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## **When is predictive maintenance a burden rather than a benefit?**

By Daryl Mather, author of "The Maintenance Scorecard"

Are you implementing your predictive maintenance managerial plan correctly? Daryl Mather explains how to get the most out of your program and decrease lifecycle costs.

Even the most disciplined maintenance regimes can actually increase the lifecycle costs of machinery.

Within the managerial discipline, we seem aware of the detrimental effects of over-maintenance. Messing with things that are working fine, without any good reason to do so, is a good way to introduce human error, reduce uptime and increase the costs of maintenance. This effect of higher-activity costs for reduced performance is symptomatic of the time-based maintenance most of us moved away from during the past two decades.

But where have we moved to? There is a range of techniques, technologies and methods that are shaping asset maintenance. However, more than anything else, most of us moved to predictive maintenance technologies.

The basic thinking behind predictive maintenance technologies is, if we can predict failures with undesirable consequences in time, then we can plan the corrective action and avoid costly, or dangerous, incidents from occurring. And if we can do this without needing to stop the machinery, pull it to pieces and reassemble it again, then we are killing two birds (avoiding consequences and increasing uptime) with one stone. Even better!

In a managerial discipline where most commentators are evangelizing about the latest technologies, it is sometimes hard to tell people that misapplied predictive technologies can cost us money, sometimes more than if we had never maintained the item at all. Predictive maintenance works by detecting early signs of physical degradation of assets.

Any system left to its own devices tends to move from order to disorder. Its energy tends to be transformed into lower levels of availability, until it reaches the point of complete randomness, or unavailability to do work. This is the second law of thermodynamics and is the scientific basis for maintenance.

In practical terms, degradation can be better understood by looking at an item such as a bearing. Bearing failures are due mainly to metal fatigue. Imagine bending a paper clip again and again until it breaks. The metal within the bearing races, balls and the cage fatigues, until it cracks.

This is when the first signs of physical degradation begin to appear, most notably in the form of vibration. Depending on the severity of the crack, it may be immediately detectable by most devices on the market. Many times, however, it takes quite a bit of time before the crack is detectable.

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Once the crack can be detected, we can start to make judgments on how long the bearing is likely to last before a functional failure (the point where it no longer does what we require of it, regardless of whether it is still working or not).

In this case, we can use vibration analysis to determine if a functional failure is going to occur. Once that information is gained, we can replace the bearing in a way that avoids or reduces the consequences of failure.

But doesn't it just beg the question – how did the metal become fatigued in the first place? What are the failure causes that led to this situation, and could these have been avoided? After drilling down into deeper levels of causality it suddenly becomes clear that we could be treating the symptom and not the cause of failure.

Bearings are quite complex items that have a myriad of potential failure causes. Some of the more common causes of early failure include:

- Misalignment between a pump and a motor, or imbalance of the rotating element itself. All of these lead to vibration, uneven stresses, and additional load on certain parts of the bearing. This in turn speeds the process of fatigue.
- Excessive axial thrust on the bearing (pushing the shaft lengthwise) rather than the designed-for radial loads. This is common where there are foreign objects passing through a pump, for example.
- Over-greasing of the bearing is a commonly quoted failure mode. It leads to overheated grease; reduced lubricant viscosity; weakening of the races, balls and cage; and increasing wear.
- The load being too far away from the bearing itself, such as with the impeller of a mixing tank, or in some cases where there are extremely long shafts between a motor and a pump. These were once commonplace in water and wastewater pumping stations.
- And of course, a bad bearing or poor installation of a bearing. Poor installation is a training and quality control issue and one that is easily rectified. But poor quality of bearings is something that I have noticed becoming more commonplace.

There are obviously many other potential causes of failure, but I have chosen these because they are all avoidable through operating practice changes, small design changes, or more effective maintenance regimes, thus eliminating many of the causes of early life failure.

In these situations, even if we are able to predict the end-of-life component failure, the bearing will still fail. We will still have an unnecessary downtime period, and will have to spend the money for a new bearing earlier than we should have. If the reason for this is chronic, something that will repeat itself, then we will just be installing a new bearing back into this short lifecycle. Some examples of this include over-greasing and poor alignment practices.

This is a prime example of a common and significant problem – developing a failure management program that manages the asset and not the failure mode. Predictive technology is being used in this case to cover deeper issues, and without performing further analysis it could even mimic success, yet the result is actually reducing cost effectiveness!

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It has been my experience that to create a truly effective predictive maintenance program, one that delivers minimum lifecycle costs for a given level of performance and risk, one of the first steps is to identify all of the likely causes of failure at the correct level of detail.

The challenge for your reliability analysts and technicians is to know when they have analyzed the failure to enough detail, and to realize when they are starting to veer into paralysis by analysis. This will be dealt with in later columns. Once the reasonably likely failure causes have all been identified, then we can put in place the failure management strategies. Among these will be changes to operating procedures, quality control procedures, asset designs and configurations, and maintenance strategies, including the correct application of predictive technologies.

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