Predictive Maintenance - How Far Do You Want To Go?

Written by:
Terry Wireman
Vice President, Vesta Partners, LLC

The individual technologies used in predictive maintenance (PDM) have broad application in plants and facilities. The three most common ones are:

- Vibration analysis
- Thermography
- Oil analysis

Typically, vibration analysis is used to detect wear in rotating equipment. Thermography is used to detect loose connections or hot spots in electrical equipment. And oil analysis has at least two uses -- to determine the condition of a lubricant and to examine the wear particles contained in the lubricant to determine the wear rate of the components in the system. When used to determine the relative condition of the equipment being lubricated, it is often referred to as "wear-particle analysis." In addition to these technologies, there are others such as ultrasound that can be used to isolate air leaks, steam leaks, defective fluid power components, and other problems.

Often, a predictive technology is used as a stand-alone technique with little impact on a company's overall asset-management strategy. In fact, there are various levels of maturity in the use of these technologies.

The Starting Point

An organization usually turns to PDM when it realizes that it has needs that cannot be addressed by a preventive maintenance (PM) program. At this point, in most cases, equipment has already benefited from the attention to details that an effective PM program imposes. Basic problems such as over- or under-lubrication, improper inspection techniques, or improper fastening procedures have been all but eliminated. However, the equipment still experiences occasional breakdowns from problems that are not related to basic preventive maintenance.

For example, an internal bearing in a gear drive may fail regularly. There is no visual inspection that can detect the wear before it causes a failure. It is in such cases that the techniques of vibration analysis or spectrographic oil analysis can be used to trend the wear on the internal bearing, allowing the maintenance organization to schedule a change out that minimizes the impact of a shutdown.

In this beginning stage of PDM, equipment still breaks down because PDM efforts are not focused on all critical equipment, just equipment that has failed in the past. Predictive technologies are used only on specific or isolated equipment problems. Even when the critical nature of some equipment is taken into account, the effort is still almost a "reactive" predictive program in which the techniques employed detect existing problems that have a significant impact on the company's business. Be aware that the cost of doing a PDM program of this kind on an on-demand basis is expensive because data is collected and analyzed on a case-by-case basis. PDM efficiency will increase when it includes the next step -- data-collection routes and dedicated personnel to analyze the data.

Strategy Development

As an organization progresses, it starts to consider the efficiency of the maintenance labor used to record and analyze the predictive data. This leads to PDM routes with readings taken on a fixed schedule. This step usually requires dedicated resources, but it also allows the scheduling of those resources weeks, if not months, in advance. In addition to the resources required to take the readings, resources are required to analyze the readings, determine the corrective actions required, and ensure that actions are taken to prevent an impending failure.

As the program becomes more disciplined and scheduled, the amount of maintenance labor needed to take the readings can be reduced to an optimal level, and the freed-up personnel can be redeployed to examine other areas where the PDM program has application. This more extended program further increases a plant's efficiency by increasing uptime and equipment efficiencies.

PM/PDM Integration

The integration of PM and PDM begins with an evaluation of the PM program based on the equipment conditions detailed by the appropriate predictive technologies. The PM program is then adjusted (increased or decreased) based on the needs of the equipment as determined by the condition of the equipment. For example, if the vibration readings on a bearing indicate that it has too little lubricant, then the preventive maintenance task dealing with the lubrication of the bearing can be adjusted to ensure that the proper amount of lubricant is applied to the bearing. Conversely, if the bearing is receiving excessive lubricant, the preventive maintenance task or its frequency can be changed to reduce the amount of lubricant being applied.

It is also at this stage that the basics of interfacing the predictive technologies with the preventive maintenance technologies should be investigated. This move may be as simple as tracking meter readings. For example, most preventive maintenance programs are tracked within a computerized maintenance management system (CMMS). The CMMS is used to track the PM frequency and schedule it based on a calendar event or meter reading. Thus, PM tasks are scheduled based on elapsed time or some amount of use (parts processed, gallons pumped, etc.).

At the same time, the predictive interface may be using the meter readings to track parameters such as vibration levels, temperature, or even operational measures. A base line for each parameter is established. Then, on a certain frequency, a maintenance technician takes the various readings and enters them into the "current meter reading" field. If the current reading exceeds the base line plus the allowable tolerance, a preventive maintenance inspection or service -- possibly even a work order -- is issued. The PM or work order will detail the instructions necessary to correct the situation that is exposed by the out-of-tolerance meter reading.

Such interfaces are common in the maintenance "industry" and are supported by the CMMS vendors who contributed to this article, as well as other providers of CMMS software and services.

This stage, as it progresses to maturity, further reduces the amount of maintenance labor required to conduct the PDM program and further increases equipment uptime and throughput.

The Use of RCM

Available space allows only a quick overview of the role of reliability-centered maintenance (RCM) in a mature maintenance operation. Nevertheless, the use of the RCM concept further adjusts the frequency and amount of preventive and predictive maintenance performed on equipment.

In an attempt to decide whether to perform some type of preventive or predictive task or allow the equipment to run to failure, the initial RCM decision tree examines the consequence of a failure. When performing an RCM analysis on existing equipment that is part of an established preventive and predictive maintenance program, one uses the RCM process to evaluate the cost effectiveness of the tasks currently being performed. The RCM process assists in the decision of whether to increase or decrease the frequency of the task, eliminate the task, or add new tasks.

The RCM process ensures that an effective predictive regimen is used for the equipment. RCM also ensures that the regimen is cost effective -- not performed too much (which is a waste of resources) and not performed too little (which causes excessive downtime). By the time a company has progressed to this stage of development, there is little, if any, waste in the PDM program.

Full Integration

Full integration entails the integration of the predictive system with the CMMS or Enterprise Asset Management (EAM) system and other operational systems in the plant. The first level of integration is the mounting of real-time sensors used to detect the predictive parameters -- vibration, temperature, airflow, etc. The output from each sensor is fed into the CMMS/EAM system, where there is an established baseline for the measurement.

The CMMS/EAM system will maintain a tolerance parameter, and as long as the signal from the sensor does not exceed the tolerance, nothing happens. However, as soon as the tolerance is exceeded, a warning is issued from the CMMS/EAM system that will dispatch someone to inspect the sensor and discover the reason for the out-of-tolerance reading.

It is even possible to set multiple triggers in the system so that: 1) If the tolerance is exceeded by a small amount, an inspection is generated. 2) If the tolerance is exceeded by a greater amount, a work order asking for a repair is generated. 3) If the tolerance is completely out of range, an emergency warning is generated.

At this level of sophistication, some CMMS/EAM software packages have logic trees built into them that assist in determining the cause of an out-of-tolerance reading. Such rule-based systems allow criteria to be set so that when, for example, a pump flow starts to drop off, maintenance personnel check the inlet filters and/or look for a clog in the inlet line. If the flow drop is combined with an increase in pressure at the outlet of the pump, then a downstream restriction might be suggested as the problem. The possibilities are endless. Today, when many older craft technicians are contemplating retirement, such a software feature could be the device used to capture their years of experience before they leave their companies.

This highly developed stage of maintenance management will be enhanced in the near future by the addition to the maintenance, repair, and troubleshooting process of applications that employ artificial intelligence.

So, there are various levels of sophistication that a company can achieve in its PDM efforts. The suppliers of CMMS/EAM systems in partnership with the providers of PDM technologies will continue to offer new enabling systems that will even further enhance and expand asset-management capabilities. The question is whether your organization will limit its use of these technologies and remain at an early stage of PDM development or develop an integrated strategy and become more competitive in the new millennium.

For more information, please contact:

Vesta Partners, LLC
60 Long Ridge Road, Suite 403
Stamford, CT 06902
203-517-0400
info@vestapartners.com
www.vestapartners.com