Review of Maintenance Planning Activity

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ABSTRACT: In today's industrial scenario huge losses/wastage occur in the manufacturing shop floor. This waste is due to operators, maintenance personal, process, tooling problems and non-availability of components in time etc. Other forms of waste includes idle machines, idle manpower, break down machine, rejected parts etc. are all examples of waste. The quality related waste are of significant importance as they matter the company in terms of time, material and the hard earned reputation of the company. There are also other invisible wastes like operating the machines below the rated speed, start up loss, break down of the machines and bottle necks in process. Zero oriented concepts such as zero tolerance for waste, defects, break down and zero accidents are becoming a pre-requisite in the manufacturing and assembly industry. In this situation, a revolutionary concept of Maintenance Planning Activity (MPA) has been adopted in many industries across the world to address the above said problems. This paper deals in length about this MPA.
Keywords: Maintenance, Planning, Intelligent Maintenance

1. INTRODUCTION

In order to be successful in today's world-class manufacturing environment companies have to fulfill several requirements. Maintaining a reliable manufacturing process is a key success factor to satisfy these requirements which can be achieved through implementing a proper maintenance strategy. Any operation or process done on machine or its parts to enhance the efficiency of machine before or after the breakdown is called maintenance. In the recently released European Standards regarding maintenance [2], maintenance is defined as "the combination of all technical, administrative and managerial actions during the life cycle of an item intended to retain it in, or restore it to, a state in which it can perform the required function". A manufacturing business is said to be prosperous over the years, when it runs non-interrupted and always maintains a stable and high productive production flow. Plant can achieve productivity up to a satisfactory level by proper maintenance work[1]. An efficient maintenance strategy not only reduces the probability of breakage of machine elements or shutdown of machines which hinders the production's schedule, but also such a strategy enhances the efficiency and life-span of machines, process quality and labor force productivity[3].

MPA has widely been accepted as an effective strategy for improving maintenance in the manufacturing companies. Especially in the last decades because of a growing competitive environment the importance of MPA has increased [7]. Therefore in this paper by getting help from system dynamics which is a part of system thinking concept the effects of implementing MPA on machine breakdowns, machine reliability, process quality, machine and labor force utilization for production in manufacturing companies is investigated. Form of maintenance is as shown by the block diagram Fig 1.

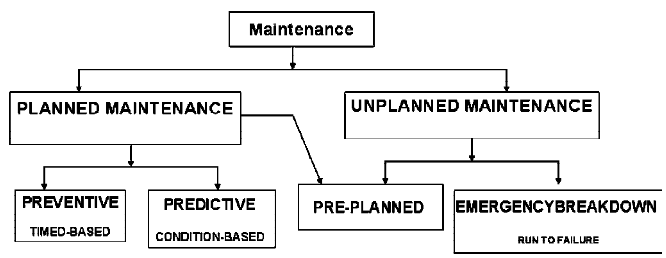

Figure 1: Form of Maitenance

Types of maintenance: [5]

1. *Breakdown Maintenance*: In this type of maintenance, no care is taken for the machine, until equipment fails. Repair is then undertaken. This type of maintenance could be used when the equipment failure does not significantly affect the operation or production or generate any significant loss other than repair cost. However, an important aspect is that the failure of a component from a big machine may be injurious to the operator. Hence breakdown maintenance should be avoided.
2. *Preventive Maintenance (1951):* It is a daily maintenance (cleaning, inspection, oiling and re-tightening), design to retain the healthy condition of equipment and prevent failure through the prevention of deterioration, periodic inspection or equipment condition diagnosis, to measure deterioration. It is further divided into periodic

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maintenance and predictive maintenance. Just like human life is extended by preventive medicine, the equipment service life can be prolonged by doing preventive maintenance.

2. PERIODIC MAINTENANCE (TIME BASED MAINTENANCE- TBM)

Time based maintenance consists of periodically inspecting, servicing and cleaning equipment and replacing parts to prevent sudden failure and process problems. E.g. Replacement of coolant or oil every 15 days.

Predictive Maintenance

This is a method in which the service life of important part is predicted based on inspection or diagnosis, in order to use the parts to the limit of their service life. Compared to periodic maintenance, predictive maintenance is condition-based maintenance. It manages trend values, by measuring and analyzing data about deterioration and employs a surveillance system, designed to monitor conditions through an on-line system. E.g. Replacement of coolant or oil, if there is a change in colour. Change in colour indicates the deteriorating condition of the oil. As this is a condition-based maintenance, the oil or coolant is replaced.

3. CORRECTIVE MAINTENANCE (1957)

It improves equipment and its components so that preventive maintenance can be carried out reliably. Equipment with design weakness must be redesigned to improve reliability or improving maintainability. This happens at the equipment user level. E.g. Installing a guard, to prevent the burrs falling in the coolant tank.

4. MAINTENANCE PREVENTION (1960)

This program indicates the design of new equipment. Weakness of current machines is sufficiently studied (on site information leading to failure prevention, easier maintenance and prevents of defects, safety and ease of manufacturing). The observations and the study made are shared with the equipment manufacturer and necessary changes are made in the design of new machine.

Maintenance Planning and Scheduling:[5]

One of the most effective ways to control costs and improve maintenance productivity Maintenance Planning And Scheduling.

Definition: maintenance planning and scheduling is the allocation of needed resources and materials in the sequence in which they are needed to allow an essential activity to be performed in the shortest time at the least cost.

Maintenance Planning consists of the following:

- Identification of work to be planned (job scope);
- Determination of work complexity and composition;
- Estimation of manpower requirements;
- Identification of spare parts and other materials –B.O.M. (availability);
- Identification of special tools required;
- Use of standard job plan(if available) ·
- Completed Permit-To-Work (P.T.W.).

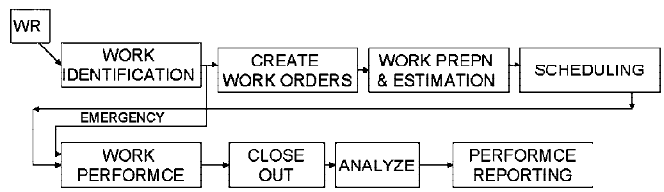

Figure 2: Typical System Work Flow Diagram

Trends in Maintenance Knowledge [4]

Maintenance modeling is inherently evolutionary in nature. As equipment complexity increases, and as the need for high equipment availability becomes paramount in today's complex, dynamic systems, there has been a corresponding increase in maintenance modeling sophistication.

1. *Corrective Maintenance:* Corrective maintenance involves all unscheduled maintenance actions performed as a result of system/product failure to restore the system to a specified condition. Corrective maintenance includes failure identification, localization and isolation, disassembly, item removal and replacement or repair in place, reassembly, and checkout and condition verification. Preventive maintenance includes all scheduled maintenance actions performed to retain a system or product in a specified condition. These actions involve periodic inspections, condition monitoring, critical item replacements, and calibration.
2. *Predictive Maintenance:* Predictive maintenance is a relatively new concept in maintenance planning. This category of maintenance occurs in advance of the time a failure would occur if the maintenance were not performed. The time when this maintenance is scheduled is based on data that can be used to predict.

Approximately when failure will occur if certain maintenance is not undertaken.

Data such as vibration, temperature, sound, color, and so on have usually been collected off-line and analyzed for trends. With the emergence and use of programmable logic controllers (PLCs) in production systems, equipment and process parameters can now be continually monitored. With condition-based maintenance, the PLCs are wired directly to an on-line computer to monitor the equipment condition in a real-time mode. Any deviation from the standard normal range of tolerances will cause an alarm (or a repair order) to be automatically generated. Installation costs for such a maintenance system can be high, but equipment service levels can be significantly improved.

5. INTELLIGENT MAINTENANCE

Intelligent maintenance, or self-maintenance, involves automatic diagnosis of electronic systems and modular replacement units.14 Sensor data from remote facilities or machines would be provided on a continuous basis to a centralized workstation. From this workstation, the maintenance specialist could receive intelligent support from expert systems and neural networks for decision-making tasks. Commands would then be released to the remote sites to begin a maintenance routine that may involve adjusting alarm parameter values, initiating built-in testing diagnostics, or powering standby or subsystems, for instance. The U.S. Federal Aviation Administration (FAA) is developing the Remote Maintenance Monitoring System (RMMS) that is an example of the future direction in maintenance automation." In some cases, robotics may be used for remote modular replacements.

Case Study of Maintenance Management

Case examples from industry will be used to illustrate different approaches to maintenance management. These descriptions focus on the "as is" condition of maintenance planning within these companies. The five primary maintenance categories of corrective maintenance, preventive maintenance, predictive maintenance, condition-based maintenance, and intelligent or self-maintenance as defined earlier will be used to classify the maintenance management systems. It must be remembered that there will be overlap among the maintenance categories and that the primary purpose of this classification scheme is to illustrate the distinctions among the different types of maintenance. To enrich the classification of maintenance management systems in a study of three companies, the factors of tasks, people, technology, and structure in examining organizations are considered. They are used to understand the interdependencies of these four elements but will be included in this section to add more dimensions to the maintenance categories. These elements have been renamed as Maintenance Tasks, Structure and Management Systems, Technology and People.

The Mobile Hydraulic Division

The factory that was studied is connected to the mobile hydraulic division that produces mechanical steering units for heavy machinery. The case only covers a part of the production process and the description below concentrates on this part.

The factory understudy is a ub-supplier to assembly factories within the tractor industry, which requires accurate and on-time JIT delivery according to customer emand given by their assembly plan. The production philosophy is production of buffer stock in the production area with three weeks of throughput time. The production is in large batch and the process flow can nearly be characterized as a production line. After the analyzed area, there is a pull-oriented assembly area with production directly to customer orders. The product program consists of about 39 different product variants based on nearly the same components, with minor differences.

In the analyzed part of the factory there are about 20 major machines, with almost no standby parallel machines. The machines can be characterized as complex CNC machines, transfer lines, and machine centers of which the major parts of the machines were implemented from the beginning of the company. The machines are normally running in three shifts; some machines run in four and five shifts. Maintenance is organized centrally under the production manager and can be characterized as mechanistic-oriented. The maintenance tasks are divided into operators, setting-up fitters, and maintenance workers. The operators should perform daily cleaning, but this does not work well. The fitters only perform minor maintenance tasks, but there are some problems with qualifications and coordination. Maintenance workers perform the remainder of the jobs.

Both the maintenance tasks and the workers are divided into mechanical and electronics. Approximately 30% of the maintenance tasks are preventive maintenance, the rest corrective maintenance. The maintenance jobs are given a priority depending on the urgency. Each worker is responsible for his or her own machine. The company has a traditional centralized information system for maintenance. The system is used for managing the stock of spare parts and for planning preventive maintenance. The information system is used to coordinate the stocks of spare parts across the factories in the company. In addition, there are log books placed at each machine, but they are not used regularly.

The maintenance function uses SPC (statistical process control) to measure the machine conditions and the need for preventive maintenance or major overhauls. A central quality functions takes calibrations and minor machine tests (such as oil tests), which are carried out regularly.

There is poor, informal coordination in planning between production and maintenance. There is no performance measures connected to daily maintenance, and the only measurement connected to the machine conditions is SPC measurement.

The management focus on maintenance is based on capacity utilization in the production area.

The Hospital Sector

Manufactures products for the hospital sector, such as protheses and other devices to assist people recovering from operations. The case study focused on the factory that produces parts for the other factories in the company.

The production philosophy in the factory is pull oriented demand from the other factories, with approximately two weeks of buffer stock on most products. There are local stocks of finished goods in each sales company.

The production process consists of few processes and machines. The first part of the production is characterized as a production line with production in large batches. The last part of production involves two minor process centers/machines. Most machines are company-designed and constructed. The production equipment is complex and sensible according to quality, process parameters, and tolerances. Production occurs in three shifts during the first three days in the week. The remaining two days are used for maintenance and other tasks.

The company has a mission to minimize documentation and formal business processes. The production is organized as local production centers. Many support functions are integrated into the production centers. Daily maintenance tasks are assigned to a maintenance operator at each production center. The maintenance function is organized as a staff function to the plant manager. The function has seven employees, of which one to three is working with maintenance. The rest is working with building new machines and construction changes on existing machines. The preventive maintenance jobs use one employee. Each maintenance worker has an assigned machine/production area of responsibility.

An operator at each production center has the responsibility for maintenance and changeover. This operator has technical education and performs minor tasks. The company uses no EDP based information system for maintenance. Some PC-based programs are used in planning preventive maintenance, but most plans are made manually. The only recording of maintenance is that the preventive maintenance jobs have been completed. Some of the registrations are made in a log book at each machine. Maintenance has first priority, and a new project has second priority. There are no economic valuations of each machine's importance to production.

To ensure an educated maintenance staff, there is an education plan for each maintenance worker. The education is connected to the tasks in the production area where the worker is responsible for maintenance. Maintenance workers cannot operate the different production machines and do not have any knowledge of the production flow.

There is no formal cooperation between maintenance and production planning. There are no measures-only that the preventive maintenance jobs have been completed. One of the reasons is that the maintenance function does not have clear goals related to production.

Also there is no follow-up on maintenance costs. Most maintenance costs (salaries) are hidden in the production centers and in new projects.

Management focus is that the maintenance function is a necessity but needs to be minimized and invisible.

6. GENERAL OBSERVATIONS FROM CASE STUDIES

A number of general observations may be made from analyzing these three case studies of companies. The general observations are summarized below:

An analysis of the case studies suggests that formal systems will deteriorate if not meaningfully reinforced. Maintenance workers must be motivated and top management must see a clear link between maintenance activities and corporate objectives. The case studies reveal that the maintenance sections were not involved in production systems development. This observation is consistent, which showed a general lack of integration between the maintenance and production functions.

The case studies reveal a lack of maintenance resources in the companies. As is frequently the case, the concern for the execution of daily operations diminishes the capability for long-range maintenance planning. Also, the maintenance planning and supervision functions were mixed. Such a situation lead to more supervising than planning. In the companies studied, the motivation of production personnel to perform basic maintenance was weak. A key observation emerging from the case studies is that the knowledge base for maintenance was not systematically organized or structured. This organization of maintenance knowledge is a prerequisite for improving maintenance performance. All the case companies were struggling with the quantification of maintenance metrics.

The case studies illustrate the need to better integrate maintenance planning with the production function and highlight the need for a broader framework for maintenance systems development. Thus it needs to develop maintenance systems that may be used with different organizational structures and may include combinations of centralized and decentralized maintenance activities as well as outsourcing of certain maintenance functions.

The fundamental managerial implications for maintenance from analyzing the case companies may be succinctly stated as follows:

1. A situational approach to maintenance systems development is needed due to varying company dynamics, products, processes, technologies, and market influences. The maintenance function needs to be integrated with production systems development, organizational structures, people, and information technology issues.
2. Current maintenance systems have poor links to corporate strategy, which leads to a deterioration of formal systems due to lack of meaningful reinforcement.
3. The knowledge base in a company for maintenance is typically not well organized, structured, or current.

7. CONCLUSION

Despite advances in computer technology and manufacturing techniques, studies of actual maintenance performance signal the need for new, improved methods for analyzing and designing maintenance systems that are consistent with novel developments in information technology and management systems. This paper highlighted some of the managerial implications for future maintenance management by examining recent trends in maintenance methods, knowledge, organization, and information systems.

REFERENCE

[1] Piotrowski, J. April 2, 2001, "Pro-Active Maintenance for Pumps, Archives", February 2001, Pump- Zone.com [Report online]. Available URL: http://www.pump-zone.com. Reprinted with Permission of Pump-Zone.com.

[2] An Introduction to Reliability and Maintainability Engineering By: Charles E. Ebeling Published by: McGraw Hill College Division Publication Date: September 1996.

[3] Maintenance Engineering HandbookBy: Lindley R. Higgins, Dale P. Brautigam, and R. Keith Mobley (Editor)Published by: McGraw Hill Text, 5th EditionPublication Date: September 1994.

[4] Condition-Based Maintenance and Machine Diagnostics By: John H. Williams, Alan Davies, and Paul R. Drake Published by: Chapman & Hall Publication Date: October 1994.

[5] Maintenance Planning and Scheduling Handbook By: Richard D. (Doc) Palmer Published by: McGraw Hill Publication Date: March 29, 1999.

[6] Maintainability and Maintenance Management By: Joseph D. Patton, Jr. Published by: Instrument Society of America, 3rd Revision Publication Date: February 1994.

[7] Intelligent Decision Support and Data Mining Service Resource Planning, by T. L. Bharatheesh, Ph.D Thesis.