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Maintenance Management System: A Profit Centre

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Abstract

Too much "Maintenance" is a necessary evil. It is considered as a cost centre. It is therefore, the general tendency to avoid maintenance to reduce the cost. This was considered to be fine few years back when the cost of equipment was not so high and the competition in the market was not stiff, people could afford to maintain any production cost. In the present scenario, market competition is such that companies can only afford production at lowest cost. The cost of production equipment is going up with more sophistication. The increasing cost of production goes hand in hand with the increase in downtime cost. Therefore all attention is focused on the equipment availability and reliability and reaping profits out of maintenance is becoming a common trend. It is a positive paradigm shift in thinking that maintenance is should no longer be considered as a group of people undertaking repairs rather than it is a group of people who avoid the breakdown of equipment. Maintenance is now being converted to a "Profit Centre". Maintenance can generate profit by its own activities. Maintenance is nothing but service and it cannot be free of cost. Maintenance has to search for its customers & satisfaction of the customers should be the objective. In achieving that goal, support from management is a primary requirement. Management has to give due respect and position to maintenance in their main company strategy, assigning specific authority and responsibility at different levels so that all may be able to contribute to the 'line of sight'. Similarly, maintenance must be ready to accept the challenge of the day by defining their various activities which collectively will act to make the equipment/system more reliable, available and cost effective. Similarly, the people engaged in today's maintenance are required to be more knowledgeable, trained, and sensitive to failure and success. Success and failure of maintenance depends upon the measure of the availability and reliability of equipment and cost of maintenance. The main objective of this review paper is to describe a scientific approach to maintenance and clearly define maintenance.

Keywords: Approach of Maintenance, Equipment, Maintenance, Profit Centre, Reliability

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1. Introduction

Managers around the world are keen to have a new approach to maintenance. The development of a strategic framework that combines new developments into coherent patterns. The authors of this paper bring together the idea about maintenance in the past that was limited to repair of broken equipments. We bring together a new meaning of maintenance that is learned through practical experiences and analysis of failures. Before proceeding further, it is important to define the term maintenance in all of its true sense.

"MAINTENANCE" can be defined as a combination of technical and associated administrative actions intended to retain an item in, or restore it to, a state in which it can perform its required function with guidelines from International Standards like ISO 55000 or BS 3811 : 1994. It may cover all activities undertaken to keep equipment in a particular condition or to return it to such a condition. As per the model developed by Kelly (1992)[2], the main objectives of maintenance are-

i. To keep planned availability performance at the lowest cost and above all within the safety.
ii. To develop activities required to preserve the functioning of an equipment during its life.

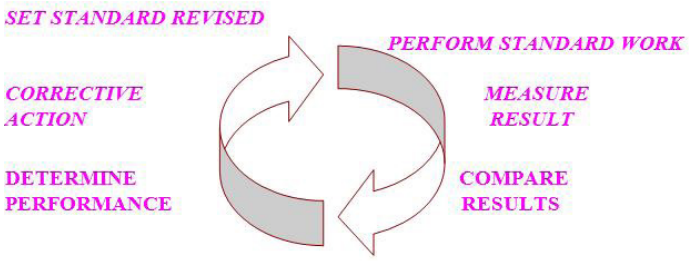

Figure 1. The Basic Maintenance Cycle (Moubray, 1997)[5].

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2. Prescription

To achieve the objective as stated above, we have to discuss the subject "Maintenance" in more details:

THE BASIC MAINTENANCE CYCLE

From the figure above, it is clear that maintenance cycle is a 'Continuous Improvement Cycle'. Every time, one assesses it's performance with one's own set standards and again performs with necessary corrective actions, thus, revising one's own standards.

It is therefore clear that Maintenance is not that simple as it is perceived by common people. Maintenance is a combination of many activities with specific nomenclature and objectives. Maintenance is divided in three major activities (Villemeur, 1992)[6]:-

3. Definitions

3.1 Corrective Maintenance

The general perception of corrective maintenance is as follows- Corrective Maintenance covers all maintenance which is carried out in order to correct (repair) a fault in equipment. While this definition per say isn't completely wrong, the industrial asset maintenance today require a broader view of corrective maintenance.

Corrective maintenance can also be divided in two parts.

3.1.1 Unplanned Corrective Maintenance

"The maintenance is carried out after equipment break down on urgent and emergent basis" (Moore et al., 2005)[4]

Such type of maintenance causes low utilization and high cost. Not only that **you are controlled by equipment**. (Certainly undesirable)

3.1.2 Planned Corrective Maintenance

"The maintenance is planned and prepared properly to minimum the loss of productive hours at low cost." (Moubray, 1997). Under these condition-situation remains As such, as maintenance personnel, **our effort should be to increase the percentage of "planned maintenance".**

3.2 Preventive Maintenance (PM)

As stated earlier, our efforts should be to increase planned maintenance. It is not an easy task where we organize our self properly. We have to anticipate the failures in advance so that correction is taken before it converts to a break down. It is called Preventive action and we come to a terminology **"Preventive Maintenance".** A formal definition of preventive maintenance as given by BS 3811:1984 is "The maintenance carried out at predetermined intervals or corresponding to prescribed criteria and intended to reduce the probability of failure or the performance degradation of an item".

Preventive Maintenance is always a part of planned maintenance, whilst corrective or emergency maintenance may or may not be (Williams, 1994)[7].

HOW?

To make the things more clearly we need to explain (PM) in further details:

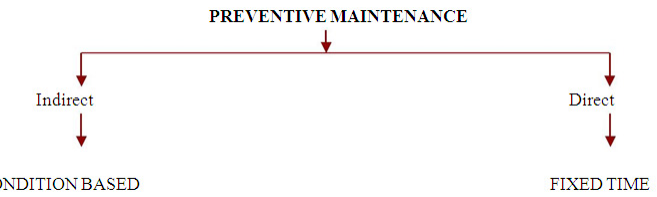
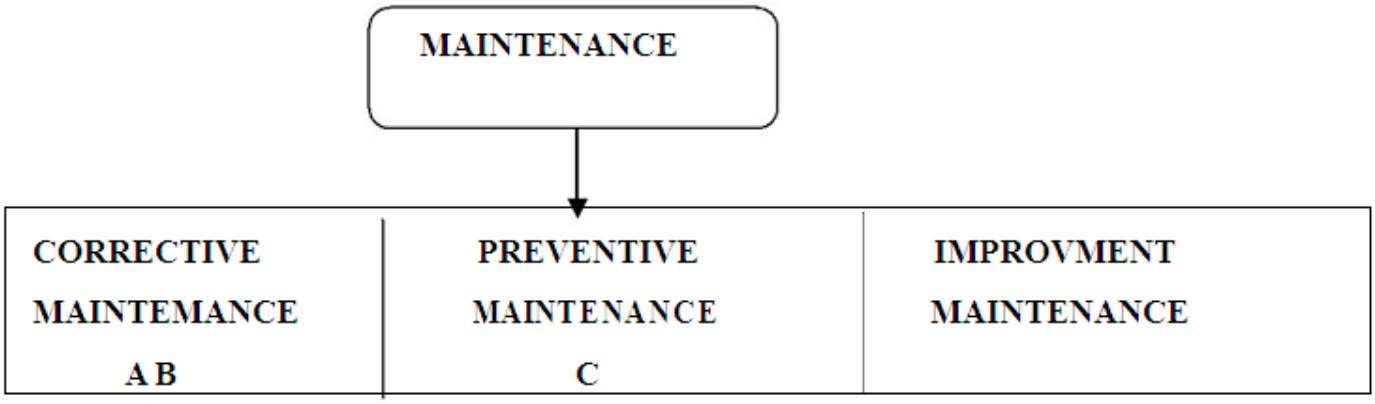


Figure 2. Preventive Maintenance Structure (Williams, 1994).

3.2.1 Fixed Time Maintenance (Direct PM)

This type of maintenance is generally followed by people to avoid personal risk and investment on equipment required for Indirect PM. Cleaning, lubrication, fixed time part replacement are considered as Direct PM. Such maintenance is costly compared to Condition based maintenance.



3.2.2 Condition based Maintenance (Indirect PM)

Maintenance system based on indirect (PM) is called condition based maintenance (CBM). This system is developed to identify the fault in advance before equipment break down occurs. CBM enablers are the techniques which aid in providing accurate results from CBM strategies. Figure 3 below shows one such example.

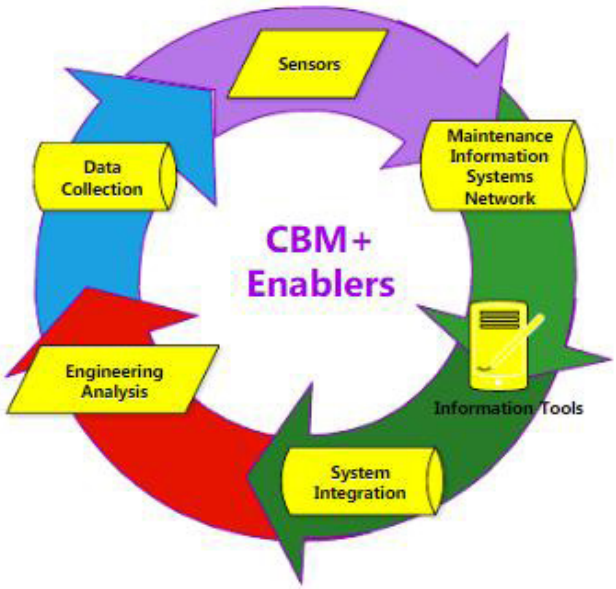


Figure 3. Example of CBM including sensors, algorithms, data collections, maintenance information systems etc (Gillespie, 2015)[1].

Such maintenance helps to increase planned maintenance thereby reliability of equipment at minimum cost. Indirect PM is of two types.

3.2.2.1 Subjective Indirect (PM)

In this system, we use human senses such as Visual, Feeling, Audio, Smell and Taste. For example, when we see black smoke being emitted from an engine, we definitely come to know that fuel is not burnt in the combustion chamber properly and this may be due to choked air cleaner, defective turbocharger, defective injector etc. So in this case, we have used the human visual sense for PM. Similarly, by touching equipment, an experienced operator can say whether the operating temperature of an equipment is normal or high.

3.2.2.2 Objective Indirect (PM)

This is a "condition monitoring" system by which we shall be able to find out the measured value of different systems of the equipment, the values so collected can be compared with the standard to establish the maintenance action required. Objective condition monitoring can be done by two methods.

(i) **"Off line condition monitoring"** is done by sensing instruments from a distance even without stopping equipment by operator or by maintenance personnel.
(ii) **"On line condition monitoring"** is done continuously by the instruments fitted on the equipment. In this case requirement of man power will be less. This is specially essential where failure development time is too short.

Some of the conditions monitoring tools are:

1.Vibration analysis
2. Shock pulse analysis
3.Resistance testing
4.Infra red scanning
5.Ultra sonic testing
6.Lubricating oil analysis
7.Temperature sensors etc.

The following example may be useful to understand subjective and objective condition monitoring.

From Figure 4 above, it is found that if we do the objective condition monitoring, we shall be able to notice the beginning of

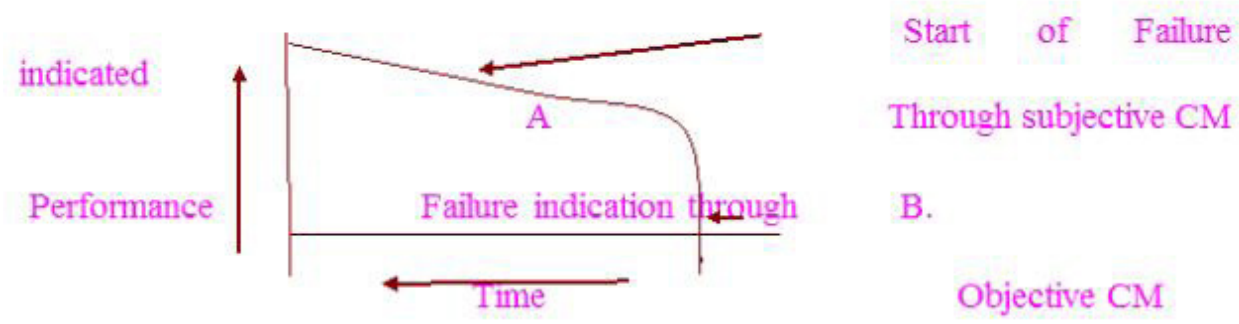


Figure 4. Subjective and Objective Condition Monitoring as understood from Wowk (1991)[8].

the failure at point "A" and point "B" in case of subjective condition monitoring, The difference is that in case of objective condition monitoring, we get the notice much earlier to prepare over self to attend the problem. But in case of subjective condition monitoring, we get less time to attend to the problem. Therefore we must adopt the objective condition monitoring over and above subjective condition monitoring. Even in the most industrialist country like Sweden, 70% of all condition monitoring are done subjective.

3.3 Improving Maintenance

Last but most important maintenance practice is "Improving Maintenance". When there is repetitive failures of a system, it is to be thoroughly studied whether there is any reason due to which it can be eliminated by minimum modification of the equipment and system? If yes, modification(s) should be carried out.
Improving maintenance can be identified in two parts (Mather, 2002)[3].

3.3.1 Design Out

Sometimes it is observed that due to bad design of an equipment, failure is repetitive and maintenance requirement is very high. In such case one should positively try to change the design and modify the system so that failure rate comes down drastically. That is why it is essential that the engineers must be associated from the very beginning rather from conceptual stage in the procurement process of a plant and machinery.

3.3.2 Life Time Extension

This is another essential task of an engineer to find out ways and means to extend life span of a component by modification, by changing material composition, by protective layers etc.

4. Conclusion

This review paper describes a scientific approach to maintenance engineering. Having established maintenance of an equipment as a self correcting and continuously improving cycle, the authors go on to discuss the different types of maintenance practices being used in the industry. Special attention has been given to condition-based maintenance classification under preventive maintenance and the authors go on to discuss what different condition monitoring tools are being used today. All in all, the authors have made an attempt to employ a strategic framework that extends the perception of maintenance of industrial equipments beyond simple break down maintenance or maintenance that is provided only during the occasion of a failure.

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