Five Steps to Optimizing Your Preventive Maintenance System

Introduction

Many people have preventive (PM) and predictive maintenance (PdM) systems in their organizations. But in many cases they're static systems. Once installed little attention is given to optimizing them so they deliver the greatest reliability at least cost. In this paper I'm going to suggest 5 ways you can use to optimize your PM system. The term PM as used here includes condition assessment (PdM) tasks.

Compare corrective maintenance costs to preventive maintenance costs

One way to help identify those machines that may have the wrong degree of PM is to compare the cost of corrective maintenance with the cost of preventive maintenance. The traditional U-curve (Figure 1) showing the variation of costs with amount of PM usually has a minimum in the total cost curve at about the point where PM cost (PM$) equals CM cost (CM$). The real minimum is not necessarily exactly at that point but for most realistic curves is close.

Plotting PM$/CM$ on a log scale should result in a curve similar to Figure 2

Most of the machines will usually be close to the one-to-one ratio; those that are not are the ones we're looking for.

Start with the machines having the biggest ratio and smallest ratio. At one extreme, a few machines will have as much as 30 to 40 times as much spent on them for corrective maintenance as for preventive maintenance. It is likely that these machines probably need additional preventive maintenance to reduce the total cost of maintenance and to improve their reliability. If these are critical machines, then you may want to consider doing a full reliability centered maintenance analysis for them. If they are priority machines, then consider a simplified RCM analysis or contact the OEM for their recommendations.

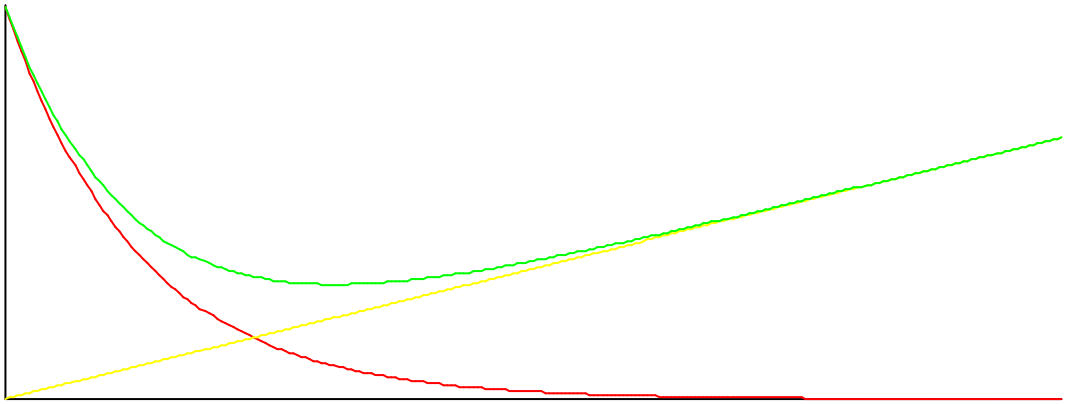

Figure 1

For those machines that have PM$ much greater than CM$, look at the existing tasks — do they really impact the reliability of the machine? Often PM tasks are done because they can be, not because the have any cost effective impact. PM tasks should improve the reliability of the machine, its operating cost, its life cycle cost or its useful life. Another possibility is that the tasks are needed but they are being done too often.

When you calculate the ratios, you will probably find some machines with no corrective maintenance cost or no preventive maintenance cost. Look especially carefully at these machines. Make sure the results match the degree of preventive maintenance you want for those machines.

Use age exploration to determine periodicity

One of the biggest causes of overspending on PM is doing tasks too often. Assigning periodicity is usually done by the OEMs recommendation or by gut feel. The OEM has different objectives in assigning PM than you do. He wants to make sure the machine lasts through the warrantee period. He is not particularly worried about how much the PM costs. You want to find the most cost effective PM.

If you know the age-reliability relation for the machine or component, possibly from RCM or another source, you can calculate an appropriate periodicity directly. If you suspect that tasks are being done too often, you can increase the periodicity while monitoring the impact on the machine. This technique is called age exploration.

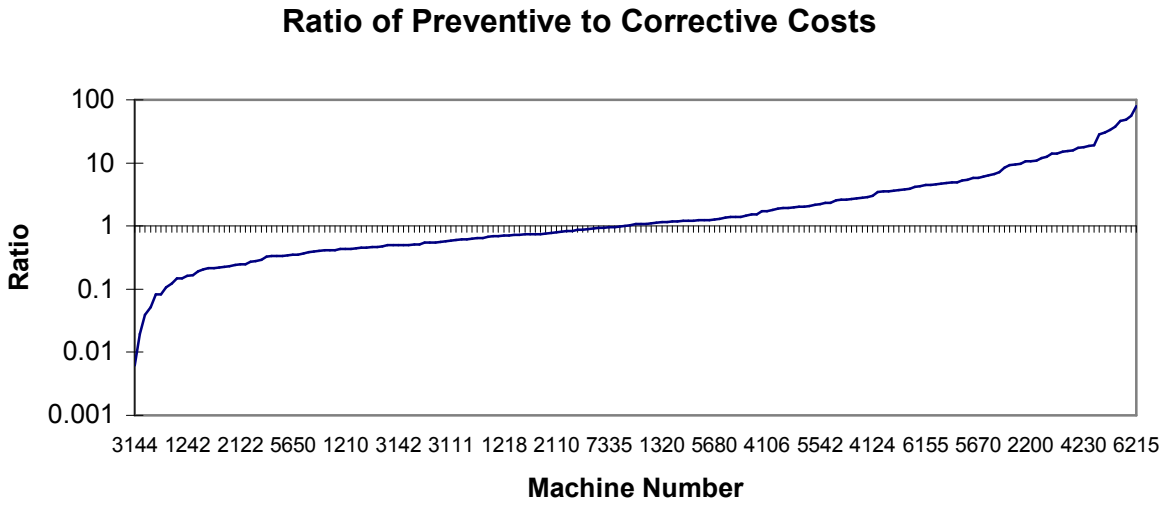

Figure 2

Before starting to explore the period, measure and record in detail the condition of the affected components. If the components show no sign of wear and tear during this inspection, increase the period of the PM by 10%. At the next scheduled PM, re-inspect the components. If there is still no sign of wear, increase the period by another 10%. Repeat this cycle until at one the inspections, signs of incipient wear out are found. Now back off the periodicity by about 10% and take this as the new scheduling periodicity.

It's a good idea to closely inspect the components at the next several scheduled PMs to make sure the wearing has stopped. If you find signs of continued wear, reduce the period again and continue to observe.

A reduction in corrective repairs is a side benefit of increasing the PM period. United Airlines found that by using age exploration they could increase the overhaul interval of a hydraulic pump from 6,000 hours to

14,000 hours. They also found that the rate of corrective maintenance was reduced by over half. This reduction was attributed to less intrusion and handling of the pump that could introduce faults and dirt.

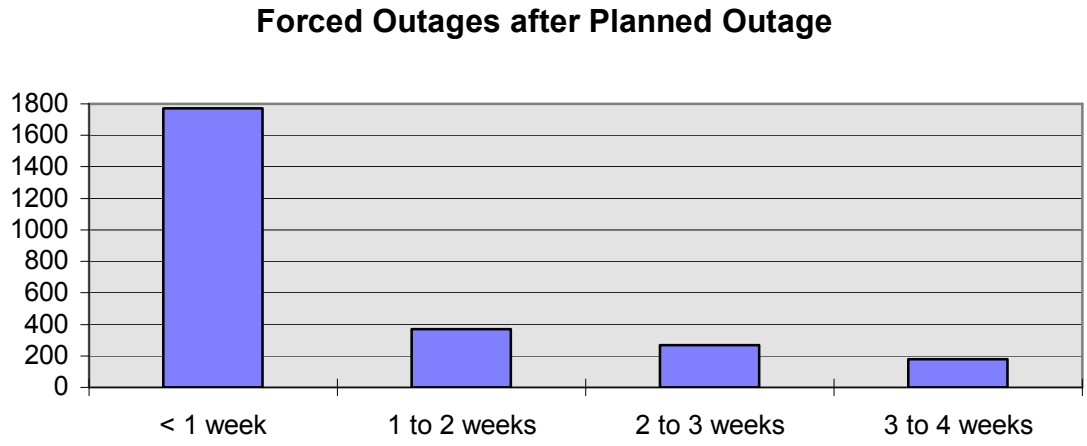

Figure 3

Sort tasks by labor costs and look for maintainability improvements

Another way to find tasks that can be improved is to sort the tasks by the amount of labor required. It's best to use actual historical figures if they are available but planning estimates will work also. Look at the tasks that require a lot of manpower. Is there another way to accomplish the intent of the task without as much manpower? Can the machine be modified to make the task easier? For example, say a task to inspect the wear on a gear set takes a machinist, 2 riggers and an electrician a total of 12 man-hours. An interfering electric motor must be rigged out of the way, a cover plate is un-bolted and rigged out, the inspection made and then interference is restored. By putting a hinged inspection port in the gear set cover, the inspection could be done in 30 minutes by one machinist.

Other possibilities are changing the route the lubricator or vibration data collector follows when making his rounds to save time, building a special tool or jig to make the task easier, installing an access platform, or even upgrading to a higher grade of lubricant or component which will last longer.

Look for correlation of number of repairs with particular PM tasks or production events

History has shown that the incidence of corrective repairs is greatest immediately after an overhaul or major repair. (See Figure 3)[1,2] by looking at the rate of corrective maintenance over time you may find there are regular periods where the number of repairs is higher than normal. This may occur only for one machine or for a whole line. Now look at your PM history. What PMs were done just prior to the increase in failure rate? Could they be causing the failures? Look especially for

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[1]Corio, Marie R. & Costantini, Lynn P., "Frequency And Severity Of Forced Outages Immediately Following Planned Or Maintenance Outages," Generating Availability Trends Summary Report, North American Electric Reliability Council, May 1989.

[2] Smith, Anthony M., Reliability Centered Maintenance, McGraw Hill, NY, 1993

PMs that could introduce dirt into the system such as lubrication, PMs that break the system boundary such as an overhaul or PMs that affect some related component such as alignment. If you find likely candidates, investigate them to see if they can be eliminated, the procedure changed or new tools made available to eliminate the problem.

Another area that may be introducing problems is production setup. Do the higher CM rates correlate with changes in setup? If so, look for ways to correct the problem before startup. Maybe a PM to do an adjustment or check an alignment is needed?

Adjust degree of PM based on classification of machine

Is the amount of PM on each machine appropriate for the classification of the machine? A machine whose failure will affect sales or safety of people or equipment should have a higher degree of PM than a machine whose failure will only affect production but not sales or safety. And that machine will have a higher degree of PM than a machine whose failure will not affect production. See Figure 4.

A machine whose failures will immediately impact sales should probably be operated near the point of lowest downtime at least maintenance cost. A machine whose failure will not affect sales or production should be operated near the point of most economical maintenance. A machine that can affect production but production can be recovered before sales impact should be operated at the point of least maintenance and lost production cost.

Finally, ask yourself if you even need to do PM on some machines. It may be cheaper to let them run to failure than to PM them.

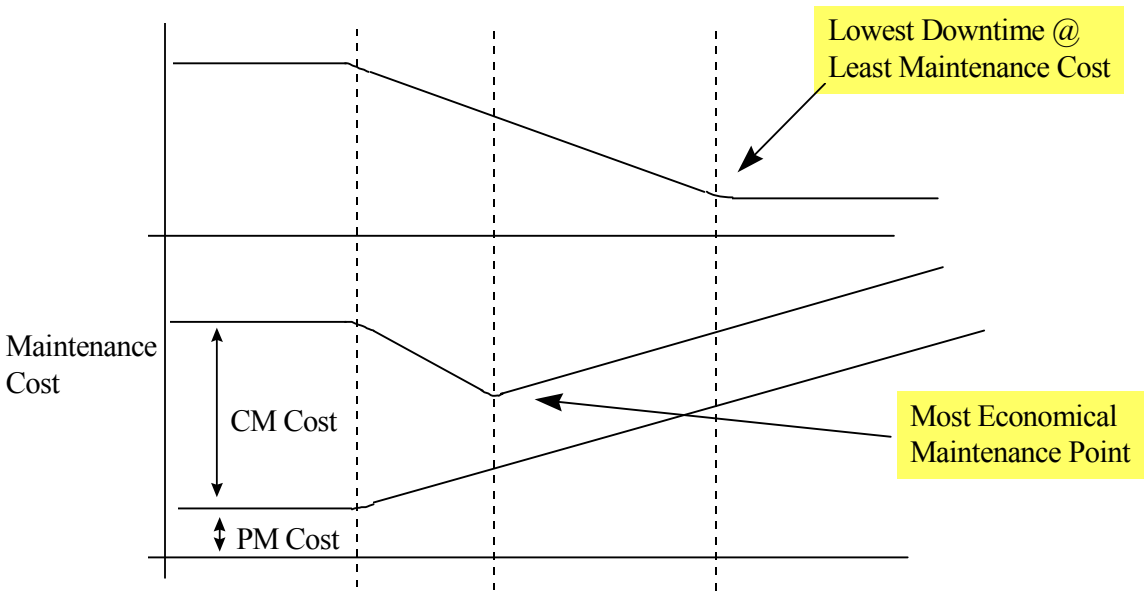

Figure 4