Cost versus risk

In all honesty, do you believe you're doing the best for your plant? Brian Tinham looks at little known decision support tools that can make your maintenance truly fit for purpose

Here's a thing. Suppose you've got condition monitoring in place on plant: if you find some equipment trending towards failure, what should you do? Or suppose you haven't gone the condition monitoring route, so you're running planned maintenance: how do you know you've got it right? For that matter, suppose plant is getting close to its recommended overhaul, but operations wants to keep going to the next major shutdown, what advice can you give?

Each is an entirely different scenario and, of course, if you have condition monitoring, at the very least you have the advantage of early warning. However, in all of these situations, as a plant engineer, you need more information.

In the first example, your actions will almost certainly depend on the bigger picture – usually requiring investigation around, for example, operational safety and the financial ramifications of an early shutdown. In the second, you're relying on history and practice, but technology of pumps, lubricants – you name it – isn't static, so the answer is, you don't know. In the third, with or without condition monitoring, there remain some unknowns – mostly concerning failure modes and their implications for the plant – so again, it's difficult.

At the moment, you have to rely on engineering judgement around risk factors, fault trees, costs and best practice – all of which is invariably dependent on industry lore and experience. And the problem with that is it's different from individual to individual.

It's at times like these when plant engineers would do well to consider some little-known decision support tools – software that can help you objectively quantify costs, risks and the rest, and provide solid foundations for your advice.

Sceptical? Can't imagine when you might need the technology? Think your plant maintenance regime can't be bettered? In 2006, Tubelines – which provides maintenance services for trains and infrastructure on the Jubilee, Northern and Piccadilly Underground lines – won the Asset Management category in the IET Innovation and Engineering Awards for a project that transformed its escalator renewals. It did so by using exactly these tools.

In the oil and gas sector, SASOL in South Africa massively improved its maintenance management procedures, again founding its approaches on the outputs of cost/risk optimisation tools. Shell in South America, SAMIR in Morocco and, closer to home, National Grid plus some of the UK's utilities, North Sea oil exploration companies, as well as the MoD – all have profited from stepping back and letting these tools help them to ask, 'what if?'.

What's behind the tools is an EU R&D project from the late '90s called MACRO, which developed a methodology for range-estimating costs and understanding equipment degradation against alternative maintenance, design and operations scenarios. Now available as APT cost/risk tools from consultancy TWPL (Woodhouse Partnership), they provide impact analyses for any options you throw at them, also identifying the engineering assumptions that matter and those that don't.

In Tubelines' case, the issue was its fleet of 224 escalators and two passenger conveyors, which together transport 1.5 million passengers 11,000km every 20 operational hours. Using the APT tools, the organisation's asset planning team developed what it calls residual life models for every escalator and each major component. To do so, maintenance and project engineers plugged operational data into the tools, using maintenance inspections, condition surveys, information from corrective tasks and fault data, as directed by the system.

Slashed maintenance

The model proved that a phased component intervention strategy won hands down over the 'big bang' style, half-life refurbishment approach, traditionally used for maintenance on the Tube. It also identified the factors that had greatest impact – enabling the project team to focus there.

As a result, Tubelines developed new ways of working and provided the right tools at the right time – leading to escalator refurbishment times descending from 26 weeks to just nine. Other benefits reported by the engineering team included: a 43% reduction in the number of faults in the three years to January 2006 (forecast to rise to 77% by 2017); maintenance and capital costs down 18%; and another 18% improvement in escalator MTBF.

Jack Huggett, principal consultant with TWPL, gives another example – this concerning an unnamed oil platform in 2004. "The platform had a major shutdown scheduled to coincide with the 40,000 hour service life of its gas turbine, so management wanted to know if it was feasible to postpone the turbine's 30,000 running hours planned maintenance until then."

Pointers

- Engineering judgement is a wonderful thing, but often we all need more information
- Proven software tools are out there to quantify cost versus risk and make your advice more robust
- Tubelines used MACRO to cut escalator refurbishment times from 26 weeks to nine
- Oil and gas companies have used the tool to challenge gas turbine maintenance periods
- Given a legacy of ageing plant and de-manning on plant, these tools can serve engineers and operators alike

Tubelines developed different ways of working that led to refurbishment times for its escalators descending from 26 weeks to just nine – and with an 18% MTBF improvement

What would you say? A bit of background: evidently, there was no condition monitoring programme in place – a fact that Huggett concedes is surprising – meaning that all the engineers had to work on was the turbine OEM's advice, which was to do the service or risk serious turbine damage.

"In this case, engineering teams from the platform operator and the OEM used the APT tools to estimate the probability and severity of a range of outcomes – resulting in figures for potential downtime and repair costs per 1,000 hours run beyond the 30,000 hour point," says Huggett. That done, they postulated using off-line condition monitoring – with vibration analysis at three-monthly intervals and boroscope inspections of the turbine blades at six monthly intervals – and found that this would reduce the risk of major failure by 25%.

Moving up to online condition monitoring was next considered, and the cost/risk tools showed a further 25% reduction in risk of catastrophic failure, if automatic protective trip-outs were also built in. Additionally, from an optimised cost point of view, the analysis suggested keeping a spare rotor for the turbine, so that, in the event of the most likely failure, unplanned downtime would be reduced – indicating a payback time of under two years.

How difficult are these tools to use? Peter Jay, also a principal consultant with TWPL, says they're easy. "They're designed for use by practical people, so they ask simple questions like 'when do you think earliest onset of failure is likely?' and 'how many are likely to have failed after so many years?'

"So, with pumps, for example, the tools might then tell you whether your estimates need to be more precise to get the balance of cost and risk right. At the other extreme, they can work out the optimum maintenance regime for heating and ventilating plant in your factory. They're fairly intuitive, work well with RCM [reliability centred maintenance] and are consistent with the requirements of PAS 55 [BSI's standard for managing physical assets and infrastructure]."

Jay believes these tools are more relevant today than ever. Previously an engineering manager responsible for maintenance policy at National Grid, he recalls their use in the '90s to help steer efficiency improvements, post privatisation.

"At the time, we wanted to know how we could get smarter, using the maintenance data we already had," he explains. "But we were also aware that corporate memories can be very short, so if things are working well, there's a temptation to cut the maintenance overhead, which damages all the good stuff. So, for us, using the tools was about helping the business to make better decisions, based on a sound understanding of maintenance regimes and asset performance – and using that to ensure that the right balance is struck between cost and risk."

Bringing that up to today, he says, given that so much of our industrial asset base is ageing, plant engineers need exactly this kind of pragmatic decision-making assistance. "The strength of the MACRO tools is that they can be used to provide an objective basis for what engineers do all the time – make engineering judgments – but better, using a computer to do the maths, instead of gut feel." PE