United front

Why is the potential of TPM so consistently underrated in lean programmes? Annie Gregory talks to a manufacturer who has adapted TPM to be lean's natural ally

Oki's TPM success is driven by (left to right) Kenny Millar, Thomas Brown and Stuart Grady

TPM suffers from an identity crisis. Is it total productive maintenance or total predictive maintenance, or even – as belated recognition that its impact goes way beyond the engineering department – total productive manufacturing? Too many words for something straightforward: a way to stop wasting your time fixing machines when you could be making good products. TPM – however you choose to spell it out – is absolutely fundamental to the operations of any company claiming lean working or pursuing world-class manufacturing.

Within lean, the most obvious implementation of TPM principles is autonomous maintenance, where operators take responsibility for basic first-line maintenance. Without good planned preventative maintenance (PM) from the engineers, it won't work. Yet, according to Dennis McCarthy of DAK Consulting, many lean implementations often ignore the role of the maintenance department completely. In his book *Lean TPM – a blueprint for change*, co-written with Nick Rich, he examines the results of three similarly sized food manufacturers. Across these three plants, the overall gains from lean are significant – some £3.6m. But £1.5m of that is actually attributable to maintenance activities through improved asset care. And even that ignores the net effect of the maintenance department's engineering and process improvement skills in reducing defects and levels of intervention. That stacks up to a hefty £917,000 coming directly from process optimisation and more than doubles the contribution made by maintenance to total lean gains.

> "To get TPM across the factory, you have to benchmark improvements as you go along – it makes people want to join in"
>
> *Thomas Brown, Oki Printing Solutions*

It gets worse. Maintenance leaders from 50 major manufacturers were surveyed to find out what impact they could have on the seven lean wastes. The average score was 51 out of a possible 63 (showing significant impact across all areas). Yet not one of their companies had initiated a programme that directly engaged the maintenance function in supporting lean manufacturing processes. I wonder if the engineers bothered to hide their resentment?

McCarthy blames the pioneers of lean who formulated their approach by observing Japanese lean methods. The Japanese already knew and valued the importance of equipment reliability. "For those observing a reliable flow process, however, it was a bit like looking at a building and not realising how deep its foundations are," he exclaims.

Iain McLean

"They could see operators doing maintenance. What they couldn't see was that it was only one element of what's needed."

Let's look at how one plant has adapted TPM to support its own production process. The consumables plant of Oki Printing Solutions, based in Cumbernauld, North Lanarkshire, started its TPM project in 2009. Oki's maintenance supervisor, Thomas Brown, was adamant he wanted to make the whole thing modular, using the minimum amount of people to make small-scale achievements and then mapping those across to other machines and lines. It's easy for TPM to take over everything but, without any obvious, short-term gains, the whole thing often falters. He, however, planned to complete the initial programme in only nine months.

His aim was an effective, production-driven maintenance plan that would – alongside the normal benefits – also begin to develop operators' skills in asset care. His long-term goal is TPM across the factory. "To do that, you've got to benchmark improvements as you go along. It's important; it makes people want to join in." Brown had experienced the formal, top-down approach to TPM when he worked for NEC and believes that it hasn't really advanced since the 70s. He was keen to incorporate elements of lean and Six Sigma to combine the best of all three disciplines.

Craig Douglas, general manager operations, became a firm and enthusiastic backer virtually as soon as Brown presented the case, partly because the project clearly offered tangible gains for limited investment. "It was 2009. We were heading into the recession and no one in manufacturing knew how they would come out the other end. So projects like this had their merit," Brown recalls. The balance of his team was equally important: senior technician Kenny Millar had over 10 years' experience of TPM and Stuart Grady, equipment engineer, had led equipment improvement for 15 years. They had the skills to drive short-term improvements in existing machines into longer-term gains through modifying and redesigning processes.

Brown boiled down the seven principles of classic TPM into a simple five-step plan: examine the initial condition of equipment and maintenance procedures; restore equipment to base condition; improve; simplify activities; and, finally, sustain. They started on the toner filling line which had the worst downtime record, defining a method for operators to record stops and failures. This was an interim move until a parallel project to implement FrontLine, a computerised maintenance management system (CMMS) from Shire Systems, was completed. "We knew this wasn't really accurate enough for an OEE study since there could be small errors of human perception. So we did it as a downtime report, averaging it over the period of the study. It came out to four hours and 55 minutes per week of downtime before the introduction of TPM."

What followed was hard work without the option of delegation. The three men cleaned every bit of equipment themselves. It took them seven hours over a weekend and – with typical thoroughness – Brown records that they used 47 fibre cloths, the existing extraction system and three cans of descaling agent. He didn't measure it to prove a point to the operators: "I wanted to factor in the consumable usage to keep a machine clean. It's an expense that people forget about." When the operators came in on Monday morning, they looked for the magic wand.

Regular monitoring gave them the basis for an autonomous maintenance schedule. The results weren't exactly comforting. Because of the high level of contamination by toner powder, the schedule demanded roughly five hours a week offline – an actual increase over current downtime. "We couldn't lose that amount of production time so we decided to share the work in the first instance," explains Brown. Operators spent 35 minutes on things like nozzle cleaning while the technicians handled the bulk of the work offline.

Even at this stage there were clear benefits. Downtime was reduced to 78 minutes a week, including operators' cleaning time. Obviously, technicians were taking up some of the load but it let them inspect key parts for early signs of failure, using the results to modify and refine the existing PM schedule. The schedule was

stable within only a month. With less unplanned stoppages, overtime was almost completely eliminated and the whole appearance of the place was better, both for visitors and those working there.

"The hard part in your first project is justifying to production why you want to close the machine down. We are fortunate here that they trusted us to deliver something beneficial," recalls Brown.

"And it's a lot easier to get buy-in on a small-scale project like this. It helped that we got a lot of things right first time which made it more appealing to management and allowed us to continue with other machines and areas of the business. And now we've seem such dramatic improvements that other areas are asking for it."

Focus on detail

With stability achieved, the team turned their attention to continuous improvement. They looked at the standard lean technique of single minute exchange of dies (SMED) but decided it was better attacked separately: "It took us down a road that wouldn't be very visible to management or operators and it would increase the project time while possibly losing focus." Instead, they conducted a failure modes and effects analysis (FMEA) on the problem areas previously highlighted.

The fundamental cause of many of them was quite simply powder being deposited where it shouldn't. When pucks stopped hard, powder flew out, so Grady found a mechanism for softening stops to dampen impact. They introduced localised extraction at key points on the line: at the filling nozzles and the welding stage. It cost remarkably little – they spliced into an existing system.

Pucks would collide when there was a slight build up on the line, creating a powder cloud. So Grady designed puck-to-puck dampeners. The remarkable thing is that they did it all themselves for a tiny cost. Yet the soft-stops alone took 22.5 hours per month out of the maintenance load. And, as a welcome by-product, dampening collisions cut noise levels so effectively that operators could now work without ear defenders.

FMEA threw up one major issue: filling accuracy. Each toner and cartridge type is filled to a given tolerance. The existing procedure did not account for variances in plastics and cavity types. It meant that under-filled cartridges were regularly scrapped later in the process. Using Cpk, a process capability index, the old nozzles were found to be incapable of matching Oki tolerances repeatably. So Grady designed a new nozzle and sourced a firm to make them.

Oki used TPM to get to a stable position where it could start using more sophisticated techniques derived from Six Sigma. It let the business clear away the simple but costly causes of production loss so it could concentrate on the underlying issues. And the net beneficiary was the bottom line.

By this time, the team had designed out large chunks of the maintenance load. The basic cleaning schedule had gone from 25 hours a month to 2.5 almost immediately and much of it could be transferred to the operators for autonomous maintenance. Brown says they were fortunate: as with so many Japanese manufacturers, continuous improvement was already embedded in the ethos of the company and the transfer was simple. In a parallel project, they taught operators to start up the line. Rather than one technician handling it all, five operators now perform start-up checks.

By now, the CMMS was up and running. "FrontLine let us understand the nature of downtime because now we could categorise it – it wasn't just 'machine down' any more – and feed it back into both the maintenance schedules and FMEA work. We got real control thanks to the other engineer's project." The initial work on line one hadn't captured downtime as accurately. So from September 2009, they used CMMS on line four, a mirror-image of line one, without making any of the improvements. Brown says they didn't want to lose the opportunity to understand the underlying causes of the difference between the two lines' output. It was undoubtedly tough on line four, but the decision was justified. For example, it showed up an issue with the conveyor – not part of the original TPM project – that caused a major breakdown. Although it made the disparity between the two lines' performances even worse, it identified that the root cause was once again powder contamination – clear justification for the preventative work done on line one.

The success of Oki's adaptation of TPM is unarguable. Between October and November 2009, line four's downtime was 255 minutes more than line one and maintenance on line four took 6.03 hours longer for the same scheduled tasks. To date, the project has reduced downtime by 41.58 hours per month, saved 22.5 hours in autonomous maintenance time and three hours in maintenance time. Add in the £23,000-plus saved annually by redesigning the nozzle and cutting rework, and it adds up to more than £35,000 per line.

Tougher work may come. "True TPM says we must get to where we no longer need extraction," says Brown. "If powder is being sucked out, that costs us. There is no end point to these projects. You can get a quick gain over 12 months and set yourself up really well, but then you have to do the difficult bits. Moving from 1 and 2 Sigma is relatively easy and cheap, but moving from 5 to 6 takes a lot of investment and you have to quantify what it's worth."

Thus speaks the perfectionist. Nonetheless, consider this: Oki saw a return on investment for the capital costs of the project in only three months while productivity gains are ongoing. It's the type of help that every company hopes for in the long haul out of recession. ■