
4. Waste disposal and salvage
5. Insurance administration
6. Janitorial services
7. Property accounting
8. Pollution and noise control
9. Scrap yard control and maintenance
10. Vehicle maintenance and estate function
11. Any other function delegated by the management.

**1.5 Objectives of Maintenance Function**

1. To provide freedom from breakdowns during manufacturing operations.
2. To maintain the equipment in a satisfactory condition for safe operation
3. To maintain the equipment at its maximum operating efficiency
4. To reduce to a minimum, the downtime due to breakdowns
5. Consistent with the above points to reduce to a minimum the cost of maintenance
6. To maintain a high level of engineering practices in the performance of the work handled by the department
7. To store and maintain sufficient and optimum quantity of spares consistent with the current demand and conditions
8. To investigate continuously the causes and remedies of emergency breakdowns
9. To keep abreast of the technological developments, new methods, equipment and materials
10. To have close cooperation with production personnel.

## 1.6 Responsibilities of a Maintenance Department

1. *Engineering and execution of planned maintenance:* The responsibility for the continued economical use of the equipment lies with the operating supervisor. It is however the responsibility of the maintenance staff, in cooperation with the operating supervisors to organize preventive maintenance schedules, to improve the equipment efficiency necessary to meet the production schedule requirements.
2. *Generation and distribution of power and other utilities:* The power engineer is responsible for the generation and distribution of the utilities like steam and compressed air in suitable quantities as also the purchase and distribution of electrical power, water etc. at minimum cost.
3. *Stand-by power generation:* Apart from purchase of the electric power from EB. If stand-by diesel generator is available in the factory, it is the maintenance staff that would be responsible for the operation of this generation and supply sufficient power during power cut periods.
4. *Administrative and staffing:* In order to handle mechanical work involved in carrying out the functions of maintenance department, an adequate skilled labor force provided with suitable equipment and properly supervision is necessary. The type and size of this group is determined on the basis of a balance between the costs of establishing and maintaining the group versus the cost of contracting for the maintenance work by outside firms, considering the factor of emergency and round the clock service. It is the responsibility of the head of the maintenance department to plan and coordinate work distribution among the crafts and to organize and carry out the programmes for the training of the supervisors and craftsmen.
5. *Engineering and supervision of construction projects within the scope of the group:* Maintenance engineering is a definite part of the preliminary and final design of the construction projects. It is the responsibility of the maintenance group to be familiar with all the projects under consideration or execution that will eventually become a part of the plant.
6. *Technical consultation:* The maintenance engineer would act as a consultant to the production department in solving the mechanical problem of the equipment.
7. *Plant safety activities and equipment:* Provision and control of all safety equipment, their maintenance and monitoring for the general observance of plant safety practices by all workforces in the plant, would be the responsibility of the maintenance department.

8. *Plant insurance:* Planning for the plant insurance and maintenance of all cornered records and documents as well as taking the necessary action in the event of accidents.
9. *Service facilities:* Engineering, administration and maintenance of various service facilities delegated to the departments like yards, roadways, washing rooms, sewers and waste disposal sections and employee welfare services within the budgets provided by the management.
10. Maintaining the property and all relevant records of all plant and equipment required for the annual accounts and audit.
11. Keeping the breakdown record for each and every machinery and equipment meticulously as required for future maintenance planning.
12. Last but not the least is to perform all the above functions in a safe and efficient manner.

### **1.7 Responsibilities of Maintenance Engineer**

*Reliabilityweb.com* suggests the following functions for the maintenance engineer.

1. Ensures that the equipment is properly designed, selected and installed based on the life cycle philosophy.
2. Ensures that equipment is performing effectively and efficiently.
3. Establishes and monitors programs for engine and compressor analysis and vibration and other condition monitoring techniques.
4. Reviews deficiencies noted during corrective maintenance.
5. Provides technical guidance for Computerized Maintenance Management System (CMMS).
6. Maintains and advises on use and disposition of stock, surplus and rental equipments.
7. Promotes equipment standardization, recommends spare part levels and coordinated sharing of spare parts with other asset teams.
8. Becomes available for consultation with maintenance technicians.
9. Monitors new technology and keeps management and staff apprised of the new developments.
10. Champions quality assurance services including shop qualifications for outside services.
11. Develops standards and procedures for major maintenance jobs.

12. Periodically makes cost/benefit review of maintenance management programs for areas of responsibility and exchanges information across asset teams.
13. Provides technical guidance for PM and PDM programs.
14. Monitors competitors' activities in the fields of maintenance management.
15. Becomes the focal point for monitoring performance indicators for maintenance management programs.
16. Optimizes maintenance strategies.
17. Becomes focal point for analyzing equipment operating data, root cause analysis, ultrasonic and vibration analysis.
18. Imparts maintenance training.

### **1.8 Tero Technology**

In 1970 UK introduced the new concept of Tero-technology which is a combination of management, financial, engineering and other aspects of management related to physical assets in achieving economical life cycle costs. This includes the specification and design for reliability and maintainability of machinery, equipment, buildings and structures with their installation, commissioning, maintenance, modification and replacement.

### **1.9 Integrated Maintenance Management System (IMMS)**

Integrated Maintenance Management System is the modern maintenance practice similar to Tero-technology but concentrates on the maintenance activities. All the maintenance tasks are planned and executed in a holistic approach. Of more significance is the expert system where all data on the maintenance history of each and every asset is made available in the form of computerized reports. The name expert system or intelligent system is derived from the fact that with the availability of full data as stated above, the maintenance engineer would be in a better position to understand, plan and execute the optimal maintenance tasks. The relevant software for this is Maintenance Management System Improvement (MMSI or MMIS) which is described more in detail in chapter 22.

### **1.10 Conclusion**

We should look at maintenance as an integral part of production and should apply the respective principles of production planning, work study, stock control; etc., for the efficient fulfillment of this function.

Peter Drucker said, 'in the third world societies, the modern technology demand is a radical break with the social and cultural traditions and produces a fundamental crisis in the society'. Specific to Indian industry, the factors leading to such a crisis are:

- *Economic dependency*: In developing countries the mechanization is highly linked with the foreign aid given by the donor countries, as also the equipment supplied by the collaborators. Due to this and the limited foreign exchange situation, the Indian economy depends on the proper maintenance of the existing Machinery and equipment.
- *Technical dependency*: This too follows the same argument as above. The more sophisticated the machinery is, the more we have to depend on the supplying country for maintenance of the plant and equipment.
- *Social change*: The imported mechanized technology is basically of the industrial culture and philosophy of the western countries. The fact that India has a rural oriented society necessitates a different approach of education and training.

The following chapters hence are devoted to the explanation of these basic principles of maintenance practices as can be applied to Indian industry.