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TOWARDS HIGHER PRODUCTIVITY OF EQUIPMENT AND ROLE OF MAINTENANCE

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Abstract : Higher Productivity is the joint responsibility of both line managers and maintenance engineers. In this article maintenance engineer's responsibilities have been mentioned and a practical approach has been suggested for increasing equipment productivity considering the company objectives through identification of the "Process Requirement" and maximization of the commercial objectives of the company.

Keywords : Maintainability, reliability, availability, plant performance specification, redundancy, condition based maintenance.

1. Introduction

Now-a-days the plant and equipment costs are so high that an endeavor to increase the equipment productivity has become an unwritten objective for all production plants. Equipment output depends on many factors, but important amongst them are given in Fig.1.

2. The Problem

It is clear from Fig.1 that the equipment productivity is the joint responsibility of both line managers and maintenance engineers, because one wants to express the ultimate productivity of the equipment in terms of the output of the plant or the equipment. Since it is a joint responsibility, there is always a conflict between the line managers and the maintenance engineers of the plant about their role in achieving the productivity objective of the plant or unit [1]. Relevant books have suggested in general terms that line managers and maintenance engineers should work together to achieve the equipment productivity objective, but, in practice, this "should" and "work together" objective, are very vague terms and each department tries to shirk their responsibilities [2]. Unless the jobs of each department are clearly specified between the partners these conflicts will not be dissolved. "Behavioral Scientists" and "organizational Experts" have suggested various means to establish control over the situation, but unless the responsibility areas, separately and collectively, are identified, this conflict will not go.

It is evident from Fig.1 that the visible maintenance related factors for improvement in productivity are "Maintainability", "Availability" and "Reliability" which ultimately leads to equipment availability, reduction in terms of frequency of breakdown and the downtime due to maintenance. But, in a running plant the maintenance engineer should also engineer the equipment in such a manner that the equipment gives the rated output and the desired product quality. At department level, when a part of the job is done, it means the unit meets the "plant

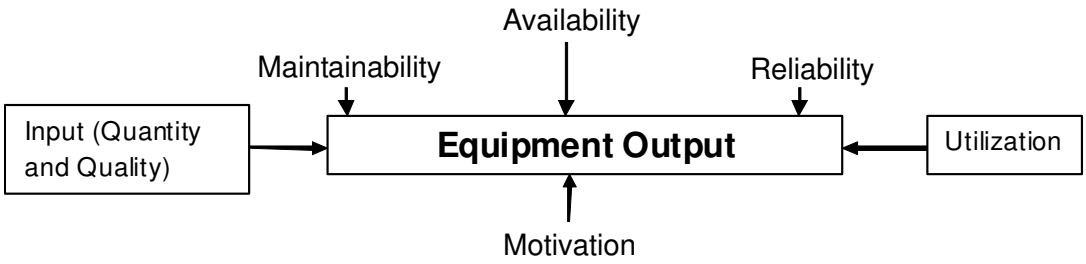

Fig.1 Factors influencing equipment output

performance level". The Availability should be considered taking the total manufacturing objectives of the company and not taking the isolated maintenance department's objective, i.e. reduction in downtime.

3. Manufacturing Objective of the Company

Company's manufacturing objective can be determined by identifying the following three requirements:

- ➢ Product requirement
- ➢ Process requirement
- ➢ Commercial requirement

While considering the above three requirements simultaneously some compromises are to be made, but these requirements must be defined right at the beginning. Depending upon market conditions these targets may be improved, but these targets should be fixed before subsequent operations.

3.1 Product Requirement

"Product Requirement" actually means product quality requirement which means to manufacture precisely what the customer wants. Similar product for different end use may cost differently and, accordingly, the quality characteristics will be different. If the end use of the product is for sophisticated purpose, the customer is ready to pay more, whereas a similar product used for unsophisticated purpose may cost less. The cost of lathe used in tool room will be more, compared to the lathe of similar dimensions used in general repair shop- because the tool room precision is not needed in general repair shop. Quality characteristics of the product are to be expressed in terms of fitness for its use and specified in terms of the following categories :

- Technological : Physical or chemical characteristics like length, breadth, thickness, diameter, hardness, frequencies or chemical properties.
- Psychological : Sensory characteristics like taste, look, fragrance, beauty, etc.
- Contractual : Guarantee, warranty, safety, etc.
- Time oriented : Reliability, life, maintainability, etc.
- Ethical : honesty, integrity, etc.

So, the product quality requirement means identification of the customers expressed and implied needs at the possible minimum lost.

3.2 Process Requirement

Proper process and equipments are to be chosen to manufacture products as envisaged by product requirement. The process requirements depend on two factors:

- Quality of design
- Quality of performance

Process requirements for the products needing higher quality of design will cost more compared to the process requirement of products requiring lower quality of conformance, because it means less number of defective products to be produced. In large scale manufacturing by developing right process and equipment and using Statistical Quality Control (SQC) techniques, the process cost can be substantially reduced. Maintenance department can help a lot in selecting the proper process and equipment. The only thing which the line managers must indicate specially is the "Plant Performance Specification" (discussed later). Based on this the engineering standards are determined by the maintenance department.

3.3 Commercial Requirement

Commercial requirement includes the price, market, demand, budget etc. The engineering performance must be related to the performance of the plant and the performance of the plant must lead to the generation of surplus profit. Commercial requirements are usually taken care of by the production planning department. They finalize the targets in consultation with "marketing" and "finance" departments and get that approved by the top management. Depending upon the market demand and process capability along with production targets, plant availability is also determined. In multi-product situation the "Production Planning" department determines the sequence of production of different products and the length of their production runs. With this information line mangers prepare the "Plant Performance Specification" which the maintenance department will try to adhere to.

"Plant Performance Specification" and "Plant Availability" will determine the other maintenance details like "Engineering Standard", "Maintenance System", "Spares Requirement" etc, and, at this stage, the cost is estimated to achieve these targets. This cost is then compared with the budgeted cost indicated by the line managers. If the difference is substantial compromise may be brought in the maintenance system. This system has been depicted pictorially in Fig.2.

4. Plant Performance Specification

Plant Specification Performance is the physical results which have to be achieved in order to meet the process requirements and product requirements of the plant. The Specifications are to be laid down by line managers. These specifications will relate to independently controllable units of plants and not to the ultimate specifications of the product. These standards are to be specified quantitatively, so that they give to which the plant is to be engineered. These physical standards will form the basis of engineering standards. As for example it is not expected that the line manager will set limits of bearing wear in a set of rolls but they will give the limit in the relative movement of rolls. The engineering standards of bearing wear will

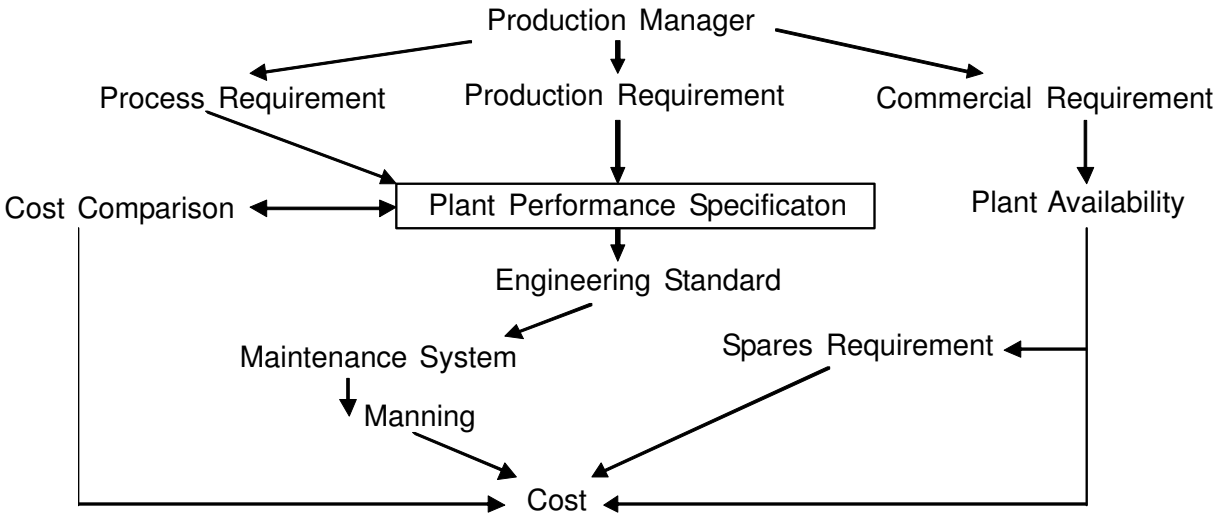

Fig.2 Activity Chart to Meet Manufacturing Objective

be determined by the maintenance department. The benefit of plant performance specifications are that by setting physical standards of the plant some measures are obtained with which the maintenance department will come to know how the plant is being engineered. The line managers can also come to know whether there is some deviation in these measurements. Thus plant performance specifications and the budget are two contractual obligations which the line managers and maintenance engineers will abide by.

Table 1 Example of breakdown in a plant

Type of breakdown	% total breakdown	% of total number of breakdowns
Electrical	47.00	31.00
Mechanical	44.00	50.00
Refractory	6.00	15.00
Others	3.00	4.00
Total	100.00	100.00

5. Plant Availability

The plant availability must be related to the demands of the whole plant and also the demands in relation to other plants which it serves. Since "plant availability" is the total calendar time minus the total breakdown time, poor availability may be due to either Σ (denser frequency of breakdowns) $\times$ (longer duration of breakdown), or, Σ(higher frequency of breakdowns)$\times$(shorter duration of breakdown).

So, both availability and reliability play a dominant role in plant availability. Yield, energy consumption, quality of repair all is dependent on these two factors. Proper actions are to be taken depending upon the importance– which factor is more dominant in the particular case in consideration. This may be illustrated with an example shown in Table 1.

If the downtime cost of the mill is very high, in the above example, the priority area is electrical, where more time is lost. But, on the other hand, the above data also indicate that in the mechanical area the number of

Towards Higher Productivity of Equipment

- Select right equipment and technology
- Get Plant Performance Specification from Line Managers
- Identify areas where continuous monitoring is required and improved inspection procedures
- Improve Availability and reliability by
  - ➢ Preventive maintenance
  - ➢ Quality repair work
  - ➢ Quality of spares
  - ➢ Following standard operation practices
- Optimize maintenance costs
  - ➢ Condition based maintenance
  - ➢ Proper Inventory, management of spares and consumables with control of consumption
  - ➢ Attention to spares accessibility and readiness
  - ➢ Provision of most effective tools and all possible aids to accessibility and handling
- Analyze causes of equipment breakdowns and also rectify the cause and identify priorities by using Pareto type Analysis
- Improve utilization

Fig.3 General steps to be followed for higher productivity

breakdowns is 60% higher than that in the electrical. So, where the continuity of the machine running is more important, emphasis on proper repair work should be arranged accordingly.

6. Maintainability

Maintainability is the readiness to meet a breakdown time within which the equipment is restored to the specified running condition after breakdown. Again, time taken to repair the equipment depends on how it has been designed, installed and also the maintenance system of the company. Here, the maintenance system means the manpower requirement (number, education, experience, training, etc.), testing procedure, built-in redundancies, degrees of automation, inspection frequency, safety requirements, emergency reorder policy, provisioning of spares, discard policy, availability of common resources like bolts, nuts, screws, modulus of electronic components etc. Since design and installation are taken care of at the project stage and not much change may be done at a later stage, maintenance system within budget will determine the maintainability.

7. Conclusion

For higher productivity along with the steps mentioned in Fig.2, the steps mentioned in Fig.3 should be followed in general.

References

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[2] Stephens, M.P., Productivity and Reliability-based Maintenance Management, Purdue University Press, 2010.