Peak performance

Predictive maintenance and condition monitoring are often thought of as luxuries on plant. But the technologies – and the prices – have moved on, says Brian Tinham

Maintenance is about looking after plant, right? So how much we spend on it, depends on the value of that plant. That's how we make our decisions over what maintenance policy to apply – break/fix, preventive, predictive. Isn't it? And, if we go the whole hog and use predictive maintenance, the same applies for our choice of condition monitoring techniques. Low value plant, lower cost monitoring; high value plant, bigger ticket technology. Right?

Wrong: the word 'value' is what matters here, and not of any single piece of equipment, nor its components. Because the real deal is risk mitigation – it's about protecting our organisations' ability to function efficiently. So the question we should be asking ourselves is: 'how important is any piece of our plant in those terms?' And then, 'how much does it make sense to spend preventing failure?'

As Kate Hartigan, managing director of bearings and condition monitoring equipment manufacturer Schaeffler UK, puts it: "Although the cost of a machine component, such as a bearing or a motor, is very small, compared to the cost of the machine, the cost of downtime and any consequential losses can be significant. Ask your finance director what he or she would pay as an insurance premium."

Okay, so let's quickly romp through current arguments around the three main maintenance regimes. Anthony Mayall, who looks after process control systems for Siemens Automation and Drives, warns that break/fix – often thought of as the simplest type, because there's no inspection workload – is ultimately the most expensive. "This approach will only suffice as long as [your plant] is relatively cheap and quick to fix or replace, and you can afford unscheduled downtime," he observes.

As for preventive maintenance – where equipment is taken off-line at pre-defined intervals for inspection and overhaul – he says: "Although well intentioned, it can be very expensive. 60% of the time, equipment is replaced unnecessarily." We should add that the approach also risks the nightmare of engineers inadvertently causing problems as a result of their intervention.

Finally, for predictive maintenance, in which equipment is monitored to assess likelihood of failure, Mayall offers this: "Many think this is the most expensive option, but, in the long term, it is far more economical – despite the initial outlay – because labour, materials and production schedules are used much more effectively." Just as important, it means you can manage problems at the earliest opportunity, which – especially when lead times, even on some mid-size plant bearings, are now stretching to months and years – is good news.

Real cost savings

Mayall suggests cost factors of 1 for break/fix, 0.5 for preventive and 0.1 for predictive maintenance. "That means, if you consider an average maintenance spend of £1 million, by upgrading to predictive, you could save between £500,000 and £900,000," he says. Which sounds high, although not if you factor in the real cost of downtime.

There is, of course, a fourth way: you can hold stocks of spares – such as gearboxes, couplings, shafts and bearings – to minimise downtime when breakdowns do occur. But remember: stock can deteriorate or become obsolete; it also takes space, costs money and has to be managed.

Enough of that: let's look at techniques for condition monitoring and what's changed, because it's long since ceased to be just about vibration analysis. For years, there have also been oil analysis, endoscopes, ultrasonics and acoustic emissions monitoring – as well as

Pointers

- How much you spend on plant maintenance kit and support should depend on the cost of downtime and any consequential losses
- Hitherto specialist condition monitoring techniques – such as acoustic emissions monitoring, known to more mature engineers as stress wave analysis – are actually now very low cost
- Condition monitoring equipment, properly applied, is proven to positively impact product quality

Above and below: good vibration analysis can transform plant operations and maintenance

temperature and flow meters, and the wider range of process, electronic and electrical instrumentation.

Today's must-have is an infrared camera – and for way more than assessing thermal losses from buildings, or hot spots in electrical wiring and switchgear. A word of caution here: although these instruments are now sold at a fraction of earlier prices and marketed as simple, point-and-shoot devices, they're not quite child's play.

As Austin Dunne, of the Institute of Infrared Thermography, warns: "I can get an eight-year-old to take a picture, but it's the ability of the technician to evaluate it. That's a skilled job and even a five-day dedicated training course is just an introduction. Sales people gloss over this and, as a result, quite a few cameras end up locked in cupboards, because users lose confidence."

Nevertheless, in the right hands, infrared cameras are being used successfully for everything from checking temperature profiles on chemical reactors, distillation columns and heat transfer equipment, to investigating ovens, liners in pipework and even finding leaking gases, which absorb energy at signature wavelengths.

That said, the truth is there isn't a single technique that's ideal for monitoring everything, and you need to be aware of pitfalls and limitations. As Ian Taylor, business development engineer with CNES (Corus Northern Engineering Services) says: "For example, if plant is rotating at less than 80rpm, it's difficult to assess anything with vibration sensors." And the same goes for machines with variable running speed or load. "In any of those situations, we would recommend acoustic emission sensing. The technique has been developed to the point where you can now get everything from simple trends to fault tree analysis, no problem at all."

And he should know: CNES' service team has been using the technique for years. "One of our best successes was on 2m tall vessel tilt bearings, moving at 0.25 rpm on our BOS (basic oxygen steelmaking) plant in Scunthorpe. We found several defective bearings, despite varying loads, and were able to do damage limitation while waiting for parts. You don't want a vessel containing 400 tonnes of molten steel to get stuck."

He also cites triumphs on conveyor belts and epicyclic hoist gearboxes on 500 tonne overhead cranes. None of which is a surprise to Trevor Holroyd, managing director of Holroyd Instruments and formerly with Rolls Royce Aerospace, developing what was then called stress wave technology. "Since those days, we've made this technology very practical for shopfloor use by fitters and maintenance engineers," he says. "The sensors are easy to attach close to bearings, whatever the size and type, and we've taken all the complexities out of getting an instant indication of problems, irrespective of the machine."

Stress-free

What's more, Holroyd's portable instruments start at just £800 and range up to £4,250 for the professional data logger, including PC software. "We did research on tens of thousands of machines back in the '90s, looking at 'distress parameters', and our signal processing captures all that. When we demonstrate the kit on the shopfloor, engineers start using it straight away. We've also now launched an instrument integrated into a sensor that can be wired to a PLC or SCADA [supervisory control and data acquisition] system. That starts at £250 and we've also got a wireless version."

Meanwhile, CNES' Taylor confirms that, for the majority of rotating machinery, vibration monitoring (fixed or mobile) remains the technology of choice. "Every bearing has its own frequency signature, so with modern equipment you can very quickly detect problems such as inner race, outer race or cage faults, as well as out-of-balance machinery,

Getting back to mechanical basics

Today's maintenance engineer is a far cry from the latter-day image of a spanner-wielding repairman. Predictive maintenance approaches have made significant inroads into moving engineers' focus away from the repair shop and on to machine operations, detecting early onset of problems before they become crises. Maintenance now should be less about fire-fighting and more about diagnostics and counter-measures.

But behind every successful plant maintenance regime are some assumptions – mostly that plant has been installed and commissioned correctly. Sadly, that's not always the case, and bearing failures, for example, are often not the result of normal wear and tear. As Gerald Rolfe of SKF warns: "Far too often, [premature failures] can be directly attributed to a combination of poor installation and maintenance. Misaligned shafts are responsible for up to a half of all costs related to rotating machinery breakdowns." SKF also estimates that poorly specified and applied lubrication is responsible for around 36% of bearing failures.

"Getting these basics right from the start, in plant design and construction and in setting up maintenance procedures, leads to extended machinery operating life and improved plant reliability. And it's easy to do, using the appropriate tools," he says.

Easy, because, for instance, today's laser-based shaft alignment products (from the likes of SKF, Schaeffler etc) make the job simpler, faster and more accurate. Getting the basics right has never been simpler. It's worth the initial investment to keep the bigger investment on-track.

mechanical looseness and lubrication problems."

Gerald Rolfe, general manager of SKF Reliability Systems, probably the largest condition monitoring company on the planet, agrees and makes the point that recent years have witnessed significant improvements. "For example, our systems are now much more capable, even with non steady state speeds and loads. On wind turbines, for example, the system is designed to separate readings according to speed and power, and it also rejects data if there are changes as it's read," he explains. "This is an emerging area that could be used in other applications, such as on critical light duty machines. And the rail industry is also interested for monitoring drive trains, axles and bearings."

Rolfe also refers to developments in computer software that enable, for example, vibration frequencies on centrifugal pumps to be automatically compared against known failure modes. "It means you don't need diagnostic skills on-site. Also, once the system has identified a fault and the action required, it can send that information to your CMMS [computerised maintenance management system]."

SKF is far from alone here. Look at companies such as Monitran and Schaeffler. Incidentally, FIS (FAG Industrial Services) service engineer Ian Pledger makes the point that, if cost is an issue, it's worth looking around. "For example, one of our data collectors only costs about £3,000, and that's because we've built it with minimum data handling. The clever stuff is done offline on your PC."

The last word goes to Taylor. "A lot of engineers still think of condition monitoring as a luxury, but for us it's a major maintenance tool. You don't have to stick your head in the sand. You can start seeing faults before they become problems, even on a limited budget. A hand-held vibration data collector needn't cost much. You can do it yourself or use a company like ours at £400—500 per day. And the same goes for thermal imaging." PE

Corus is using everything from vibration to acoustic emissions and thermography at Scunthorpe