EDITORIAL

Condition Based Maintenance – Information or Technology?

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I like to think of Condition Based Maintenance (CBM) as an Information Technology process that converts machinery vibration data into useful information. By useful, I mean information that contributes to a clear course of management action. Reporting that HVAC X has excessive vibration of 1 in./s at 1× rotational is communicating data. Adding comments on the possible causes, cost and recommended corrective action is communicating useful information. The usefulness of raw data is very dependent on who receives it. If you show a time waveform to a novice, they will see a squiggly line. Show the same waveform to a vibration expert and he or she will see a wealth of information on the condition of the machine. That is an important distinction. A manager wants the information, not the time waveform.

Machinery vibration analysis has become one of the most widely used maintenance tools in the world, precisely because it has the ability to provide such operational information. Unfortunately, the information is often buried under a ton of data!

We have learned much, and our industry has produced many innovative and powerful diagnostic techniques since its inception during WWII. Understandably, most carry with them an increasing degree of complexity. This has been good for the vibration expert, but does little for the average maintenance mechanic. At vibration workshops much of what is said is not clearly understood – too many experts talking to other experts. Is that really progress? Perhaps we should be using technology more to provide information and less to dazzle people.

The jargon of our trade now rivals that of the legal or medical professions, as illustrated by Figure 1. Terms like Frequency Spectra, Coherence, Cepstrum, Spiking, Windowing, Frequency Enveloping and Demodulation have become part of the normal vibration 'techspeak.' It is not surprising that demands for skilled personnel with highly specialized training are increasing.

Most of us are familiar with the old 80/20 rule. It postulates that 80% of maintenance activity involves 20% of the machines. This makes sense – how long would a processing or manufacturing plant stay in business if more than 20% of its equipment was troublesome? Experience also tells us that more than 80% of the problems with those machines can be handled by capable maintenance personnel – balancing, alignment and similar

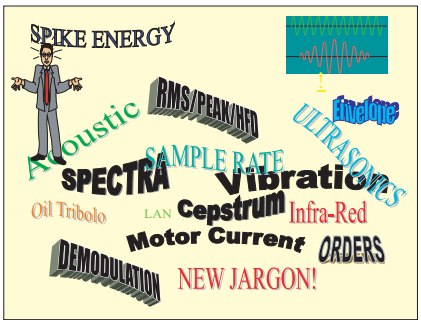

Figure 1. Technical jargon in Condition Based Maintenance.

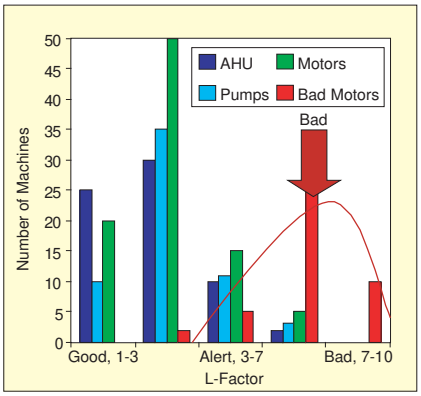

Figure 2. Life factor distribution.

conditions. Therefore, the high-powered techniques and expertise are usually required on about 4% of the total machines. Ergo, the vast majority of the work does not require a Ph.D.

It is also worth considering that the focus on sophistication and complexity severely limits the wider application of the technology. If information and ease of use are the goals, we should emphasize tools that help us achieve these goals.

One such simplification is to classify machines according to their criticality and the potential cost of a failure. We agree that taking detailed spectra on the fan in the men's room may be a waste of resources. (The ladies room, or the executive suite, may require special consideration!) It also makes sense to survey the vast majority of machinery with surveillance procedures that do not involve detailed analyses but will reliably flag problems and report them meaningfully.

Figure 2 illustrates a frequency distribution of simple number ratings that represent the life expectancy of a number of air handling units (AHU), pumps and motors in a facility. L-factors of 1-3 are good, while those from 7-10 have drastically reduced life expectancy. A manager can quickly see that the AHUs and pumps are in generally good condition, a few are in alert, but a number of motors are in need of immediate attention.

This does not imply less sophisticated technology. In fact, the technology required to do this is actually more complex, but easier to use and provides information rather than data. (I didn't say it would be easy!)

Quarterly CBM reports sent to management with 50 pages of spectra and one paragraph of "Executive Summary" are seldom digested, even by technically qualified managers. Oliver Wendell Holmes once said: "I would give my life for simplicity this side of complexity."

Television technology is bewilderingly complex, yet, when you come home from work you only need to kick off your shoes, open a bag of pretzels and push a button on the remote to get the football game. You do not need to understand video bandwidth, color saturation or sync rates to check the score of the game. Is there a lesson here for us in vibration technology? Perhaps so, but I think change is blowing in the wind.

Here's why: A few years ago, I met with the facility manager of an extensive CBM program. He managed five complexes with over 700 maintenance employees. His program included an expert system with vibration, oil, ultrasound and thermal analysis. A believer in CBM, he still felt that the information reports to upper level management were inadequate.

In many cases he felt management did not fully understand what CBM was doing. He was operation oriented, and felt overloaded with data that did not directly help him make decisions. He wanted more operational metrics, such as those listed below (see also Figure 3):

- Equipment reliability condition by facility, building and floor.
- Are we optimizing equipment life?
- Where are the high cost, high-risk problems?
- How do we reduce the risk?
- Do we run a critical piece of equipment until the next maintenance cycle or shut it down now? What are the metrics of that decision?
- Is the quality of our maintenance operation improving?
- How can we objectively benchmark various maintenance areas?

He believed that "If you can't measure it, you can't control it!" and viewed the technology only as a means to obtain the metrics.

What does all of this have to do with vibration? Surprisingly, most of the desired information he wanted was buried

in the 50 spectra CBM reports that are being filed under "We don't know what they are doing anyway."

Reports to management should not include 50 spectra. For example:

One of his facilities had a co-generation 350 hp gas compressor (Figure 4). This system had been sending out cries for help for months. CBM technicians had been including the machine in their monthly reports, with spectrum plots showing bearing frequency components trending upwards for some time (Figure 5). They suspected the drive end bearing on the motor was near failure. The reports were filed, and the machine kept running. It seems the bearing data did not convince the department head. When asked, he acknowledged that it was noisy, but it had been like that for a long time. They were watching it and planned to schedule it for maintenance, periodically giving it a shot of grease to quiet it down and keep it running.

Meantime, the facility had introduced a new reporting system, addressing most of the elements outlined by the facility manager. The new system stressed distilling data and reporting information rather than providing raw data. Figure 3 illustrates this improved paradigm for CBM reporting. One side shows the technical activities of CBM and the other lists type of information that management expects.

In the new system, department benchmarking, machine condition, life expectancy and actual bearing conditions were stressed. The data were distilled down to facility and area scores with recommended actions and related cost savings. The system was so unique it has several patents issued and pending.

The new report, distributed to top level managers, flagged the area with this machine. The report allowed them to see overall results, but also allowed them to drill down to get more information on specific problems. The report presented four pieces of information on this machine:

1. The Factors that his maintenance staff had controlled – lubrication, balancing, alignment – were rated good, with next scheduled maintenance overhaul in 90 days.
2. The Probability of Bearing Failure in the next 90 days near 100%.
3. The estimated Cost of Bearing Replacement if maintenance was performed promptly – $12,000 for labor and materials.
4. Estimated Cost of Catastrophic Failure – $250,000.

A separate section of the report contained the supporting data.

Recommendation – shut down immediately, check and replace all worn or defective bearings.

The decision was easy. The facility manager was satisfied that his maintenance staff needed to take immediate action. The cost was not worth the risk of continued operation to the next maintenance shutdown.

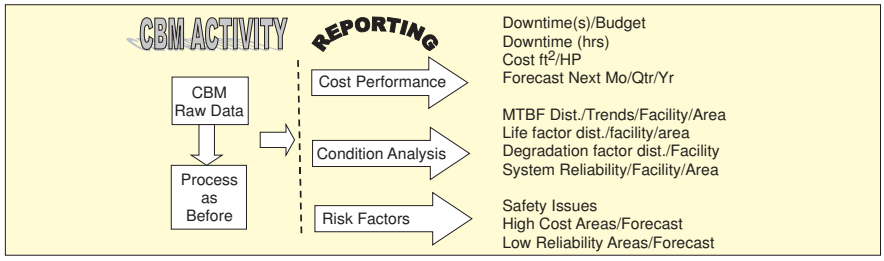

Figure 3. Management information flow.

Figure 4. 350 hp centrifugal compressor.

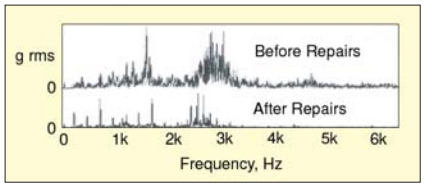

Figure 5. Gas compressor front bearing before and after bearing replacement.

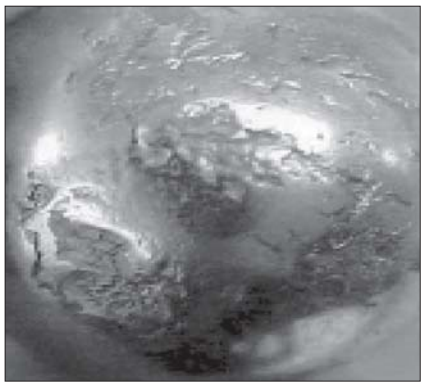

Figure 6. Gas compressor front bearing.

The machine was shut down for maintenance within two weeks. The front bearing came out in pieces, very close to catastrophic failure (Figure 6). Cost savings were approximately $238,000 – not bad, and the boss never had to look at one spectral plot.

Boss Happy! CBM technicians happy! Department manager happy! (?)

The new system also provides upper management with graphic displays on all the essential factors the facility manager desired. The information is presented in clear, understandable language, extracted from the vibration data that before was quietly filed away.

The message in Mr. Holmes' remark is clear: Resist the tendency to complicate things. You don't need a cannon to kill a fly. Keep procedures, equipment and reporting as simple as possible. Use sophisticated technology and expertise when justified, but report the findings and recommendations backed up by the data, rather than just the raw data.

System designers should remember the TV remote control. Think about what the end user is trying to do with the data, and keep the technical complexity behind the scene.

For CBM maintenance engineers, management communication is the key. Break down the terminology barriers. Find out what information is needed and how it will be used, then communicate it in understandable form backed up with the technical data. Remember, if the people at the top understand the operational benefits of your program, they will support it. Think of your CBM activity as a management information center, because that's exactly what it is. SV

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