Tip-top condition?

Predictive maintenance is an important route to cutting costs and improving plant performance. And, says Brian Tinham, the condition monitoring technologies, upon which it relies, are ripe for the picking

There are two abiding observations that tell us a great deal about condition monitoring and the reasons for its relatively slow uptake, despite the undeniable power of predictive maintenance that flows directly from it. The first concerns a story involving an unnamed paper mill, which had been equipped with expensive vibration monitoring equipment. Only three people had the authority to stop the plant: the managing director, the chief engineer and, such was the success of this system in predicting plant breakdowns, the only technician able to run it.

One day, however, said technician saw a job advertisement on that company's notice board, offering promotion and more money. The position in question was store keeper. Clearly, that organisation had failed to match his value to the business, with either financial remuneration or kudos. For as long as that remains the case, plant engineers are unlikely to start falling over one another in the chase for careers in predictive maintenance.

Our second observation comes from Trevor Holroyd, founder and managing director of Holroyd Instruments, which was recently acquired by condition monitoring specialist Kittiwake. He notes that vibration monitoring – by far and away the most mature and frequently implemented of the predictive maintenance sensing technologies – requires specialist frequency analysis before it can return diagnostic results, leading to recommendations.

"But most of the time, most plant items don't have a problem," he points out. So all that cost only goes to prove what plant engineers might claim they already knew. "That's why condition monitoring tends only to be recommended on expensive and critical plant, and the approach doesn't gravitate down to the rest of the plant." For him, all that could have changed decades ago – and certainly can now – with acoustic emission sensing turning all that on its head (see panel).

In fact, the good news is that condition monitoring technologies of all flavours have been busy blossoming. Indeed, perhaps ironically, the advent of low-cost thermal cameras, in particular, has seriously heightened both plant managers' and plant engineers' awareness of their accessibility and potential. The only caveat: it is still the case that too many infrared cameras are bought in a rush of enthusiasm, only to end up languishing in cupboards when they fail to deliver on their promises – usually because engineers receive inadequate training –yet again undermining the reputation of condition monitoring.

Getting started

So, assuming you're not in the camp that has already been wowed by a technology type, how should you kick off your condition monitoring initiative? According to Gary Setford, contract manager with SKF, the most important point is for plant engineers to be very sure that first they understand their machines. "They need to know how the machines are built, what they do and how they're likely to behave," he explains. "Otherwise, with vibration monitoring, for example, there might be a sharp increase in the sensor signals, indicating that something has changed, but nobody knows what to do – because they don't know the likely failure modes of the machine in its duty cycle."

And Paul Deighton, who runs SKF's reliability systems business unit, adds that there is also huge value in going back to basics. "When you're starting a preventive maintenance programme, you need to ensure you're going for the right technique, for the right asset, for the right reason," he urges. That may sound trite, but his point is that assessing all of those will highlight the mix of condition monitoring techniques, skill sets and management culture required – as well as the budget – as opposed to the actual situation.

"You might decide you need thermography or oil debris analysis, vibration monitoring or just a robust inspection programme, but you need first to be sure that your wish list fits with your maintenance organisation's culture and processes. You might need to buy in some training that goes with the technologies. But it might also mean creating a management culture where people want to be involved and take some ownership."

Sounds obvious? Maybe, but there are plenty of

Acoustic emissions plant monitoring equipment: easier than ever to use

Oliver Burston

maintenance managers who will tell you they tried condition-based monitoring and it didn't work. Well, I wonder why? "The other thing is not to take on too much," advises Deighton. "Applying the techniques to all your assets won't be necessary, because they're not all important. You need to assess your plant items' criticality to the business, some of the failure modes of your key plant and only then start applying the right mix of techniques for you."

That said, the next challenge is how to get going. If your choice involves vibration monitoring (true velocity, envelope signal processing, whatever), Setford suggests that, given the high likelihood that you will be working with machines already somewhat long in the tooth (meaning you don't have good benchmark data), there are two main methodologies.

"The first is, don't set any alarms until there is enough historical data. Just monitor each machine's trends and compare those with similar machines to give you an initial idea of alarm levels," he suggests. "The second is to use the ISO 2372:1974 standard [now 10816-3:2009 – both detailing four classes of machines, from small to large, soft foundation, and both indicating 'good', 'satisfactory', 'unsatisfactory' and 'unacceptable'

Choices, choices, choices

If there is complexity in condition monitoring, it is more about making the right technology selections than interpreting the results – the latter is a matter of training and/or software.

Eriks, for example, offers IFM vibration systems for general machinery, current signature analysis for electric motors (harnessing Artesis' equipment) and oil analysis for geared plant. "On the IFM system, we can take inverter inputs and set up thresholds to create band alarms. We can also ignore compressor readings during startup... It's massively flexible and we can provide a four-sensor solution, installed and commissioned, for about £4,000."

Meanwhile, Kittiwake specialises in oil monitoring, with what amounts to wet chemistry kit. Managing director Martin Lucas says that engineers can spend anything form £100 to £10,000 – the former for portable equipment, providing basic viscosity and insolubles measurements in diesel, and the latter for inline equipment, aimed at checking bulk fuel specification on large plant.

Equally, Kittiwake provides portable equipment costing around £6,000 for monitoring ferrous and non-ferrous wear debris in, for example, gearboxes. "You just plug it in, take the sample, start it up and get the result," says Lucas. "It requires practically no training."

His big news, though: full laboratory equivalent spectroscopy in the field, with an instrument due for launch this autumn. "We are redefining oil analysis in the field," boasts Lucas.

What about electrical motors? Suffice to say the big names are Artesis and Whitelegg, the latter represented in the UK by SKF's Baker Instrument Company. Baker's flagship offering is its EXP4000 dynamic motor monitor, which goes beyond standard insulation testing to include detection of power supply problems (such as imbalances and harmonic distortion), mismatched motors to load, overheating, cracked or broken rotor bars, plus a host of mechanical issues.

As Michael Herring, Baker's product manager, puts it: "By measuring the voltage and current of the motor's three phases, the EXP4000 provides estimated operating percentage efficiency."

vibration frequency ranges] to set initial levels. If, by this measure, some are already in alarm, then it's worth looking into them straight away, even if they appear acceptable for that machine."

In broad brush terms, those two approaches undoubtedly provide workable options for some other technologies, too – although there are limits, in terms of available standards, meaning experience has to become the primary guide. But here's another pointer: "There are two ways of coming at vibration – getting technicians to walk around with portable instruments or installing sensors online and running automatically," observes Setford.

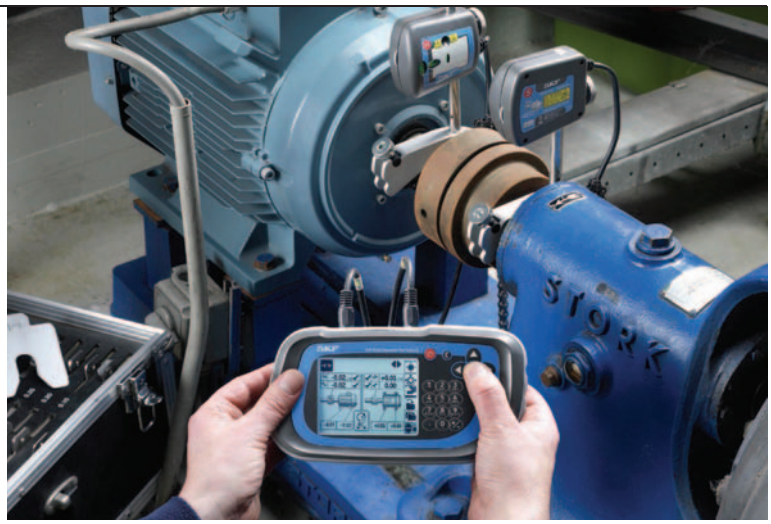
"Both can be done with simple equipment, giving overall values, or higher-end systems, providing vibration spectra that allow for deeper analysis. But, either way, you need to make sure that measurements are taken under similar machine speed and loading conditions."

Like with like

If you're using portable instruments, that's a matter of standard operating procedures. But, if you install online systems, be aware that, although you will get more measurements, you still need to group them according to each machine's running mode. "Most of the time, that's no problem," states Setford. "But if it's a paper machine, for example, different paper grades will run at different speeds, so you'll need speed signals from each section. Then you can control measurement bands to narrow speed ranges and detect genuine trends."

None of this is rocket science, but it matters today more than ever – for the simple reason that the world is increasingly signing up to variable speed drives as energy-saving devices on everything from fans, pumps, motors and conveyors to much more complex machinery. And that means your condition monitoring equipment is liable to be reading over a wide range of dynamically varying machine load conditions and speeds.

For David Manning-Ohren, condition monitoring manager with maintenance engineering firm Eriks, the solution is more comprehensive data collection – including, for example, pressures and machine speeds, to deliver consistent and comparable data that, in turn, leads to meaningful trends. Sounds like harder work? "That's why people are talking to us about installing online dynamic systems that do the diagnostics behind the scenes and just deliver condition monitoring results via a web portal. If they don't have the manpower or know-how, we can do that via the web, providing local alerts on a PLC or control panel," states Manning-Ohren.



SKF's TKSA 40 laser-based shaft alignment tool in action

His advice is to treat condition monitoring in much the same way as you would any other aspect of maintenance – with a good dose of common sense. "You need to follow the rules, and that means considering the possible failure modes on each machine and then not skimping on sensors," he explains.

"We come from a repair background, so we know what we should be monitoring. We also do condition monitoring ourselves and we see defects all the time. On a particular pump, for example, we will know that the most likely failure is the non-drive end bearing, so we'll put two sensors on that. It's easy for us to specify the correct sensors, locate them correctly and match failure modes to the signals we see."

For maintenance engineers, condition monitoring is like fruit ripe for the picking. PE

Hearing is believing

Twenty years ago, acoustic emissions sensing was a research technique that depended on expensive and sophisticated equipment. Now, it's a robust shopfloor tool for use by maintenance personnel. So says Trevor Holroyd, founder of Holroyd Instruments (now part of Kittiwake), who has been a driving force behind this development and laments its slow uptake.

"With this technique, you can get out there and quickly check machinery to find out if there is a problem, without going through the whole diagnostic process," states Holroyd. "Unlike vibration monitoring, it's quick and easy, and you don't need specialists. It puts the power of condition monitoring right into the hands of maintenance technicians, not external consultants."

And for those that still believe acoustic emission sensing scores only with slowly rotating equipment, Holroyd has an admission. His early campaign, he says, was all about differentiating the technique from vibration sensing. "With acoustic emissions, you can see problems with low speed rotating equipment that are difficult for vibration. But our technology has always been able to handle high speed perfectly well – and also manages right down to super slow.

"We can check the condition of plant rotating at just four minutes per revolution. At that kind of speed, the instrument just needs to know the approximate revs and it instantly starts seeing faults. It tells you the percentage of the rotational cycle in which damage has started and its spread… We also have smart sensors that can monitor short-duration, intermittently operating machinery. Even if the plant only runs for half a second at a time, the sensor adds together the bits of signal and processes them to give the same reliable readings."

Costs start at £2,500 and run up to £4,750 for the all-singing, all-dancing logging instrument. What's more, Holroyd (who is an engineer, not a salesman) claims that payback is usually in a matter of days, or at most weeks. "In fact, it's not uncommon for the instrument to pay for itself during a plant demonstration," he asserts.