Predictive Maintenance

An Integral Component of a Maintenance Strategy

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In many companies today, maintenance is not treated as a strategic business function. Over the last decade, however, it has been clearly shown that maintenance has tremendous impact on a company's profitability. In cases where maintenance has been managed as a business function, it has been a positive impact. In other cases, where maintenance has been an afterthought, a necessary evil, or a non-core business function, the impact on profitability has been negative.

In cases where maintenance doesn't seem to contribute to a company's profitability, it is usually due to the fact maintenance is never developed strategically. Many companies try to implement maintenance improvement as a "Program of the Month". They fail to view the components of a maintenance strategy as an interdependent solution. This often leads to conflicting priorities for the maintenance, operations, and facilities personnel. The failure to integrate the components of a maintenance strategy also leads to excessive expenditures and a subsequent drain on profitability.

An Integrated Approach to Maintenance Management

Instead of the common fragmented approach to maintenance, an integrated approach is pictured in figure 1.

(Originally published in "Developing Performance Indicators for Managing Maintenance" Copyright 1998 Industrial Press.)

In this figure, it is apparent that a foundation must be in place to build the maintenance management process. The basics of Preventive Maintenance must be in place for any other part of the process to be successful. Once the PM foundation is in place, Stores & Procurement, Workflow (including Planning and Scheduling, CMMS, and Technical and Interpersonal Training provide the next level of strategic focus. The Operations Involvement, Predictive and RCM techniques build on this foundation. With sufficient data, the organization can focus on their asset strategy in TPM and Financial Optimization. Once that level is achieved, all that is left is the continuous improvement loop of self-evaluation and benchmarking.

Each of these components are building blocks for an integrated maintenance strategy. While it is beyond the scope of this article to examine each of these components in depth, a brief overview to show the steps leading to a successful Predictive Maintenance program will be highlighted.

Preventive Maintenance

The preventive maintenance program is the key to any successful maintenance strategy. The preventive maintenance program reduces the amount of reactive maintenance to a level that the other components of the maintenance strategy can be effective. However, most companies have problems keeping the PM program focused. In fact, surveys have shown that only 20% of the companies in the United States feel their PM programs are effective.

This indicates that most companies need to focus on the basics of maintenance if they are to achieve any type of asset management process. Several studies have shown that up to 50% of all equipment failures in a plant are related to the neglect of PM basics, such as proper inspections, adjustments and torquing , and lubrication. Effective preventive maintenance activities would enable a company to achieve a ratio of 80% proactive maintenance to 20% (or less) reactive maintenance. Once the ratios are at least at this level, the other initiatives in the asset management process become more effective. From the financial perspective, reactive maintenance typically costs 2 to 4 times what proactive maintenance costs, due to the inherent inefficiencies. Since the maintenance management strategies focus on ROI, it is critical for all companies to have a successful PM program as a foundation. Unless this foundation of effective PM is correctly developed all subsequent activities will be sub-optimized and incur unnecessary costs.

From a Predictive Maintenance perspective, it is essential to have an effective Preventive Maintenance program instituted, since a company would not want to invest in technology to correct a problem that is related to a neglect of basics. Predictive maintenance tools are designed to monitor the health of equipment, not to perform autopsies on failed equipment.

Inventory and Procurement

The inventory and procurement component must focus on providing the right parts at the right time for the asset repairs and maintenance. The goal is to have enough spare parts, without having too many spare parts. However, the interdependency between the maintenance management initiatives becomes apparent: No inventory and procurement process can cost effectively service a reactive maintenance process. However, with an effective PM program allowing the majority of maintenance work planned several weeks in advance, the practices within the inventory and procurement process can be optimized.

An important function for the Inventory and Procurement component should be noted: Having the RIGHT parts. Often, in an attempt to lower the inventory budget, the purchasing function will purchase all parts at low bid. This often leads to substandard part being installed during routine maintenance replacements. This has a dramatic impact on the predictive maintenance programs, since the substandard components will not perform as the original components were designed and premature failure results. Many of the signs of premature failure will be detected by the Predictive Maintenance techniques, however, with an excessive amount of components to monitor, the Predictive Maintenance Technicians become over-taxed and many inspections are delayed. This allows time for failures to occur and then Senior Management will question the effectiveness of the Predictive Maintenance Program. This results in reduced funding and ultimately reduces the PDM effort to occasional check of equipment in distress.

While it is not always necessary to purchase only OEM parts, purchasing an equivalent quality part is essential.

Work Flows and Controls

This component of a maintenance management strategy involves documenting and tracking the maintenance work that is performed. This involves the use of a work order system to initiate, track, and record all maintenance and engineering activities, including predictive maintenance. The inclusion of the predictive activities is essential to track the amount of resources being expended while performing PDM activities. Unless the discipline is in place, enforced to follow this process, data is lost, and true analysis can never be performed.

Unfortunately, many organizations record only a small part of their maintenance and engineering actions and virtually none of their PDM activities, so much data is lost. When it comes time to perform an analysis of the data, the analysis is incomplete and inaccurate. Management doesn't support the decisions made, based on the data, and further degradation of their confidence in the maintenance department occurs.

The solution requires complete use of the work order system to record all maintenance and engineering activities. Unless the data is tracked from work request and work order through to completion, the data is fragmented and useless. If 100% of all maintenance and engineering activities are tracked through the work order system, then planning and scheduling can be effective.

Planning and scheduling requires someone to perform the following activities:

- Review the work submitted
- Approve the work
- Plan the work activities
- Schedule the work activities
- Record the completed work activities

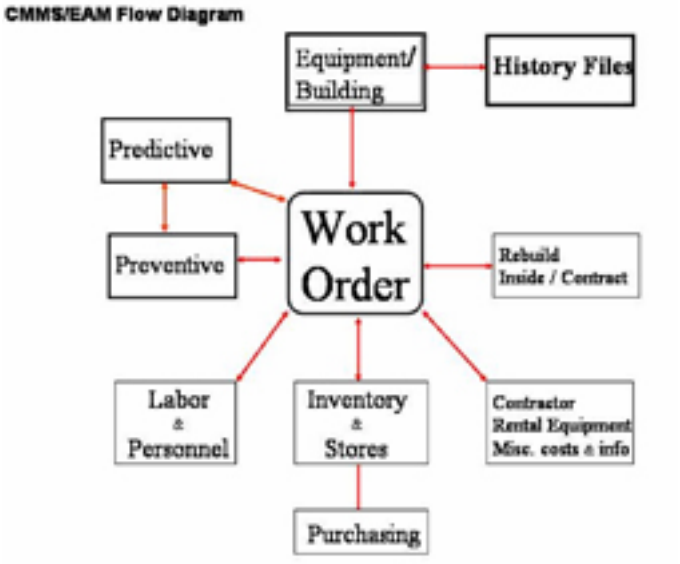
Unless a disciplined process is followed for these steps, the projected labor productivity increases and the projected reduction equipment downtime never occur. This leaves the perception that maintenance planning is a clerical function. This makes the planning function vulnerable to the first cuts when any type of reduction in overhead costs is examined.

The effective planning and scheduling are important to the predictive maintenance program for two reasons. The first is maintenance technicians need to be scheduled for the PDM activities. The resource requirements for the PDM program need to be projected and tracked through the work order and planning and scheduling functions. The second is the PDM program will identify work activities that need to be performed on equipment so that an unplanned failure does not occur. Unless a disciplined approach is taken to planning and scheduling these activities, the work will not be performed in the timeframe necessary to prevent the projected failure. The repair will then be performed in a reactive mode and the PDM effort will be viewed by Senior Executives as an unnecessary expense.

4. CMMS/EAM Usage

In most companies, there is sufficient work order data accumulated by the maintenance and engineering functions to require the computerization of the data flow. This facilitates the collection, processing and analysis of the data. The usage of the Computerized Maintenance Management System (CMMS)/ Enterprise Asset Management (EAM) has become popular in most countries around the world. This software manages the functions discussed previously, and provides information support for the Maintenance Management Strategy.

CMMS/EAM systems have been utilized for several decades world wide with mixed results. Recent surveys in the United States showed the majority of companies utilizing less than 50% of their CMMS/EAM capabilities and most companies sub-optimizing their usage. What does this mean for these companies? It means that the data they collect is highly suspect and probably highly inaccurate. Unless this is corrected, they will never be able to properly manage maintenance management, since there will be no method of tracking asset costs and calculating ROI.



From a Predictive Maintenance perspective, the CMMS/EAM system is usually interfaced to the predictive software system. There is usually an interface that allows triggers or alarms in the predictive software to generate work orders to make repairs that are identified by the PDM inspections. The work is tracked through the CMMS/EAM system allowing data to be posted in the equipment history, where analysis such as mean time to repair (MTTR), mean time between failure (MTBF) and total cost (expenses and savings) can be performed. A simplified flow diagram of this process is shown below.

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Technical and Interpersonal Training

The technology in operations and maintenance requires that the organization has employees that have the technical skills required, but also have the interpersonal skills required to work together. The interpersonal skills may include diversity training, team building training, and even some personal development training, such as coaching skills, time management skills, etc. The training is an enabler to allow the organization to begin to take more of a holistic view of itself, with everyone focusing on organizational improvement and not just departmental improvement. This training helps the employees to connect their job functions to the goals of the company.

The technical training insures that the employees have the technical skills to contribute in the new roles and responsibilities they will assume. The first issue is the maintenance organization. It is imperative to evaluate the basic skills of the maintenance personnel. Since studies have shown that over 50% of all equipment breakdowns occur due to the lack of the basics of maintenance. Once the basics are insured, then the new higher level skills required for advanced techniques (such as Predictive Maintenance) need to be defined and implemented.

With the maintenance organization's skill level heightened, the focus is shifted to the operations department. It is also important to evaluate the operators' skills in not only operating the equipment, but also in some of the maintenance basics that they can perform on their equipment. While this training is not as detailed as was given to the maintenance technicians, the concentration is still on insuring the basics are performed correctly.

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Operational Involvement

Operational Involvement requires the operations, production, or facilities departments to take ownership of their equipment to the extent that they are willing to support the maintenance and engineering department's efforts. The aspects of involvement vary from company to company. The involvement activities may include some of the following:

- Inspecting equipment prior to start up
- Making out work requests for maintenance (This includes building occupants requesting work)
- Recording breakdown or malfunction data for equipment
- Performing some basic equipment service (i.e. Lubrication)
- Performing routine adjustments on equipment
- Performing maintenance activities (supported by central Maintenance)

The extent to which operations, production, or facilities is involved in maintenance activities may depend on the complexity of the equipment, the skills of the individuals, or even union agreements.

An important point to understand is the goal of involving operations or facility personnel in maintenance related activities is not to "Downsize" the maintenance organization. The goal is to free up some of the maintenance and engineering resources to concentrate on more advanced maintenance management techniques such as Predictive Maintenance.

Predictive Maintenance

Once the maintenance and engineering resources have been freed up by the involvement of operations, they should be refocused on the predictive technologies that apply to their equipment. In some cases, real time monitoring of equipment conditions are part of the Predictive Maintenance program. For example, the devices monitoring the equipment may be connected to a building automation system, a distributed control system, or a PLC system and all parameters monitored in a real time environment.

The focus for PDM is not to purchase all the technology available, but to investigate and purchase technology that solves or mitigates chronic equipment problems that exist. The predictive inspections should be planned and scheduled utilizing the same techniques that are used to schedule the preventive tasks. As mentioned previously, all data should be recorded in or interfaced to the CMMS/EAM System.

There are dozens of predictive maintenance technologies, and some have become virtually industry standards. Those "standard" technologies include vibration analysis, ultrasound, oil analysis, wear-particle analysis, and thermography. The following are brief descriptions of the ways maintenance technicians have traditionally used these predictive technologies.

Vibration Analysis

Vibration analysis is used primarily with rotating equipment to find problems such as misalignment, out-of-balance conditions, and bearing defects. Prior to using vibration analysis, maintenance technicians had to wait until a bearing failed to realize there was a problem. Using vibration analysis, however, periodic readings are taken and recorded. Maintenance personnel then compare these readings to a baseline. When

wear reaches a certain level, the bearing is scheduled for replacement, before it fails. This reduces the amount of reactive maintenance and ensures the replacement occurs with minimum impact on the production or facility schedule.

Ultrasound

Ultrasound functions primarily for leak detection, particularly for steam and air leaks. These leaks can be expensive and many companies let them go unnoticed. The principle of ultrasound is simple. Most leakage problems produce a range of sounds. The sounds, when properly detected and measured; provide the user with the location and severity of the leak. Common applications for ultrasound include leak detection for pneumatic and other gas systems, vacuum systems, gaskets and seals, and steam traps. Ultrasound also detects valve blow-through. Since many small leaks are difficult to find simply by listening for the leak, the ultrasound technique helps technicians discover the many small leaks that add up to significant losses over time.

Oil and Wear-Particle Analysis

Some people equate oil analysis and wear-particle analysis. Actually, they are two very different technologies. Oil analysis determines the condition of a lubricant. Wear-particle analysis determines the condition of equipment based on the concentration of wear particles in the lubricant.

Thermography

Thermography serves primarily to find electrical components that are hotter than normal. Such a condition usually indicates wear or looseness. Thus, thermography allows technicians to perform maintenance on only the electrical components that need attention without requiring that all components get the same level of attention.

In utilities, for example, the correct torque is essential on electrical components to ensure that no heat is generated from a loose connection. Before thermography, it was necessary for each connection in a control panel to be checked manually for correct torque. Using thermography only the connections that are hot receive attention. This reduces the resources necessary to perform preventive maintenance on the connections.

Additional Components

While there are additional components of an integrated maintenance strategy, (RCM, TPM, Financial Optimization, and Continuous Improvement) the objective of this article was to examine those necessary to support a Predictive Maintenance Program. As has been shown, a Predictive maintenance program is not a stand alone strategy, but needs to be integrated into an overall asset management strategy.

Companies need to realize that there are various components to an asset management strategy and that they need to be integrated to be effective. It is only through this understanding that maintenance management will eliminate waste and produce the maximum benefit to a company's profitability.

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