TPM

A foundation of operational excellence

Case Studies

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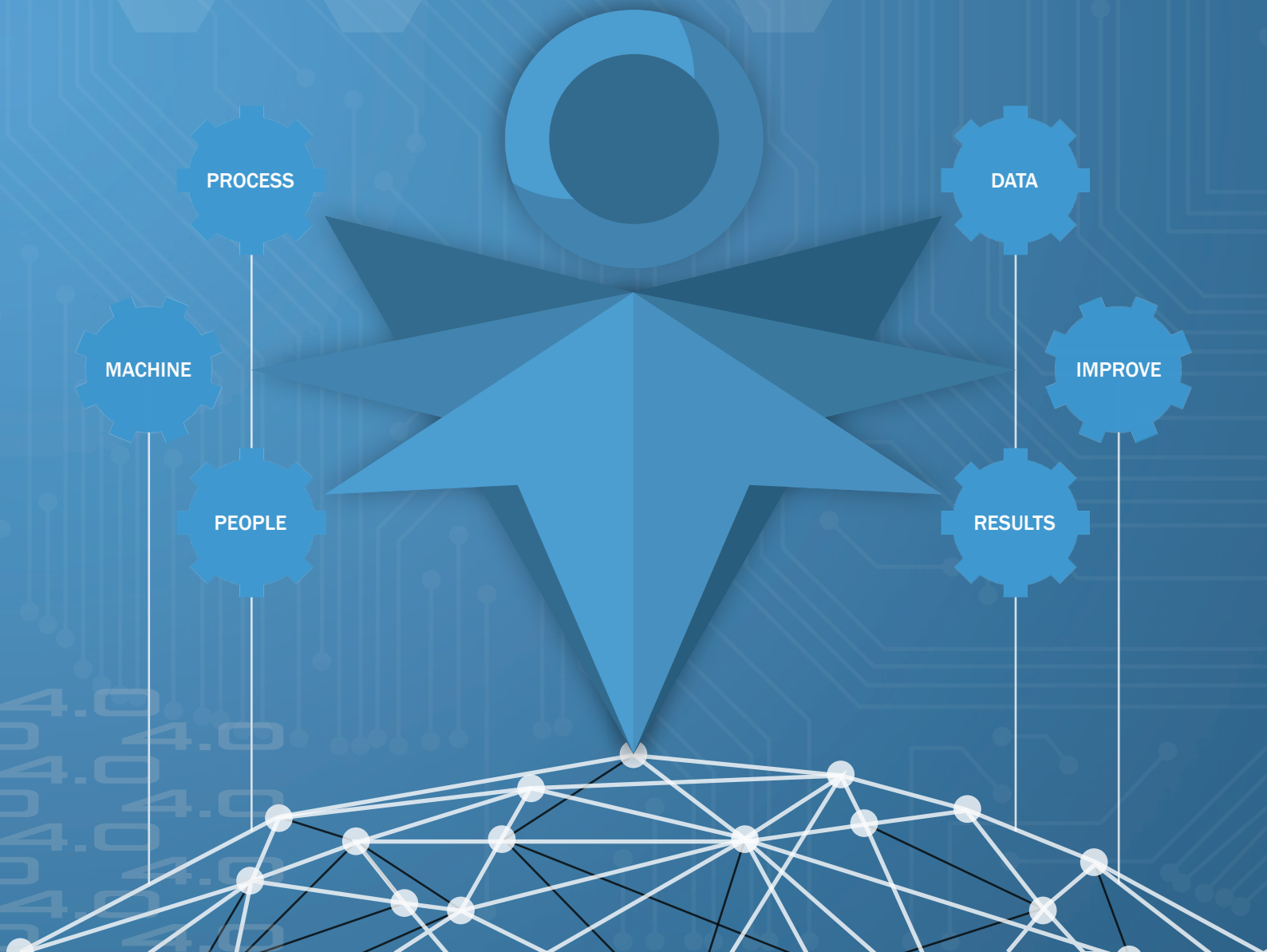


10.2 **Mylan Damastown (formerly known as Rottapharm Dublin)**

By Richard Hayes, Operational Excellence Director

Company background

The facility was established in 1999 and currently employs approximately 200 people. It became part of the Mylan group of companies, which has a workforce of 35,000 people worldwide, in August 2016. The Damastown site produces finished oral solid dosage pharmaceuticals in tablet, capsule and sachet formats. Liquid drop manufacturing and packing operations also commenced in early 2016, adding new technology and complexity to the site. The site took responsibility for new products involving the production of liquid drops, even though other sites within the group had the technology and capability to produce the new products. This was in recognition of the track record of cost competitiveness, ability to deliver projects and quality products on time and was also based on an outstanding record of operational excellence over the previous ten years.

Drivers behind Damastown's operational excellence aspirations

Figure 10.1: Pat Gerrahy, Managing Director of Rottapharm, receives the Shingo Silver Medallion at the Shingo Conference April 2017

The Dublin facility has an established history of running lean operations and using tools such as Six Sigma since 2006 and Total Productive Maintenance (TPM) since 2010. A positive culture and many desired behaviours developed from the use of these tools, but the emphasis was initially on the tools and the results they provided, rather than on the culture that was being created using these tools and systems of work. In a search for a benchmark as to how the company was performing, Damastown identified the Shingo Model™ to help shape how lean tools and thinking were deployed and to develop the culture within the organisation.

In 2013 the company introduced a strategy of cultural change within the Dublin plant aimed at providing excellent sustainable results through a principle-based model. This case study provides some examples of how the site has achieved excellence through behaviours based on the guiding principles of the Shingo Model, especially over recent times. As a result, the company received the Shingo Silver Medallion for operational excellence at the Shingo International Conference in Atlanta Georgia in April 2017.

The strategy and associated activities pursued by the Damastown site over recent years and particularly over the last two to three years have been aimed at securing the long-term future for the plant. The objectives of the company are to provide the best products for customers (patients) and develop employees for the future by working in a sustainable manner for the benefit of the environment. The Shingo Model™ with its guiding principles has been used to develop the culture within the plant that allows people to thrive in their normal job and push the boundaries, enabling people to realise their full potential.

The role of TPM as an enabling tool to deliver efficiency and results

Over the past number of years, the site has focused on efficiency throughout the plant production and support functions. The introduction of Total Productive Maintenance (TPM) and development of a continuous improvement (CI) system with a focus on removal of waste have resulted in substantial improvement in terms of business results.

Against the backdrop of the business need to absorb products and equipment from Europe by unlocking their existing capacity and retaining the same overhead and employment base, Damastown is very proud of its success in using TPM as its main foundation 'enabling tool'. In 2010 the company initiated a TPM programme, which

they called Total Productive Manufacturing to emphasise the implied and necessary teamwork between **production** and **maintenance**. Following an initial and thorough planning and scoping phase, the TPM journey comprised a chronological focus and sequence as highlighted here:

- Initial diagnostic/scoping study to establish the business case
- Site leadership team 'buy-in' to the TPM process to help deliver the business imperatives
- Initial four-day TPM practitioner's 'hands-on' training workshops – Go see & do, 'learning by doing'
- TPM pilot projects, roll-out planning and programme governance
- Progressive middle and senior management TPM 'pillar champion' coaching and mentoring
- Focused improvement activities such as VS mapping, 5S workplace organisation, area clearances/precision changeovers (SMED)
- Early equipment management/TPM for design
- Total Productive Administration in the manufacturing support functions
- Regular evidence-based top-down and bottom-up TPM audit and review processes
- An annual 50-point maintenance strategy review
- Integrating safety, environment and energy conservation opportunities into the day-to-day good manufacturing practice (GMP) tasks.

This step-by-step sequence and focus has helped the site to not only avoid some of the common pitfalls, but to continually remind and suggest how the business could best improve its competitiveness. This approach also ensured that other improvement activities, such as safety, environment and energy conservation opportunities, were integrated into the day-to-day GMP tasks within the plant. The business has also made significant savings by applying total productive administration (TPA) in the support departments.

A key part of the initial diagnostic/scoping study phase was to describe the manufacturing and packaging logic, sequence and interdependencies of the facility (Figure 10.2).

In parallel with, and based on the early successes of the initial TPM pilot projects, the site then set about defining the TPM roll-out plans for the ensuing four years (Figure 10.3).

A great deal of effort was also put into defining the TPM programme infrastructure and governance processes (Figure 10.4) linked to regular evidence-based top-down and bottom-up TPM audit and review processes.

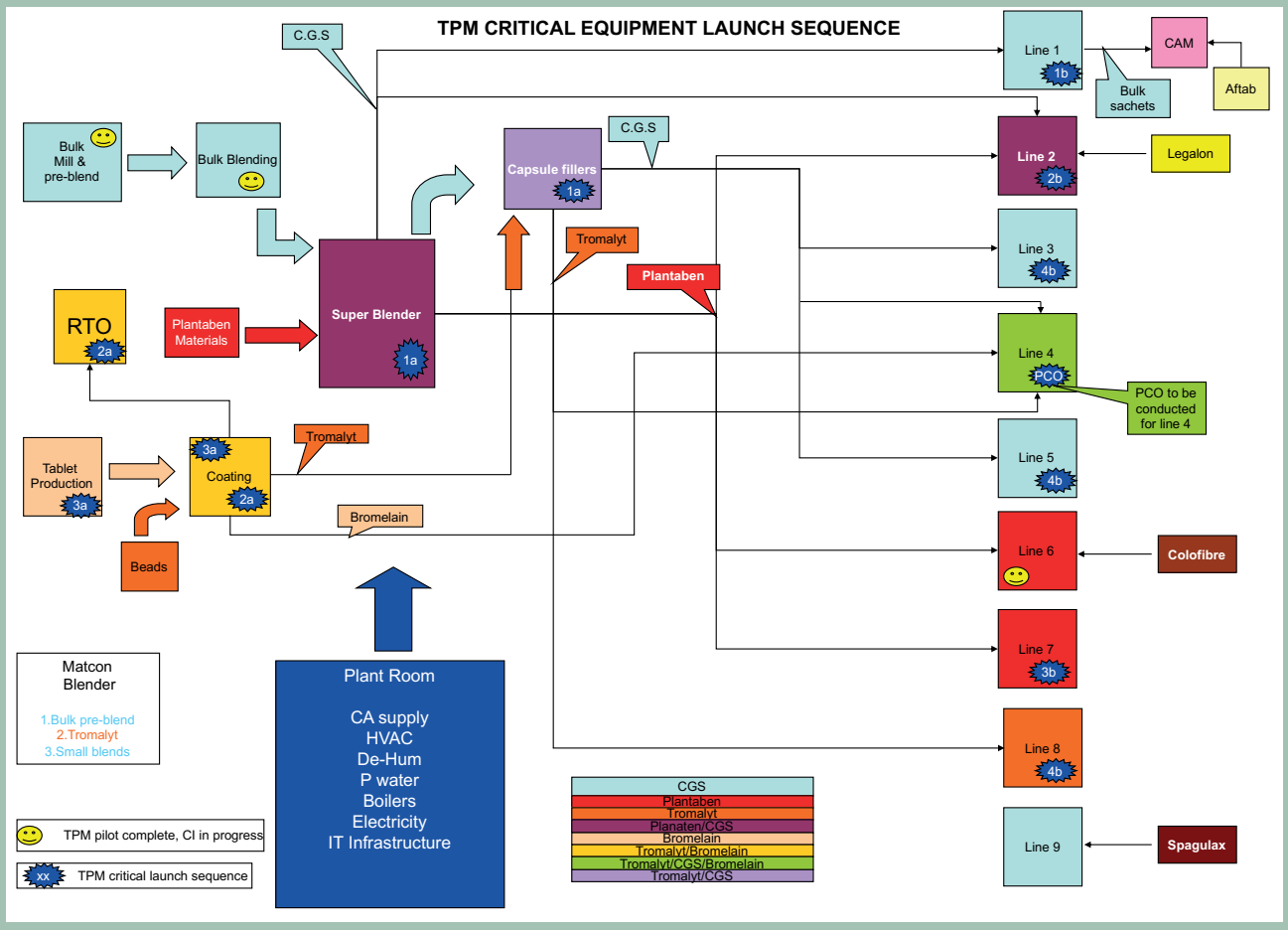


Figure 10.2: Site manufacturing and packaging process flows

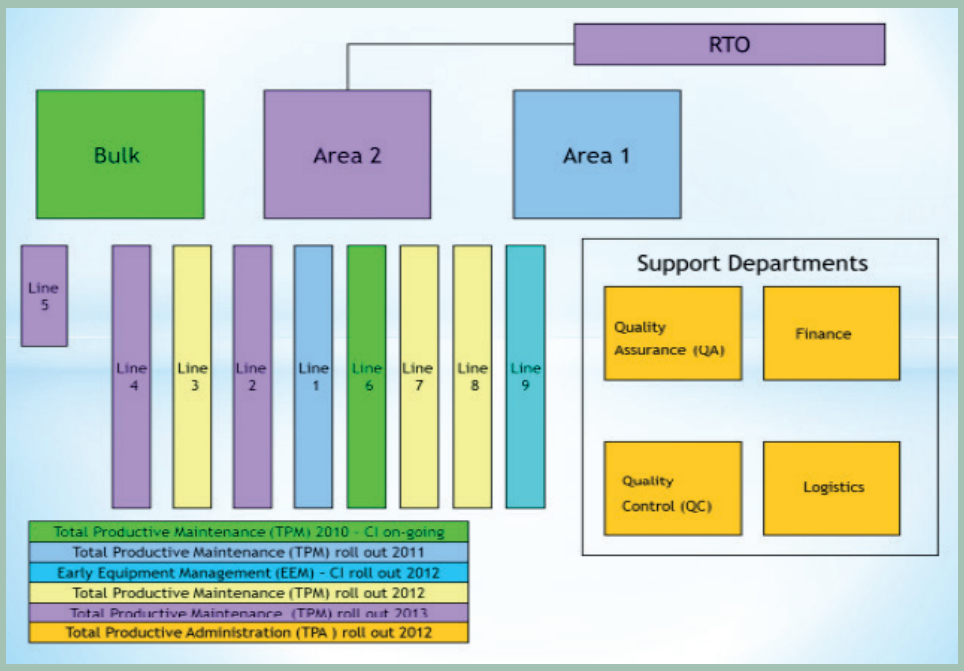


Figure 10.3: Four-year TPM roll-out plan sequence

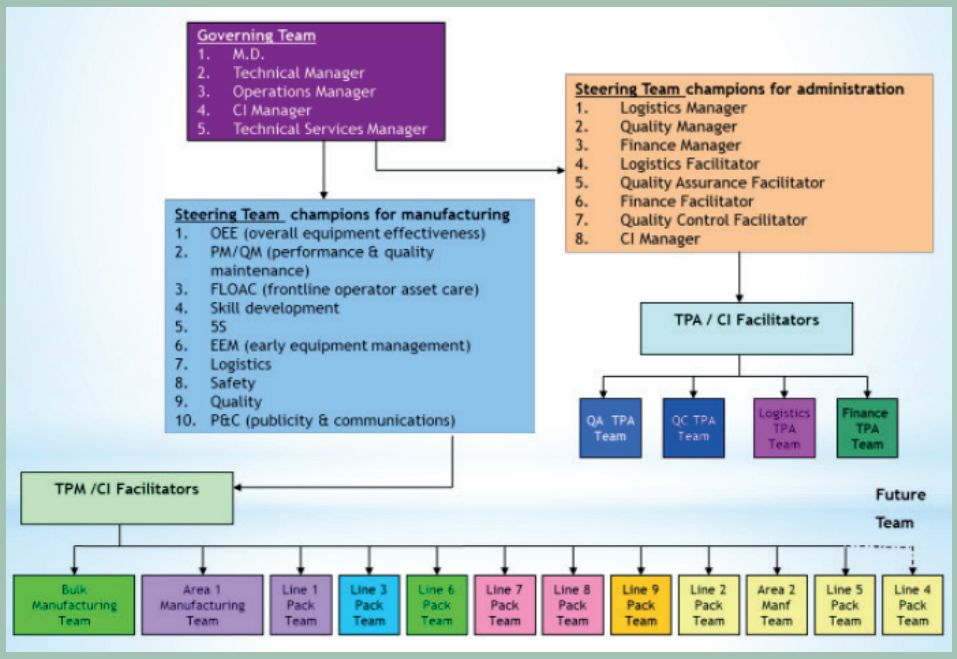


Figure 10.4: Site TPM governance and infrastructure

As an illustration of the level of improvements made possible using the TPM system, Figure 10.5 shows the results for one of the packaging lines over a nine-month period to Milestone 2 audit criteria achievement.

12 Months Average 2010		Improvement	4 wks Average by 30 Sept 2011
OEE	20.7%	x 2.5 increase	49.5%
Eq Failures	25.7%	Down by x 6	4.0%
Idle Time	38.0%	Halved	21.5%
No Data	2.1%	Eliminated	0%
Line Restraint	5.9%	Eliminated	0%
Minor Stops	7.8%	Down by 65%	2.7%
Actual v. Target (Prod Plan)	73.0%	100% OTIF	100 %

Figure 10.5: Initial TPM pilot project packing line 6 results to Milestone 2 achievement

As illustrated in Figure 10.5, TPM is designed to enhance OEE by increasing equipment availability, decreasing rework and rejects, and hence increasing productivity. It involves the integration of engineering maintenance, project engineers, production process operations personnel and the wider workforce, thereby encouraging teamwork and asset care practices. By using the 11-step model shown in Figure 10.6 TPM seeks to involve workers at all levels and departments. The resultant improvements are felt in time, money and other resources in dealing with reliability, availability, maintainability and performance issues. In many process-based industries, maintenance costs, together with energy costs, can represent the largest part of operational budgets.

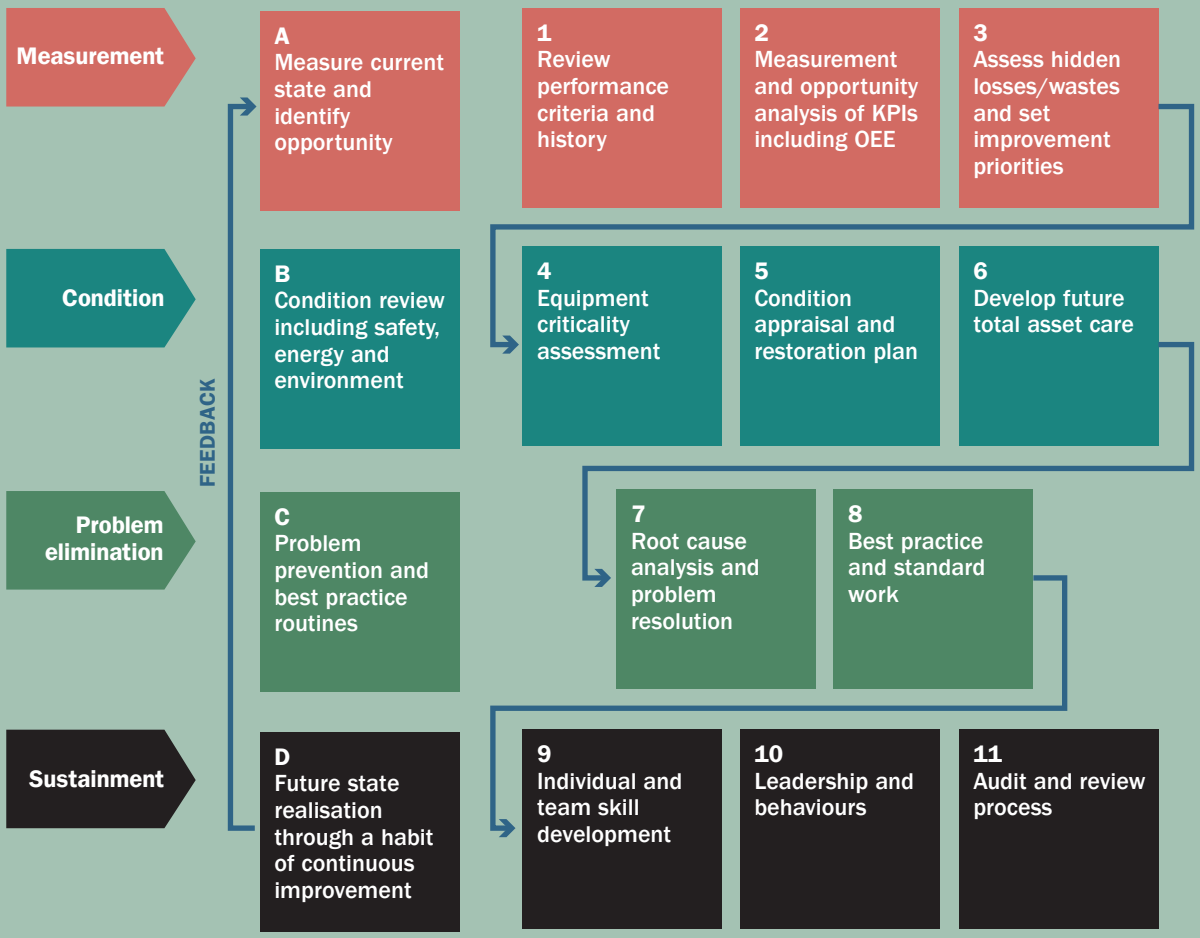


Figure 10.6: The TPM four-cycle process

Operational performance is measured using metrics commonly employed across a variety of industries. The McKinsey study of 2011 published a comparison between the pharmaceutical industry and other industries. While the report indicates that the pharmaceutical industry lags behind other industries, Damastown stands out as best in class within pharma. Through a sustained focus on OEE, the company has created value for the customer by generating year-on-year improvements and continues to show world-class levels of OEE (typically between 10% and 60% for the pharmaceutical sector, according to McKinsey). As Figure 10.7 illustrates, the OEE for Damastown, at 63% for 2016, continues in a steady upward trend as a result of the culture of operational excellence within all the teams in the company.

Batch completion time is a measure of the length of time taken to approve each batch record once a batch has been completed in production.

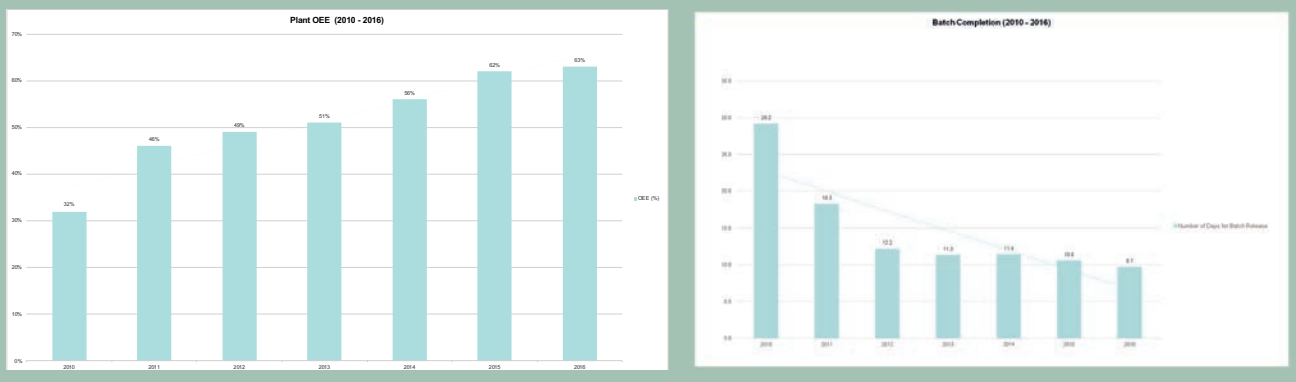


Figure 10.7: Rising OEE and falling batch completion times, 2010–2016

Figure 10.7 shows a decreasing trend in batch completion times from 2010. Over recent times this trend has continued downwards, with the current average number of days standing at 8.5 days.

Damastown has embraced scientific thinking and deployed many tools to conduct investigations into problems and eliminate recurring deviations. Solutions ranging from quick fixes on equipment to full-scale six sigma projects have been used to resolve difficult process issues. The trend on this metric has continued to decrease, with the current number of deviations reduced by 20% on the 2016 figure. The on-time delivery metric has improved over the past number of years (Figure 10.8). In June 2016 the metric was changed to Release On Time In Full delivery (OTIF). During 2017 this metric, which is harder to achieve than the previous one, had an average figure of 99% with eight of those months hitting 100%.

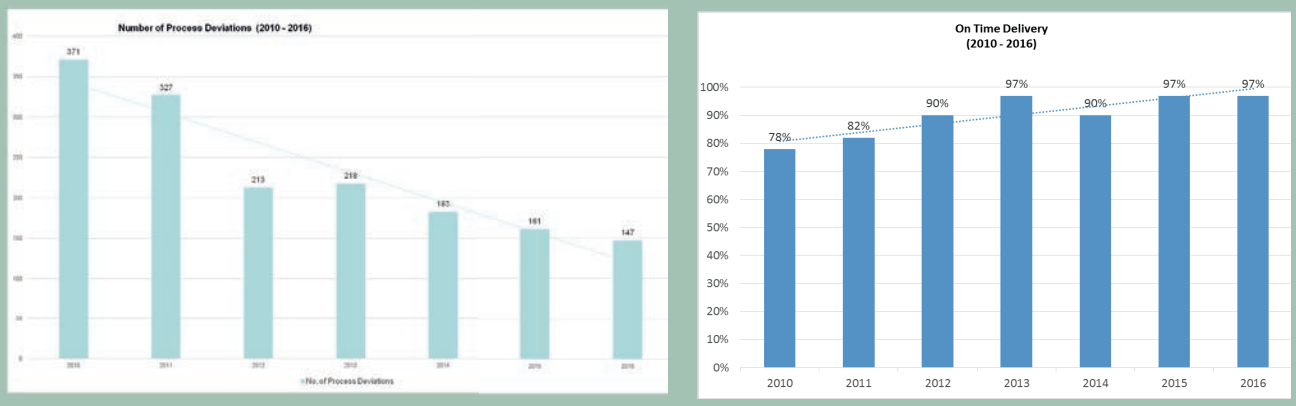


Figure 10.8: Reduction of process deviations an improvement in on-time delivery

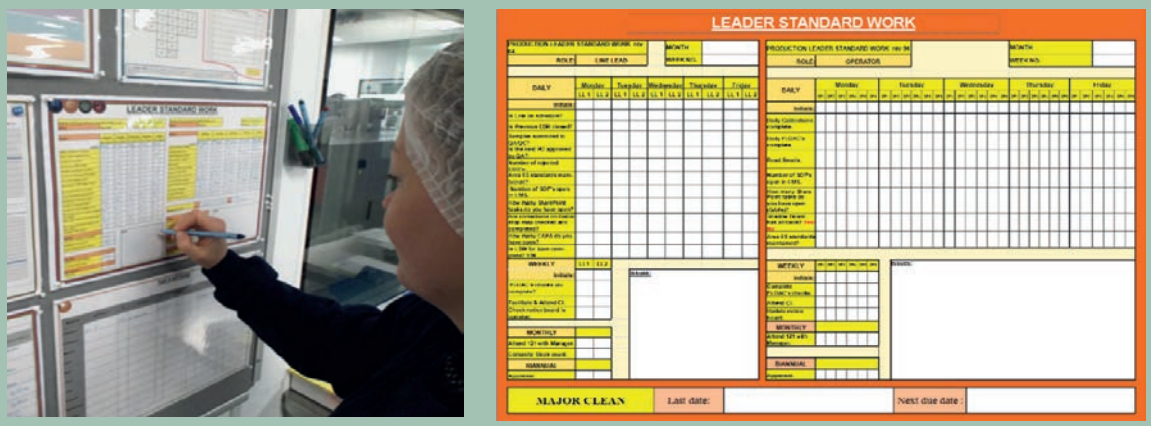


Figure 10.9: Leader Standard Work (LSW) task sheet for the packaging line lead operator

Operational efficiency using LSW

The parallel improvement of the use of leader standard work (LSW) and visual management has resulted in everyone within the plant having a clear understanding of what the daily expectations are in terms of process adherence and process performance (see Figures 10.9 and 10.10). The focus on process performance and adherence has led to plant-wide improvements in performance. People are more focused on getting things done on time and in recognising when process trends require action. Every team has a visual management board with laminated sheets that are updated daily. A number of meetings take place at these boards. The first meeting is held when work starts at 07:00 in the production areas and at 08:00 in the support areas. These are known as the pulse meetings and are carried out with the team and immediate supervisor or middle manager. At 09:00 the middle managers from operations, engineering, quality assurance and control, the

warehouse and logistics meet at the plant operations board and review any issues that have been raised and that required escalation by the various teams. A member of the senior leadership team (SLT) also attends this meeting on a weekly rotational basis. Appropriate actions are discussed and decided at the meeting. If an issue cannot be resolved and requires support from the SLT, it will be escalated to the senior team meeting at 10:00 with appropriate actions decided and communicated back to the middle management team.

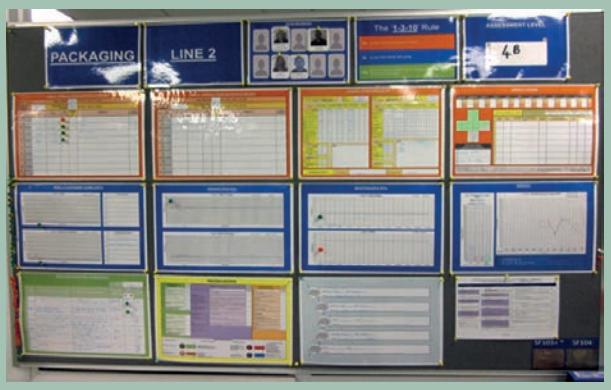


Figure 10.10: Standard visual management board to sustain focus and operational efficiency

The visual management boards have a standard layout that follows a 1-3-10-second rule. In 1 second you can tell if a team is winning or losing (orange laminate in the photo example); hourly outputs are recorded and marked with a red or green indicator to show whether or not they are on target for that hour. In 3 seconds you can tell how the KPI charts are trending (blue laminate). In 10 seconds you can tell what the team is doing about those areas where they are losing or trending below their target (green laminate). The board also includes pictures of the team members, LSW, a safety cross for each day of the month with a tracker for appropriate safety actions and a thank-you sheet to enable people to thank whom they wish for help during their work activities. The SLT meet with a production and a support team once a week and review the team's visual management board. Performance metrics and areas where the teams need support are discussed. Each team meets with the SLT at least once a quarter. Both the SLT and middle managers also meet with the people in the company during gemba walks. The SLT and middle managers split into small teams and go out and ask people how they are getting on, from both a work and general perspective, to engage with the people in the organisation. These gemba walks have proven successful in allowing opportunities for improvement to be identified and in some cases explaining why certain policies or procedures are in place. This has helped to create an open and honest culture with people who are also engaged and focused on operational efficiency.

Innovation: 3D hand scanner and printer for local spares provisioning

The emergence of Industry 4.0, combined with improvement in operational efficiency using TPM, precision changeovers and lean tools has accelerated the introduction of technology and removal of the use of paper records from the plant, which in turn has resulted in the creation of additional time for improvement activity. See Figure 10.11.

An example of this is the time provided to technicians to work on innovative and value-adding activity. Technicians and engineers have been trained on advanced design software packages such as Solid Works and applications to aid design, such as failure analysis software. The investment in both equipment and training in Solid Works and a 3D printer and scanner has empowered technicians and engineers to use the new technologies in their normal day-to-day activities.

It has resulted in users developing their ideas, designing prototypes and printing out their models for testing. If the prototypes are not suitable for the designed

application, the designer can modify the design and print another test piece. This brings cost savings by not having to manufacture actual parts that may not be suitable for their intended use, before producing the actual finished working piece. Technicians have also saved on the costs of purchasing spare parts from vendors by producing spare-part designs and having them manufactured by local tooling companies, with typical savings of between 70% and 90%.

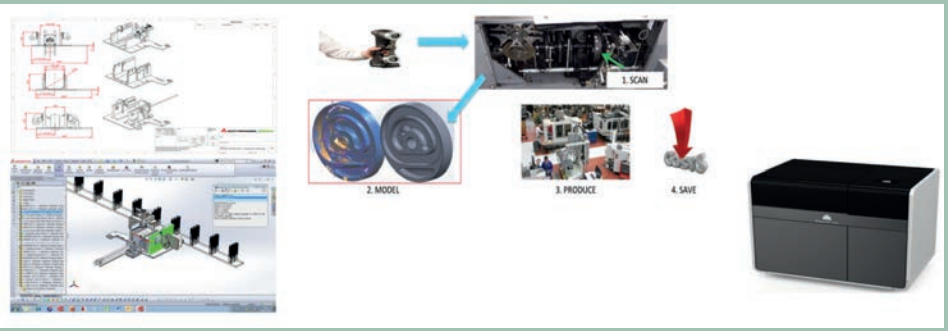


Figure 10.11: Capturing parts shapes from CAD systems or physical scanning, then outputting a replacement part on a local 3D printer

During 2016 technicians scanned and generated over 300 parts for inclusion in a virtual store. These designs can be then sent to the local supplier when needed and made available for use within 24 hours, substantially reducing typical lead times from the equipment vendors of up to three to four weeks. The aim for the engineering department is to reduce spares inventory by up to 50% over the next two to three years.

The development of the technicians in the use of these innovative tools is also particularly evident in their ability to scan worn parts in place and produce a drawing for a replacement part based on the scan, and in the use of CAD and Solid Works to reverse engineer and reproduce the required part. The associated costs for the scanner, Solid Works software and 3D printers (the original has now been replaced by a more advanced model) and training for the technicians has paid itself back multiple times over.

Raising quality standards

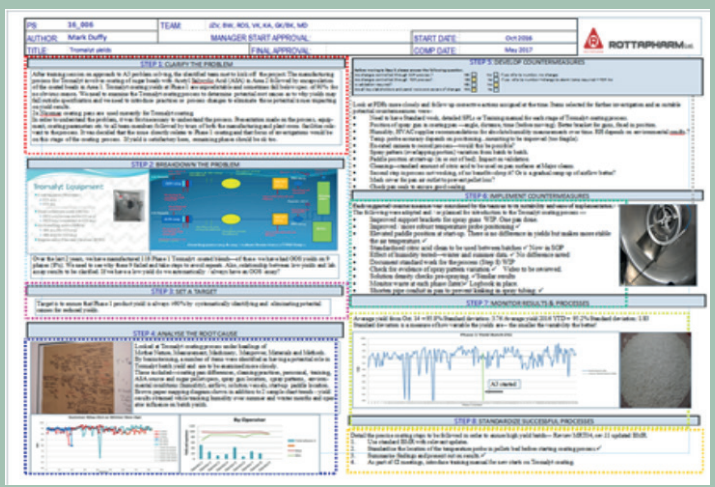


Figure 10.12: 8-step A3 methods used to solve problems

A focus on standardisation and training according to best practice for how tasks are completed has helped increase the quality of products and the operation of processes within the Damastown facility. These steps are well aligned with the Shingo principle of seeking perfection and supporting concepts of standardising processes, keeping it simple and visual, identifying and eliminating waste, and

integrating improvement with work. For example, production and maintenance personnel have developed single point lessons (SPLs) that cover routine equipment operation and operator and technician maintenance tasks. The team members capture and agree the best practices and then illustrate those practices in a simple and visual way – see Figure 10.12. SPLs can be accessed from any PC in the company via the internal SharePoint site. SharePoint is also used for managing the versioning system to ensure that only up-to-date SPLs are available. In addition to the use of SPLs, training videos are also used to demonstrate the operation of computerised systems and safety systems for trainees. By allowing the users to create the standards and continually improve those standards, the level of product quality and the processes creating those products have improved. The focus on problem solving and removing root cause issues has also helped improve quality throughout the company. Problem-solving projects and continuous improvement activities have been completed in all areas of the organisation. The use of 8-Step A3 methodology and problem-solving boards, designed by the technicians and production operatives, are located throughout all the production areas and have helped reduce deviations by 20% over the last 12 months.

Summary

This case study contains a sample of activities deployed at the Mylan Damastown plant in the area of operational excellence, using TPM principles as our start point and the foundation to drive our wider but focused improvement endeavours. Key performance indicators covering cost, quality, service, safety and the environment are all extremely positive. In the period 2010 to 2017

- the number of accidents decreased by 63%
- on-time delivery increased by 24%
- the incidence of complaints decreased by 68%
- energy consumption per pack decreased by 36%
- the time for batch release post production decreased by 64%.

The site now has an international reputation for world-class operational excellence practices and regularly hosts best practice visits for companies from within Ireland and abroad. Mylan Damastown are also recognised within the Mylan group as a best practice site and this has been reinforced through the recent awarding of additional products, which will support the 2014–2024 vision of tripling production output. The future and outlook are bright for the Damastown site as a result of building a high-performance culture that provides excellent sustainable business results.

10.3 **Application of TPM at Welsh Water**

By Jackie Gray, Lean Deployment Specialist and Dan Edwards, Lean Deployment Specialist, Welsh Water

Background

In November 2015, as part of the lean programme within Dŵr Cymru Welsh Water (DCWW), two Waste Water sites were identified as pilot areas for the wider deployment of Lean using the principles of TPM. One is called Cog Moors waste water treatment works (WWTW) and the other Five Fords (WWTW). The Cog Moors site was identified because it was the most expensive site for reactive costs in the whole DCWW area. Cog Moors WWTW serves Cardiff, Barry and the other local coastal region, and has approximately 206,000 customers, a treatment flow of 2,145 litres per second and a storm flow of 4,340 litres per second.

Five Fords located in North Wales was selected as the second site for deployment because of its large size and because it is the only gas-to-grid plant in DCWW.

Both sites have significant high value capital intense physical assets with a wide age range and condition profile.

The Lean deployment programme also included other business functions such as capital delivery, water services, finance and procurement

Our Lean deployment programme was very much bespoke to fit in with the utilities industry and adapted in order that the nomenclature was not interpreted as 'this is only applicable to what factories do'.

Figure 10.13 illustrates our lean model and Figure 10.14 shows how we articulate it.

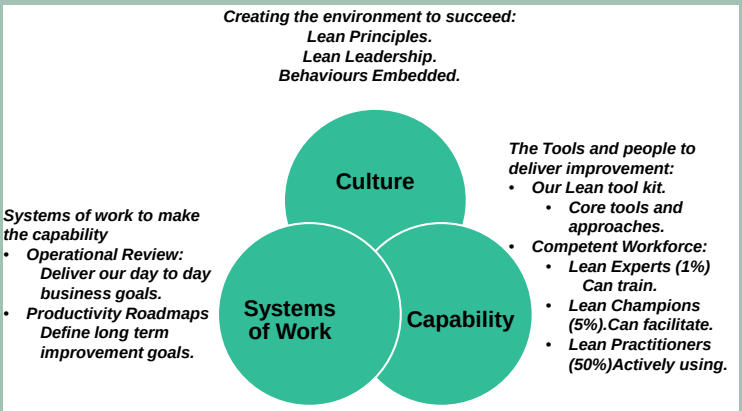


Figure 10.13: The lean model

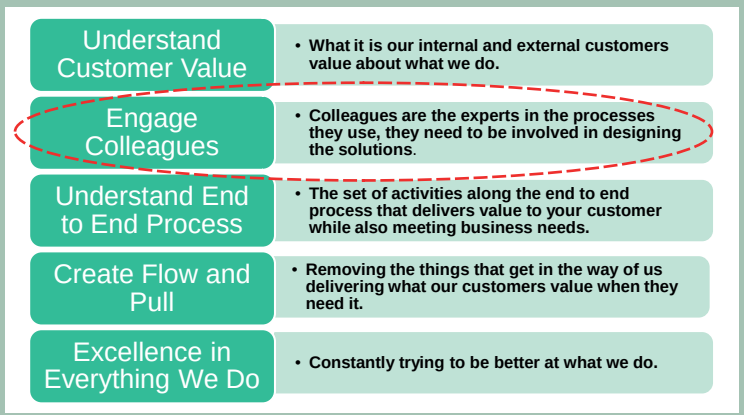


Figure 10.14: The five lean principles adapted to our needs

The third part of our improvement strategy focuses on people development intentions in order to engage colleagues (Figure 10.15).

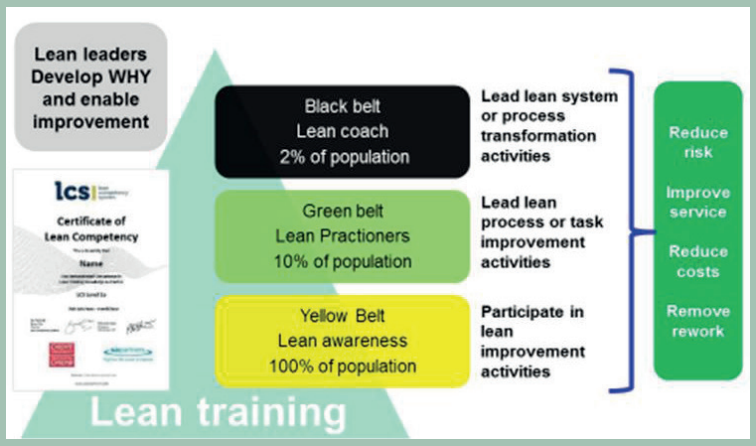


Figure 10.15: Skills development and recognition)

Although in the utilities sector, a 'product' is actually being processed and there are distinct value streams. It was critical to create an ownership culture in the business – 'this is what we do'. Subtle changes in terminology, for example a different take on the five lean principles (as in Figure 10.14) could be the difference between the programme becoming accepted as part of the culture of the company or – using the analogy of organ transplant surgery – being rejected due to incompatibility that could have been avoided by more detailed planning, analysis, tailoring and testing.

Engaging colleagues is not strictly part of the original lean principles (as expressed by Womack & Jones in *Lean Thinking*) but is something we have included because it is hugely important in getting the right culture change and engagement from the team. That recognition of team members can then be expressed as 'You are the experts who know this process inside out and this is your site'. In this way the ownership of actions, improvements and successes is never in doubt. From the outset, respect for site staff at all levels was essential for a positive deployment and sustainable outcome.

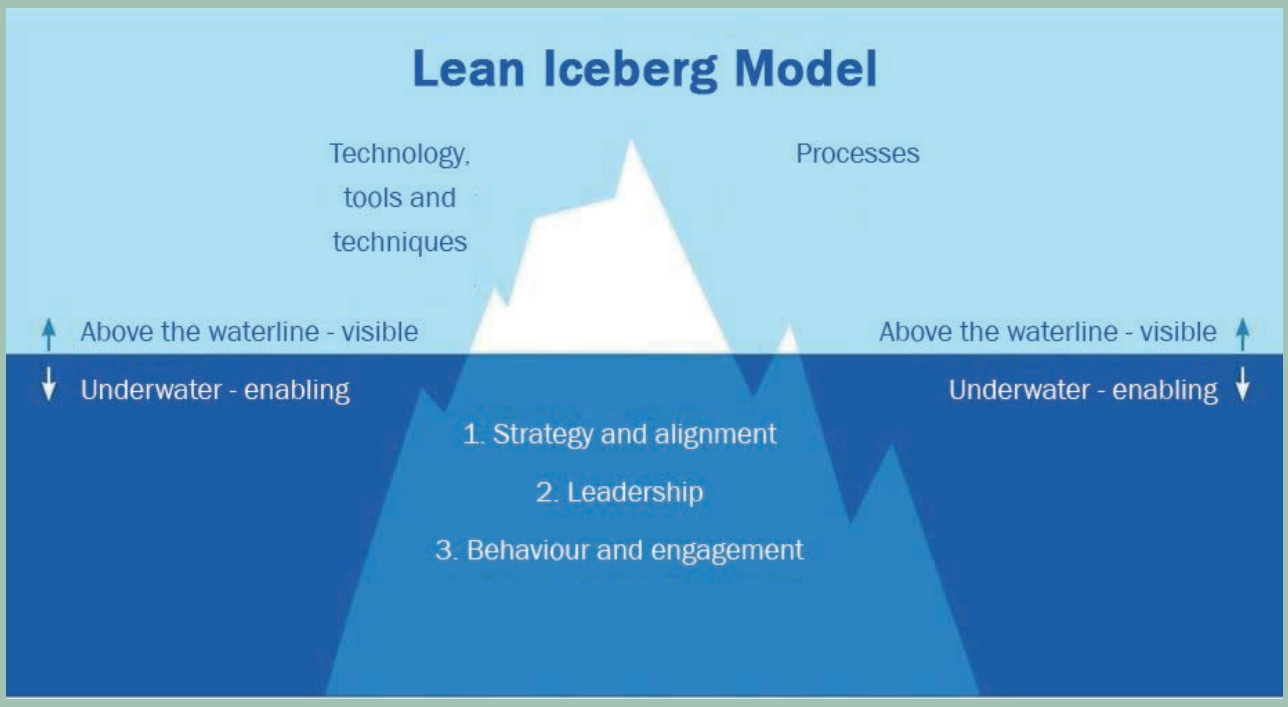
An example of the importance of engagement and ownership from previous lean deployments was that when lean **reliability-centred maintenance** (RCM) had been implemented, it had a detrimental effect on the senior operators' views on lean. This was because that person spent a large amount of time on it, including assisting with constructing standard operating procedures, but saw little or no direct benefit from it.

The RCM programme had a poor reputation and at one site, the remark that 'Lean just came in and threw out all our good stuff' was made by some members of the team. RCM can be a very effective tool. However, deploying tools without proper strategy and alignment and without ensuring the leadership behaviours and engagement is in place from the beginning resulted in the initiative failing to stick in some key areas of the business.

The plan was that once stakeholder engagement had been secured, then value stream mapping (VSM) would be carried out at both sites, to identify issues, bottlenecks and opportunities for improvement in the sludge treatment value streams. It was decided that TPM would be the most appropriate tool and philosophy to address issues relating to improving asset effectiveness.

Following a period of deliberation, it was decided that the approach in both these WWT plants would be called **asset optimisation** (AO) as opposed to TPM, as the lean leadership group correctly felt that classic TPM did not fit in the utility environment. This caution was also based on the fact that the business had been running an RCM

programme that had yielded a mixture of results in terms of tangible benefits, but had not delivered in terms of the 'ownership' culture change that the lean programme aspired to achieve. RCM is a tool above the waterline (Figure 10.16) and on its own, it will not be possible to sustain benefits without a clearly defined strategy and embracing the right management behaviours and leadership below the waterline, no matter how well the tool is deployed.



Source: P. Hines, P. Found, G. Griffiths & R. Harrison, *Staying Lean*, 2008

Figure 10.16: The lean iceberg model)

The idea behind asset optimisation was to 'build on' what RCM had delivered and certainly not 'replace' the RCM programme. As it transpired, over time the asset optimisation approach was adopted across all waste water and clean water product value streams and effectively became the primary tool used in the business to improve total asset effectiveness. A plan was put in place to align the deployment strategy and build capability while also improving site performance, and then based on this positive experience, to roll out the asset optimisation tool on both sites.

Overall approach: scoping and securing commitment

In both the Cog Moors and the Five Fords waste water work streams a value stream map (VSM) exercise was undertaken by cross functional team members working in both of the WWT plants.

Before this diagnostic process could take place, it was imperative to get stakeholder buy-in so that the process and the people involved would get full support and to ensure countermeasures were put in place to secure success. Meetings took place with the geographic area manager and the head of waste water treatment services to discuss the scope, key activities, targeted benefits, critical success factors and resources. It was agreed that the initial work would be to undertake some lean awareness training sessions on both sites for all staff before undertaking a VSM process at each site to identify specific opportunities and issues, that the right resources would be available and that any potential barriers were identified.

Establishing a good relationship with the managers and site supervisors with open and honest conversations was essential to ensure that they would support the necessary culture change. Central to this was coaching and frequent and appropriate feedback to encourage all levels of site staff throughout the VSM and asset

optimisation process. Taking the time to share the benefits of their experience and technical knowledge and allowing staff the freedom to try new approaches to running the process equipment proved to be extremely beneficial.

The VSM process followed the typical procedure as outlined in Figures 10.17 and 10.18.

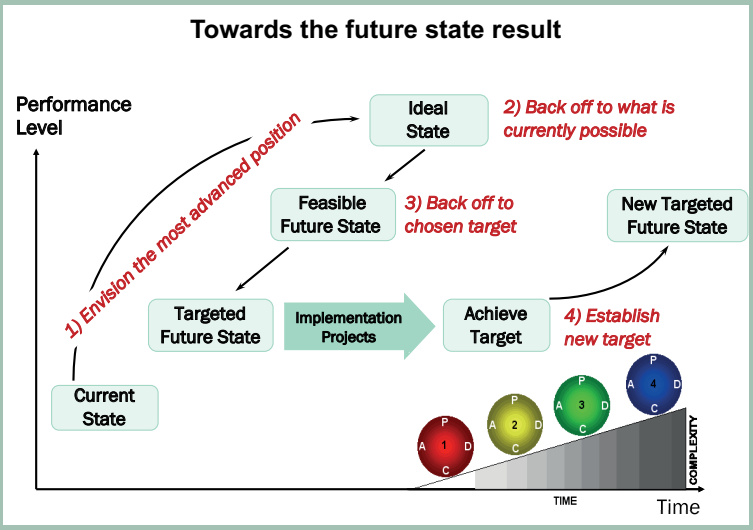


Figure 10.17: Value stream mapping

Figure 10.18: Putting value stream mapping into practice

Putting VSM into practice

Charters were put in place for asset optimisation of the gravity belt thickeners (GBTs), centrifuge, digester and the aeration lanes. An example of a charter is shown below in Figure 10.19. The projects were structured so that the supervisor would lead on the GBT with the support of the operator and then they in turn would also lead on the Centrifuge AO with another operator for support. This would develop the competency of two key staff on site as a useful operational tool. The AO projects were also deemed suitable for submission as Green belt case studies for accreditation and recognition (see Figure 10.15).

Other improvements identified were discussed and entered onto the forward-looking maintenance plan (FLCM). In addition, some straightforward issues were taken through a four-step problem-solving process to establish actions for implementation by the on-site team.

In terms of facilitation the plan was to deploy AO on the GBT with the lean coach and the mentor (a supporting SA Partners consultant). The next AO project on the centrifuge would be facilitated by the lean coach with the supervisor supporting. The plan was then for the supervisor to facilitate the roll out of AO for the digesters with the support of the lean coach. This fully aligned with the company's objective to build specialist capability within the lean team and to ensure competency on site. The first

wave of AO on the GBT would consist of a team from the Cog Moors site including the supervisor, senior operators, senior craft, operators and an electrician.

Project Scope Out
Owner: Site supervisor
What is the title of your project?
Gravity Belt Thickner Optimisation
What is in scope and what is outside of scope?
In the scope are the 3 GBTs, poly usage and primary tank de-sludge optimisation. Outside the scope will be everything downstream, (digesters feed etc)
How will you measure success (Cost, Risk, Speed, Skills, Ways of Working etc)?
Reduction in Poly and breakdown costs, less manual interventions, reduction in cost/ton of sludge, better flow and consistency of thickening/dewatering improved, reduction in Belt
Who will be the project sponsor?
Catchment(Area manager)
Who will need to be involved in the project (Responsible, Accountable, Consulted, Informed)?
Operators,Maintenance,Site supervisor,instrumentation,technical services, OEM vendors,Poly supplier technical expert ,Director of waste services, Lean specialist, Consultant
What activity, risk, issue or opportunity is it trying to resolve or improve (Object & Defect)?
To produce a more consistent flow from the SDMs and across the belts with improved dewatering. Increasing the final product (%ds) to an optimum rate of 6-7.5%. Reduce the operating costs of the equipment and optimise poly usage. Improve automation and increase H&S by reducing manual interventions. Improve OEE.
Describe the current state situation - what are the customers seeing?
Inconsistent sludge to belt, with potential to back up in PSTs where thick sludge will cause scraper failure and potential tankering costs.
No structure of pre-planned maintenance on common faults regarding blockages instead it's on a as and when basis
Thick sludge feed onto the belt results in the belt running out of design spec and hinders the transfer pump getting the sludge away.
Uncontrolled poly usage often results in belt blinding hindering dewatering and increasing cost per ton.
Intermittent failure due to rag/fat build up in transfer pumps and rising mains causing discharge failures
Wash water pumps blocking due to FE quality
Transfer pumps not being controlled by VSD
Frequently wouldn't run overnight without intervention (potentially taking advantage of cheaper overnight tariffs).
Poly mixing poor on shear valves
Not confident to operate 2 belts on Primary manually, (never been done before)
Timeline
March - October 2016
Coach
Lean specialist,Consultant
Communication to stakeholders?
Regular updates to Catchment Manager and Head of Waste. Regular contribution to 5 box updates to support steering group meetings
Regular feedback to wider site team via team meetings

Figure 10.19: Asset optimisation statement of intent for Gravity Belt Thickener Optimisation

The aim of the AO was to improve sludge quality (within a consistent range of 6.5% to 7.0%) and improve reliability of the equipment which would ensure a smooth delivery to the next customer in the process; the digester. This would lead to a positive reduction impact on both the site's reactive costs as sludge 'cost per tonne' and 'cost to serve'.

The project charter (Figure 10.19) details what the objectives are, what the current state is, what success will look like, who the team and the key stakeholders are, and how we will keep the key stakeholders informed of progress or issues along the journey. It also details what parts of the site and equipment are in scope and out of scope.

A perception survey was carried out in both the WWT plants involving one to one confidential discussion with operators, maintainers (mechanical, electrical and instrumentation) and their key contacts such as supervisors and managers.

As highlighted by two examples of the perception statements in Table 10.1, while the key contacts often had differing views compared with maintainers and operators, there was one factor regarding spares provisioning where most respondents agreed that we have a major issue and hence opportunity for improvement.

This major repeating concern was that spares are not held on site for critical equipment, especially when you consider that a WWT plant is more like a power station than a waste treatment works. It generates the company substantial amounts of revenue through its renewable energy sources, such as CHP (combined heat and power) generation and bio-methane injection. Having assets unavailable, waiting for spares that cost as much as £500, could in addition be costing more than £7,000 per week in lost revenue.

Likewise there was a strong sense of feeling that our skill sets are not acquired in a structured way. Again an issue that is addressed as a key component of the AO system of work.

Table 10.1 Perceptions Analysis-two highlighted main hinders to progress

Statement	Maintainers	Operators	Key contacts	Weighted total
Our spares stock holding is not as good as it should be	100%	93%	67%	93%
Skills are picked up rather than learnt systematically	83%	73%	33%	67%

Asset optimisation (AO) initial training and pilot project launch

Referring to Figures 10.20 and Table 10.2, the purpose of the four-day AO workshop was to familiarise the AO team with the first eight equipment-based steps of the 11-step four-cycle process in order that they had the appropriate knowledge to continue working on these steps over the next three to six months to work towards Milestone 1 (see Figure 10.27). Typically the workshop would be run in a four-day consecutive block with a team of between ten and twenty attendees taken off-line. From the operational shift logistics perspective of a waste treatment works this was not a practical option. So it was decided with the team's agreement and support to run the workshop in two blocks of two consecutive day sessions. However it's interesting to note that even with this forward planning, the second two-day block had to be re-scheduled due to unplanned breakdowns on site!

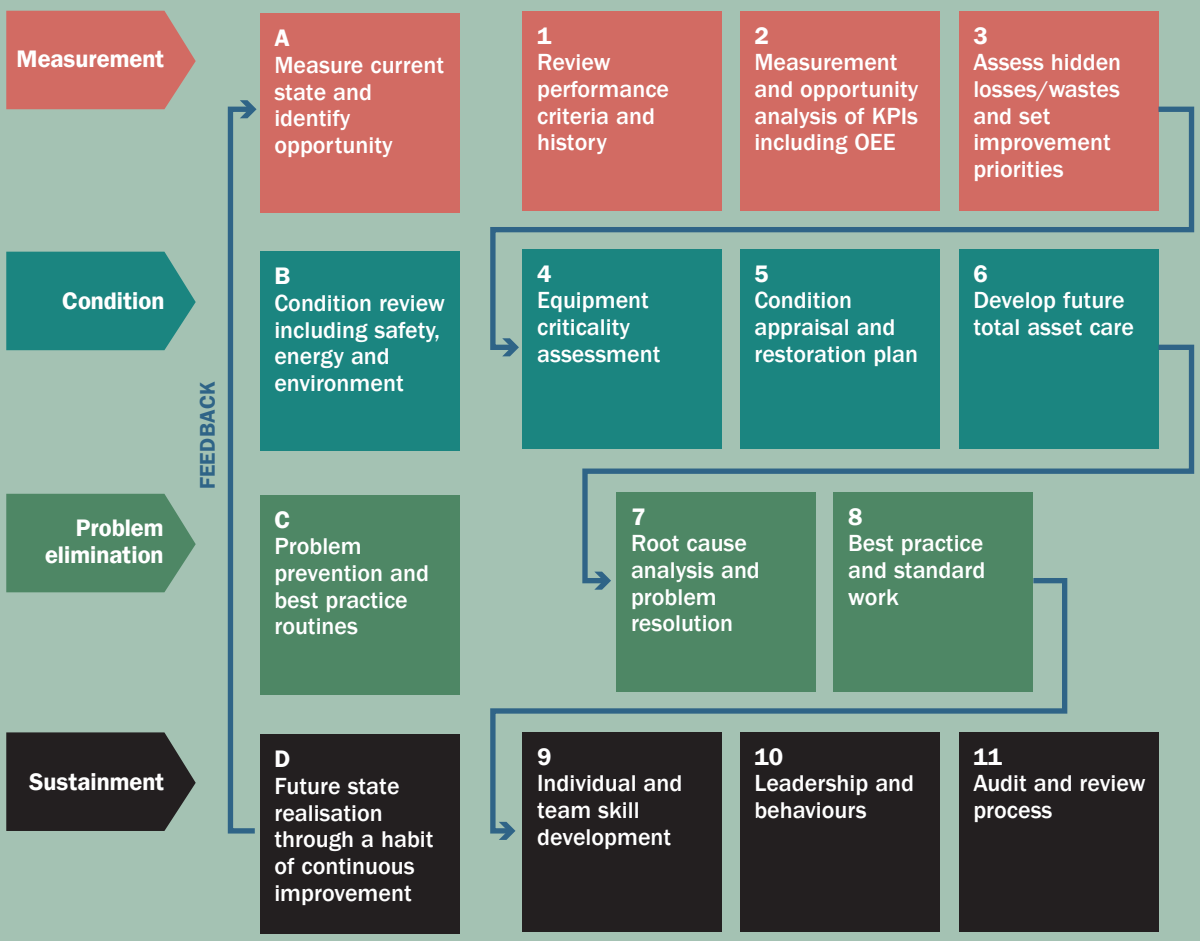


Figure 10.20: Asset optimisation – the 4-cycle 11-step process

Table 10.2 Asset optimisation 4-day hands-on 'learning by doing' training programme

Day 1	Day 2	Day 3	Day 4
Introduction to asset optimisation (AO) Maintenance Assessment Exercise • AO PRINCIPLES • Case studies • OEE Exercises.	Recap Brief Visit to Pilot and Plan the Plan Equipment Description MEASUREMENT CYCLE On-the-Job) 1) History/Records 2) OEE Measures 3) 6 loss Assessment	• Building AO Activity Boards • Consolidating Measurement and Condition Cycles • SUPPORTING TECHNIQUES • Set-up Reduction • 5S/ workplace Org CULTURAL CONSIDERATIONS	Dry Run Presentations SYNDICATE PRESENTATIONS REVIEW AND KEY LEARNING POINTS Next steps PILOTS & 4 STAGE ROLLOUT
AO TECHNIQUES AND 11 STEP IMPROVEMENT PLAN TEAMWORKING & FACILITATING BRIEFING FOR SYNDICATES On–the-Job Pilot Study	CONDITION CYCLE Exercise – Criticality assessment (On-the-Job) 4) Criticality assessment 5a) Condition appraisal 5b) Refurbishment Plan 6) Future asset care	PROBLEM PREVENTION CYCLE (On-the-Job) 7) Problem Solving 8) Best Practice Routines PREPARE AO ACTIVITY BOARD PRESENTATION	Getting Started LAUNCHING THE PILOTS Course Assessment 16.00hrs CLOSE

This experience resulted in an improved plan for the next workshops, ensuring that the supervisor would review not just staff who would be on leave, but also the standby rota as well, as callouts frequently result in unavailability (sleep time) the next day.

One of the scoping issues that was discussed prior to commencing the AO programme on the gravity belt thickeners was the need to develop their own OEE 'case study example' and hence illustrate what would be classed as 'in scope' and 'out of scope'. The team concluded that it was not only the gravity belt thickener that was in scope, but also the sludge feed pump and discharge pump (Figure 10.21). Data from these assets was also invaluable in the quest to work out an OEE both across and within this critical 'pinch-point' process flow.

Figure 10.21: Micro process flow

As the AO programme developed and the competency of the coaches to deliver AO training and facilitation improved, they were able to develop the material to be more specific to the water-utility context by including real-life examples from inside the business to help with the learning experience. Some of the training exercises used within the AO playbook were also made more interactive, improving the 'learning by doing' experience.

As the teams progressed through each AO pilot asset, an AO activity board was used to track and communicate progress as shown in Figure 10.22. The process took

around 20 weeks for the first three assets to reach and achieve the Milestone 1 audit and review.

Figure 10.22: The AO board for the centrifuge at Cog Moors (left) and the AO board for the thickener belts at Five Fords (right)

The continuous improvement cycle – future state realisation through the habit of continuous improvement (steps 9, 10 & 11)

Individual and team skills development – step 9

At Cog Moors as the asset optimisation process progressed with what was a relatively new team, it became obvious that there had been little or no formal training (this was also identified in the perception survey). Equipment was operated as it always had been with information handed down from one operator to another over the years. No-one on site knew what the original design specification of equipment was. The AO team decided that some extended enterprise would be appropriate in the form of external master classes run by the various suppliers of the equipment that were negotiated at no cost and were arranged at the pull of the site staff (see Figure 10.23).

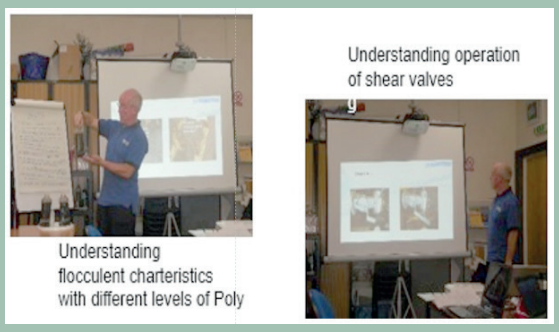


Figure 10.23: External supplier-led masterclasses

Customer-led success (CLS)

Figure 10.24: The CLS board at Cog Moors

Every five years, the industry is subjected to a Water Services Regulatory Authority (OFWAT) price review which sets out the agreed spending for a five year period. These targets are always challenging and there is always an expectation to deliver more value for less cost. These cost constraints imposed on the business mean there is a constant challenge to be more efficient and effective. The strategy of becoming a lean organisation is seen as a way to meet these cost challenges and the tactical delivery mechanism for this is called the asset management plan (AMP), and is where the AO system of work is the central driver. The business strategy is based around customer led success (CLS) and AO within the lean deployment programme is viewed as the vehicle to deliver CLS. Therefore the establishment of CLS Boards in each of the pilot areas (as illustrated in Figure 10.24) is seen as the way to establish ownership and monitor performance and continuous improvement ideas through to implementation.

The deployment of the CLS boards runs right through the organisation top down like a golden thread, as illustrated in Figure 10.25.

The CLS board ensures that everyone understands the process and buys in to how they can influence the company objectives on a day-to-day basis for the benefit of the customer. It was critical to successful ownership and engagement that the boards were built by the WWT plant teams and articulated in their own words. For example the team charter and purpose statement: rather than having it imposed upon them, the team had to think about what it is that they are here to do in order to contribute to the company strategy of 'We will earn the trust of our customers every day'. They came up with seven 'We will' statements. For every 'We will' statement, there had to be a statement in the process section which would measure and monitor performance of that commitment. For example, if the 'We will' statement said that they would 'Protect the environment for the customer', the measurement might be compliance of the final effluent going out to sea or to water courses.

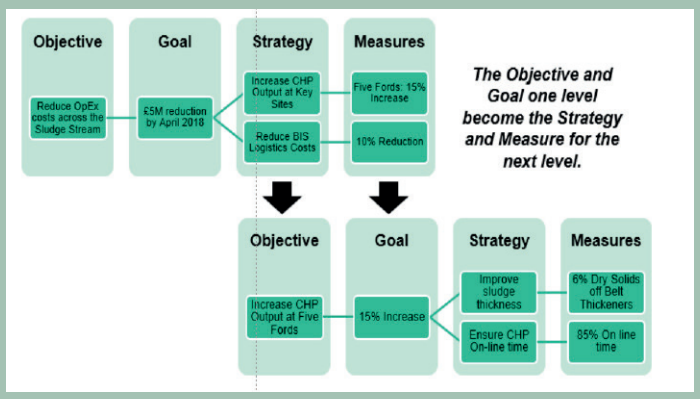


Figure 10.25: CLS cascade

Five Fords WwTW CLS Measures

Objectives	Goals	Strategy	Measures
Health, Safety & Wellbeing	Zero LTIs	Induction/ sign off for all visitors to site	100%
		Reduce risk of slips, trips & falls	Monthly 5S Audits
		Lone Working use	10 Log In's per month
		Lone Working Log Out	0 Alarm Out's
		Positive Interventions	100% closed within x
		Near Misses	100% closed out by x
		Safety Conversations	
Achieving all regulatory requirements	100% Compliance	Combined final effluent quality within parameters	Below x
		Ammonia within parameters	Below x
		Digester Temperature	Greater than 35 degrees C
		pH levels	Greater than 10
		Mixed Liquors within parameters	Between 2500 & 4500
		DO Levels within parameters	Between 1 & 3
		Record/ Monitor Digester Fatty Acids	tbc
		Record/ Monitor Digester Alkalinity	tbc
		Record/ Monitor Digester pH	tbc
Optimising processes & reducing costs/ waste & maximising energy production			
CHP Target is achieved	Over £329.31 per day	Maximise OEE from Belt Thickeners	x%
G2G to exceed target	Over £2805.06 per day		
		Digester Temperature	Greater than 35 degrees C
		Available Screened Tank Level	Between x metres
		Available Thickened Tank Level	Between x metres
		Available Reception Tank Level	Between x metres
		Level Loading of Digesters	
Availability of Sludge Centre	100% Availability	Stock Check of Critical Spares	Weekly Check & Order Process
		Reduced planned maintenance backlog	Month on month reduction
		Jetting of lines to thickened Sludge tank	Quarterley/ 6 Monthly routine?
		All assets online?	No. Assets offline?
AGA Data	None over 10 days old	Name of person vs age of data	No Jobs over 10 days old
Customers	0 contacts	No. of Customer contacts	Have we any and where are we at?

Figure 10.26: An example of the CLS deployment from Five Fords

Figure 10.26 shows the format of objectives, goals, strategy and measures cascade (OGSM). For example, it was key to ownership that the WWT plant team members understood the reason why they needed to optimise the belt thickening process. The top-level objective was to reduce cost across the sludge value streams and this was cascaded down to each WWT plant. The agreed strategy was to improve sludge thickness, with the appropriate measure being the required percentage dry solid content of the sludge off the thickener belt. The measure ultimately became the OEE of the belt thickener that incorporated sludge thickness (quality), availability and performance.

Lean principles

The work around creating the CLS board and the associated measures all tie in with our five Welsh Water lean principles:

- **Understand customer value** – What our internal and external customers value about what we do, so implementing measures to ensure site capacity for our tankers to offload (internal customer) and compliance on final effluent (Natural Resources Governance – the external customer) or maximising energy production and reducing costs (working towards potential reduction in customer water rates)
- **Engage colleagues** – The team on site know the processes better than anyone so it is they who know what we need to be looking at in terms of measures to ensure site success
- **Understand end-to-end process** – Through value-adding activities that meet our customer and business needs
- **Create flow and pull** – By implementing leading measures we are ensuring we eradicate potential bottlenecks before they occur; monitoring tank levels and ensuring capacity by targeting low levels so that we can facilitate an influx of tankers at any given time
- **Excellence in everything we do** – By having regular meetings and always monitoring our measures, as well as actioning emerging issues, we are constantly trying to be better at what we do!

Leadership and behaviours – step 10

Although the Asset Optimisation journey is not fully completed at Cog Moors, this is because it is a three- to four-year maturity journey where three of the eight equipment-based steps continue as part of the CI journey. The reality is that both WWT plant teams have made significant improvements on site and have progressed to achieve the Milestone 2 level audit (see Figure 10.27).

From a leadership perspective it has been recognised that it is very important to celebrate success during lean deployment when significant milestones are achieved and to recognise the contribution and continuous improvement effort the teams are delivering. It is also vital that managers support their team's success and celebrate with them. A number of site visits and feedback sessions with the senior sponsors, stakeholders and leadership team have taken place at both WWT plants where the leaders were able to view progress for themselves and congratulate the team members in person.

This type of visible, proactive engagement is crucial to our development as a lean company. In previous engagement surveys, staff perception had been that management were distant and they never saw them; this perception is now changing. The Cog Moors site has also become an active member of a best practice sharing networking organisation and has hosted an open day for other network organisations to come and share their story. This has in turn been reciprocated and given team members an opportunity to go and see best practice in other industries other than utilities and it is thus becoming a learning organisation.

Visual management is also a central part of our philosophy to make it easier to do a good job and catch issues and resolve them as part of daily routine through Customer Led Success.

Evidence-based audit and review process – step 11

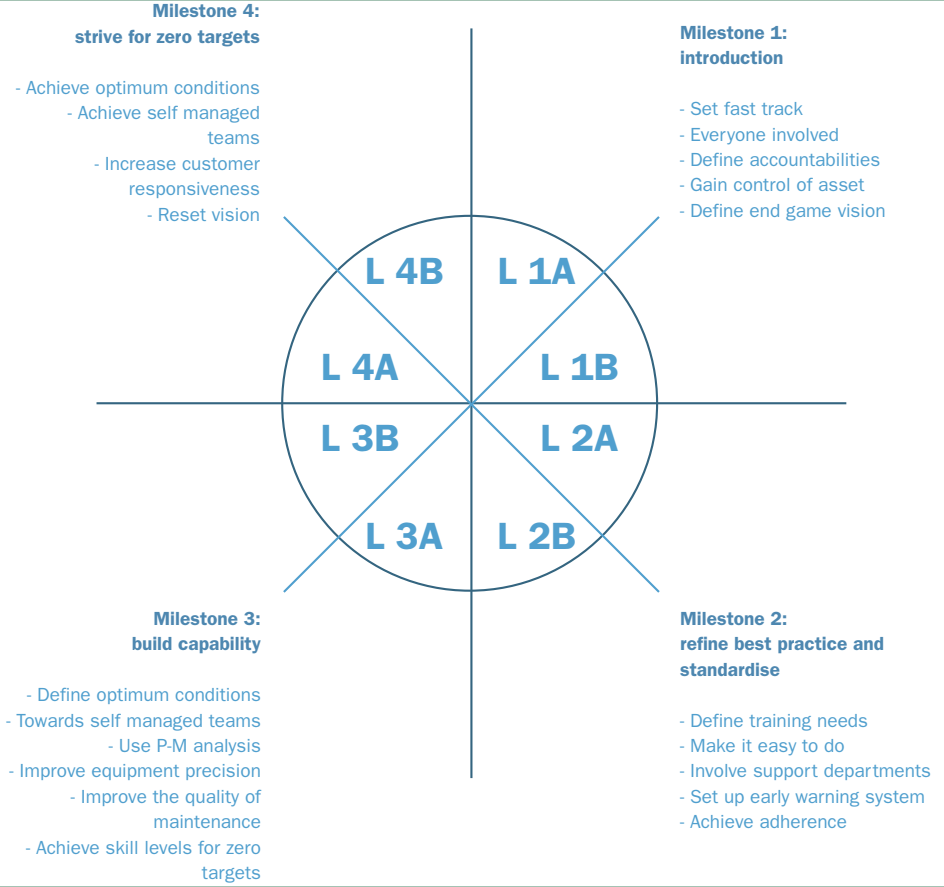


Figure 10.27: AO audit milestone review process

Operational trends are reviewed and reported on the daily dashboard. The progress of the AO is managed through a robust audit and feedback milestone review process (Figure 10.27). Individual projects are also monitored via the lean deployment CLS board, where they are reviewed monthly and assigned a red, amber or green status to prompt action if necessary.

Competency, culture and transfer of ownership to the site teams are monitored through a bespoke lean maturity structure. If a site is moving forward successfully on its maturity journey following the true lean curve, there will be regular actions in the emerging issues, and escalation of ideas along with ongoing CI projects. The sites will be monitored and supported in the use of this part of the board and in problem solving, until it becomes 'business as usual'.

It's our people at the sharp end who make the difference

Extract of an article that was published in Welsh Water's Dŵr monthly magazine in December 2017:

The Cog Moors waste water treatment works team has been busy engaging with the roll out of "Lean Exemplar". We wanted to know what is involved, and how it affects people's day to day jobs so we interviewed John Bowd the site supervisor and operator Rhodri Williams to get their views.

What was your initial reaction and how did you feel when you were told lean was coming to your site?

John: 'Apprehensive at first and not sure how this would be of benefit to me or my site.'

What is different about your site now that lean has been embedded into your working culture?

John: ‘Massive optimisation control and sludge processing improvements.’

Rhodri: ‘We all take a pride in organising our workplace which reduces Health & Safety risks for everyone on site. For example, cleaning for inspection has enabled polymer leaks to be identified and repaired quickly, resulting in a significant H&S improvement.’

John: ‘Also, reduced use of chemicals to treat raw sewage and less breakdowns and parts replacement.’

What are the main positives of the asset optimisation process for you?

Rhodri: ‘As the machinery on site now runs far more efficiently with fewer breakdowns, my work/life balance has improved significantly and I am far less likely to be called into work during evenings and at weekends now.’

John: ‘A great benefit is that Health and Safety risks are reduced in the workplace.’

Rhodri: ‘I now know how, why and what I do in my role will affect how well my site performs, and when important tasks need to be carried out to maintain the smooth running of the site, I feel far more in control now. Everyone on site has a say in lean deployment. We are all experts in our roles and have an important part to play in making lean work as a team.’

John: ‘Performance results are now helping us identify where we need to make investments on site to maintain and improve our performance.’

What would you say to someone who is about to have AO rolled out in their area of the business?

Rhodri: ‘Initially taking time out to address issues and plan a strategy of improvement can be difficult. It’s hard to find the time to dedicate to lean if you are working flat out to maintain the site because it isn’t running as efficiently as it could.’

John: ‘Short term pain for long term gain – embracing lean, engaging with the deployment specialist and making a valid contribution to that deployment will pay dividends and make our working life a lot easier in the long run.’

We also caught up with lean deployment specialist Jackie G to ask her about her experience at Cog Moors. She told us:

‘My objective was to embed the lean deployment vision – improve culture, capability, and systems of work. The team was very enthusiastic about helping me to understand the processes carried out at the site but they were a little apprehensive at first to engage with lean deployment. I gave the team a thorough understanding of our lean principles and how continuous improvement would help transform their site. We were able to identify who their customers were in the treatment process chain on site.

As we started to identify quick wins by focusing their expert knowledge and ideas, engagement built and the team were enthused and now have an excellent continuous improvement culture. Success can be demonstrated by the fact that the team are now delivering continuous improvement initiatives in the workplace which are outside of the original focus areas we identified. They have achieved their initial objective which was to work smarter not harder, with less reactive work.’

Summary of our AO progress

Since November 2015 we have grown our own in-house lean/continuous improvement capability and delivered significant benefits on projects completed to date. The culture and behaviours of the business are changing as they transition from the limited adoption of lean/CI thinking into the wider embedding of ‘business excellence’ across the whole organisation. In the case of Operations where our physical assets are based, we have adapted the well proven TPM philosophy with essential tailoring to suit our asset optimisation system of working.

Each focused improvement OA project results in a summary of benefits based on the 5Cs that are critical for the business:

- **Cost** impacts are significantly positive since tracking benefits (even accepting that many variables can preclude clarity of cost benefit)
- **Compliance** improved safety performance and reduced H&S incidents
- **Customer** improved internal and external customer service/value/relationships
- **Capacity** increased installed productive capacity by up to 20% in Waste Water Operations and reduced ramp-up lead time on Capital projects
- **Colleague** improved lean/CI capability, competence and growing confidence across the business.

This tailored approach to OA has been fundamental in our cultural transition and – we believe – will also continue to deliver both the 'hard' and necessary end customer 'value for money' business benefits as well as a culture of ownership and CI at the sharp end of the business.

10.4 **Warwick Chemicals' TPM experience**

By John Jones, Operations Support Manager

Warwick Chemicals is a leading manufacturer of speciality chemicals for the detergent industry. It has around 200 employees running a highly regulated (COMAH) site in North Wales.

The business case revolved around the pressing need to improve the effectiveness of a new – just three years old – chemical plant producing sodium acetate (SA). Customer demand was such that the company was constrained by the SA plant as the 'pinch point' in their end-to-end value stream output.

Warwick carried out a comprehensive diagnostic exercise and scoping study to establish where they were and where they needed to get to. This showed a very unstable current average OEE generally below 40%. Future demand (the next 12 months) showed clearly that the OEE needed to be at a consistent 60%, which would represent a 50% real improvement in the SA plant's current productive capacity.

The challenge was straightforward in the sense that there was a choice to either unlock the installed productive capacity of the SA plant or face the prospect of replicating current capacity through capital expenditure. The former was a possibility, the latter extremely unlikely!

The company decided to implement a TPM training programme and methodology focused on the SA plant that was designed to encourage close, cross-functional teamwork to effectively manage the plant and its equipment through the operators and maintainers responsible for that asset.

Following the diagnostic exercise, Warwick ran a one-day site leadership team TPM awareness workshop to secure their commitment and 'buy-in' to a properly resourced and visibly supported TPM system of work.

One of the key outputs of the session was to invite the site leadership team to answer the question: 'From what we have learnt today, what is TPM going to give us that we are not already doing?'

To facilitate this exercise the leadership team was split into to two groups of five and invited to list out all the business drivers and then rate each one against TPM's potential ability to deliver those business drivers. The result of the combined feedback and discussion is shown in Table 10.3.

This recognition of a 78% potential significance of TPM to help deliver the business imperatives was a major step in giving confidence to all employees that the TPM programme would be correctly resourced from the outset, in spite of likely painful refurbishment costs to restore the equipment to 'as new' condition.

Table 10.3 The potential impact of TPM on business drivers

Business drivers	Potential impact of TPM
Improved profitability	3
Increased sales	3
Customer credibility	3
Staff involvement & engagement	3
Safety performance	3
Environmental conformance	2
Diversification	1
Stakeholder value	2
Reduction in asset maintenance cost	1
TOTAL	21/27 = 78% significant
Rating scale: 0 = No impact, 1 = Some impact, 2 = Significant impact, 3 = Major impact	

This positivity was transferred to the TPM pilot project launch in the SA plant with a four-day TPM practitioners' hands-on workshop, where the operators and maintainers also set out their 'end-game vision' for where the TPM process needed to take them, which they articulated simply as:

- we will ensure a commitment to a positive safety culture via fit-for-purpose equipment and workplace organisation
- where we can plan weekly production rates with 100% confidence
- and consistently achieve our planned production on time in full
- together with consistent 100% right first-time quality
- through a commitment to **total asset care** (FLOAC, CBM & PM schedule adherence).

Achieving the vision will require striving towards our four zeros of

- zero accidents and emissions
- zero breakdowns
- zero minor stoppages/interventions/interruptions
- zero defects.

A further important part of delivering the necessary end-game vision was to present TPM as a partnership between production and maintenance, which they expressed as shown in Figure 10.28.

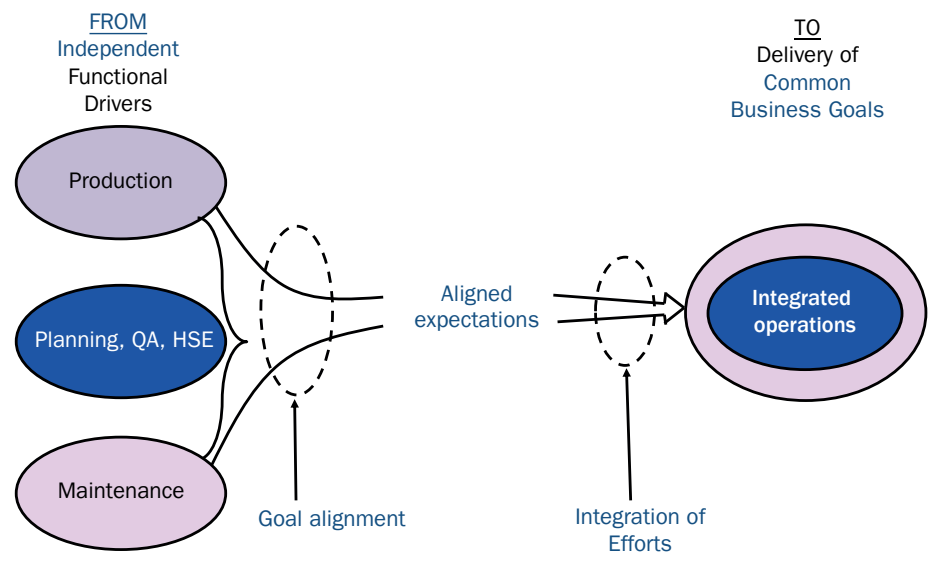


Figure 10.28: Using TPM to deliver our 'end game' partnership

After the four-day TPM practitioners' workshop, where each of the eight equipment steps is worked through as a 'learn by doing' experience on the actual plant, the company launched TPM activity days once every two weeks, organised by shift-based improvement areas, to progressively work through each of the three equipment cycle steps in all their necessary detail.

The impact over the first 14 weeks was dramatic, as shown by the trends illustrated in Figure 10.29 for availability, performance rate when running and quality rate produced.

The OEE results over 12 months from kick off show the combined impact of AxPxQ, moving from a volatile and 'out of control' 40% to an 'in control' and improving 74% and hence an ability to 'forecast with confidence'.

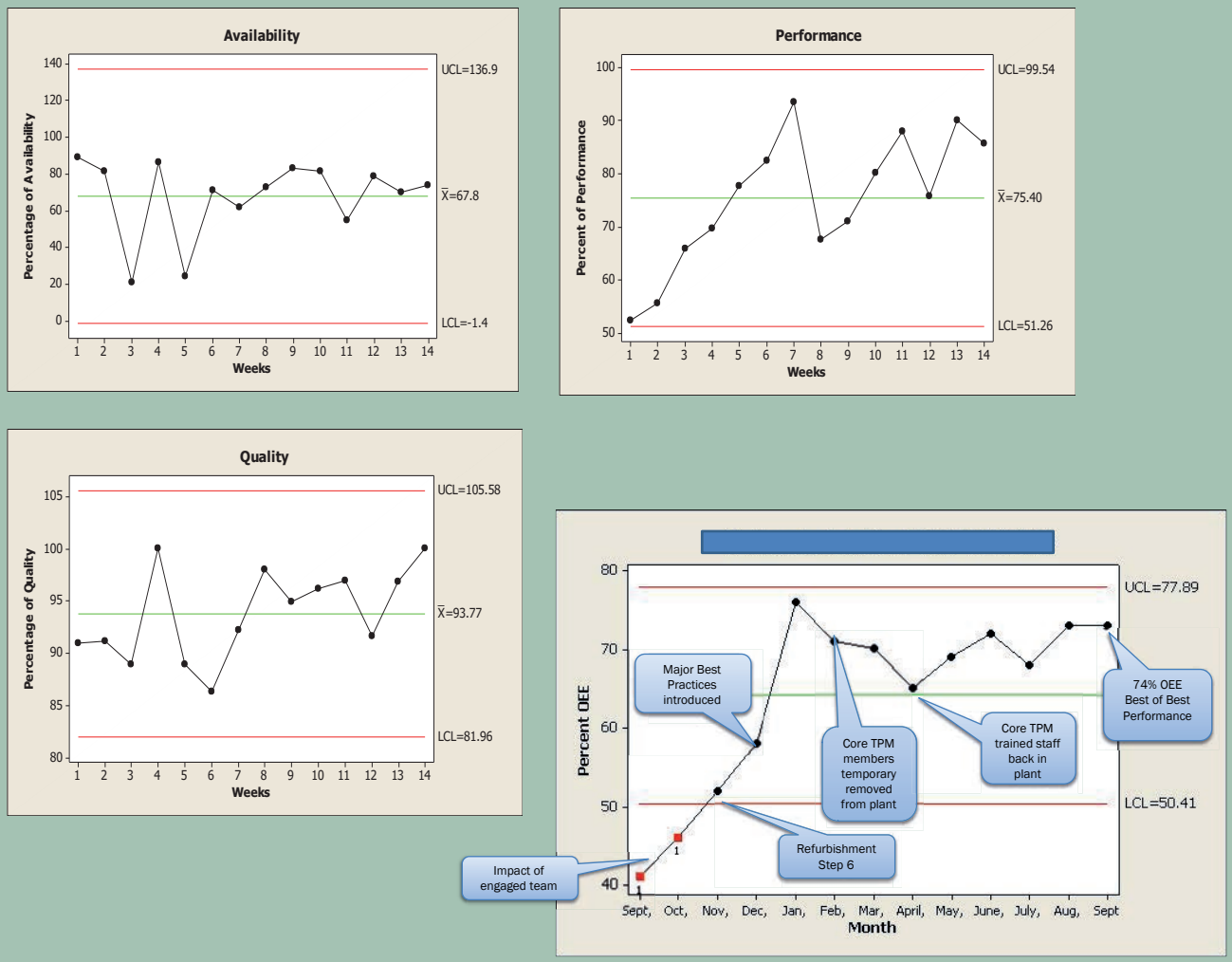


Figure 10.29: Trending the three OEE metrics and (bottom right) OEE trend over 12 months

The before and after photos in Figures 10.30 and 10.31 served as a dramatic reminder of where the company had come from at the start of its TPM journey to where it was 12 months later.

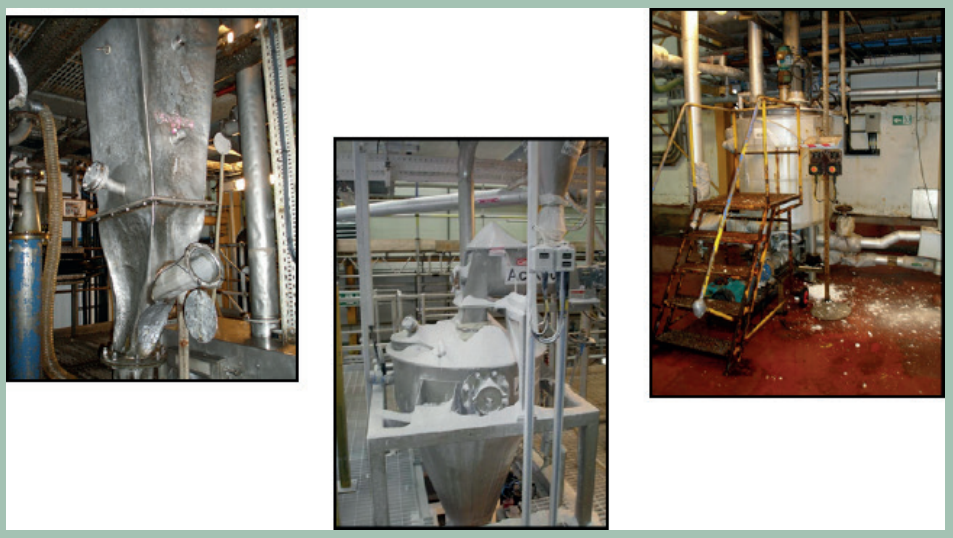


Figure 10.30: Before TPM: OEE 40%

Figure 10.31: After TPM. Equipment is well-designed, fit for purpose, safe, reliable and well-maintained. OEE: 74%

The overall business improvement benefits in plant reliability and predictability showed

- average tonnage increased from 12–14 tonnes per day to 28 tonnes per day
- additional c. $1.5m sales turnover per year
- for a total investment of TPM training and refurbishment costs of $60k
- which on the enhanced net margin of additional sales output represented a six-month pay-back.

Warwick Chemicals was also a very proud winner of the UK National Training Awards for the internal training and development of front-line staff using their 11-step TPM model.

10.5 Three brief case studies

Case Study A is from the pharmaceuticals industry. Case Studies B & C are both from the medical devices industry and both are Shingo Award™ winners.

10.5.1 Case study A: pharmaceutical industry warehouse cranes

Asset care (as in TPM) is one of this company's methodologies for creating an environment to underpin and illustrate their vision of 'This is the way we work here' (see Figure 10.32).

The company already had a number of asset care projects completed and ongoing. Recently, the warehouse and utilities team completed an asset care project for the warehouse cranes, and are now using the asset care philosophy and tools as the routine way of working.

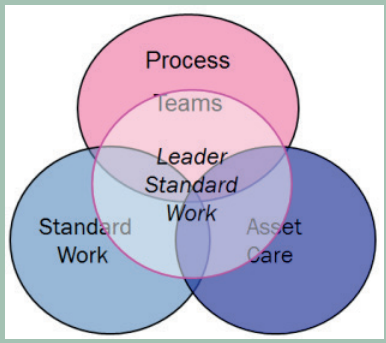


Figure 10.32: The company asset care model

Our challenge

The future vision and challenge, developed through the shift team's involvement in applying relevant measures and TPM-based asset care, is described by the team as follows:

- Operates as it should – with the ASRS (automated storage and retrieval system) part of it as a 'lights-out' operation where alarms are rare
- Operations & maintenance working as one team to self-determined standards and then sustaining those standards over the long term
- Greatly improved understanding of how our physical assets actually work, through relevant training in a safe and fit for purpose environment
- Deliver our internal customer requirements (production) on time in full.

Over six months the team followed the first eight equipment steps of the TPM asset care model:

- Steps 1 to 3, to measure current performance and assess the opportunity for improvement
- Steps 4 to 6, to improve the condition of the equipment and set up new and relevant maintenance checks
- Steps 7 and 8, to standardise the best-practice way to operate and maintain the equipment, to permanently resolve issues and prevent reoccurrence with the '100-year fix' mentality.

The outputs of the TPM asset care project include

- reduced alarms – from over 300 per month, to less than 100 (Figures 10.33 & 10.34)
- no downtime recorded by process teams for 'warehouse downtime' as in product or material starvation to production (their internal customer)
- new maintenance PMs, and operator front-line inspection checks introduced
- less fire-fighting. More proactive and innovative work (for example, mobile lighting on top of crane cab)
- sustaining system in place, using visual controls, process confirmation and leadership support
- successfully passed Milestone 1 (of 4) for evidence-based audit of TPM 'maturity'
- improved teamwork. Problems are now resolved as 'one team working together'.

Asset care now runs as normal business in the warehouse. The team meet once a week to discuss the crane's performance and agree actions to upkeep and improve the crane's reliability.

At the start of the project the team set out their 'end-game vision':

Our asset care vision

'Reliable & safe equipment assets available to run 100% of the time'

We can achieve this by striving for:

- zero accidents
- zero customer complaints
- zero defects
- zero breakdowns
- zero minor stoppages & interventions
- relentless continuous improvement every day

plus… standard (and therefore safe) operating procedures.

Figure 10.33: Improvements through restoration – examples of a crane after refurbishment works (asset care step 5b)

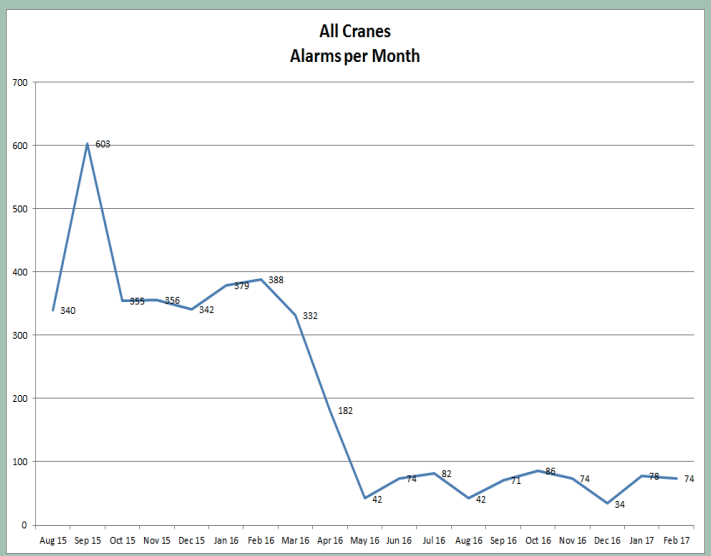


Figure 10.34: Monthly alarms down from over 300 to less than 100

Results have moved from 'warehouse downtime' to 'happy production customers'.

Some 'quotable quotes' from the asset care team

- 'We're being listened to and encouraged'

- ‘We’re all buying into it’
- ‘There’s only one best way’
- ‘We haven’t had to compromise our values’
- ‘We not only know the ‘What’ but also the ‘How’ and the ‘Where to get help’
- ‘Who would have thought we could reduce our alarms by two-thirds!’

10.5.2 **Case study B: medical devices**

TPM’s role in its continuous improvement journey

This medical device company began its CI journey in 2003 with a number of kaizen events aimed at removing waste from their processes. As their knowledge of lean manufacturing/CI grew, their focus broadened towards improving all elements of the business in an effort to guarantee customer satisfaction. To support this strategy, in 2004 an operational excellence group was established to ingrain a culture of continuous improvement. Today, lean tools such as TPM, VSM, standard work, and scientific problem solving are practised on a daily basis at a front-line level and the results are visible throughout the plant.

After a series of benchmarking visits during 2005, the company decided that the TPM philosophy and enabling tool could – in the right hands – deliver significant business benefits (through enhanced asset/equipment-based reliability and performance predictability) and also be the enabler to deliver the inclusive culture change they aspired to.

One important message that the benchmarking visit hosts stressed was the need to not only follow a clearly defined TPM process, but to also have a clear series of engagement steps to ensure ongoing sustainability:

- An initial one-day site leadership team ‘buy-in’ session to the TPM process to support the delivery of their business drivers and future vision, based on an initial diagnostic study
- A series of TPM practitioners’ ‘hands-on’ four-day training workshops
- TPM pilot project launches and progress tracking over four maturity milestones
- Middle and senior management TPM ‘pillar champion’ coaching
- Focused improvement activities such as 5S workplace organisation, precision changeovers, standard work and early equipment management
- Regular evidence-based top-down and bottom-up TPM audit and review processes
- TPM roll-out planning and programme governance.

One of the initial TPM pilot projects was in the coil-winding facility comprising 23 machines. Following a four-day TPM practitioners’ ‘hands-on’ workshop, the four shift-based TPM teams were launched in 2005. The teams progressively worked through the equipment steps using the 11-step TPM model.

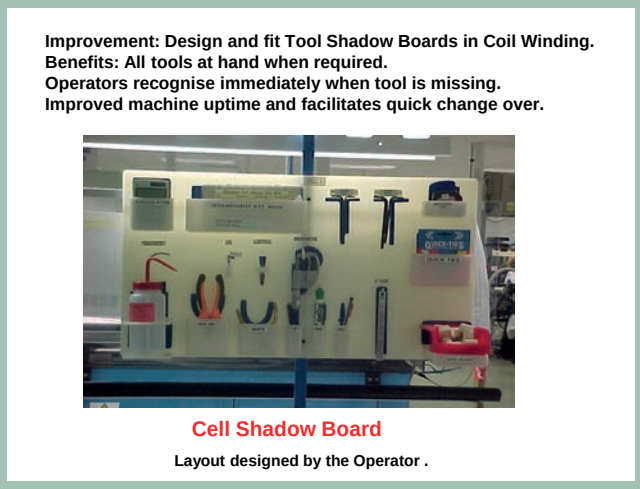
Each shift team initially had dedicated weekly TPM activity sessions over a 14-week period before passing the Milestone 1 audit process tagged as ‘Introduction – getting everyone involved’. Following the success at Milestone 1, the TPM process moved from a project-based approach to one of a regular weekly PDCA routine process review at the TPM visual management board for their specific group of assets in order to

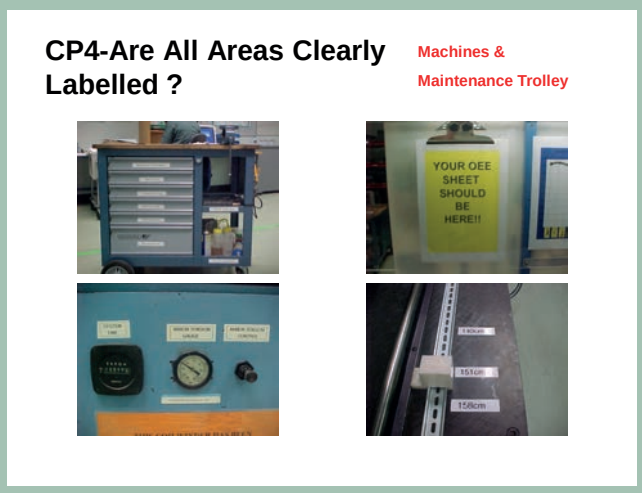
- review action list from condition appraisal
- review and progress new ideas
- discuss OEE from previous week to focus this week’s priority
- agree on corrective actions
- agree on work to be done before the next review session.

They also

- held two-hour twice-weekly sessions with the full time TPM facilitator to review progress
- held a 15-minute update presentation to the site leadership team every three weeks
- had daily discussion at the morning meeting on OEE and TPM activities
- logged all ideas on the TPM master list.

All of this was aimed at improving the initial TPM routines towards achieving Milestone 2.





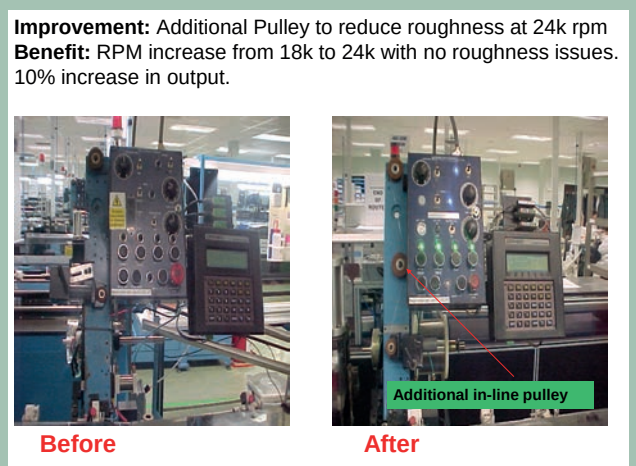


Figure 10.35: Milestone 2 evidence

Figures 10.35 shows some of the highlights of what the coil-winding shift teams presented to the site leadership team and the TPM auditors in order to pass Milestone 2 – 'Refine best practice and standardise'.

These audits are 'Go see' evidence-based comprising 20 checkpoint (CP) criteria at each of four 'maturity' milestones. In this case they achieved these Milestone 2 results just six months into their TPM application journey.

Summary of TPM-related highlights

The company increased the standard coil-winding capacity by 10% to 33% depending on machine type. This included converting standard machines to accommodate a wider product range, with a saving of $120k per machine and with no additional floor-space requirement.

Based on their successes in coil-winding, the company rolled out the TPM philosophy over the next few years to all parts of their facility, including the manufacturing support functions, and also used the EEM pillar of TPM for new capital projects.

The company's TPM journey has brought other benefits, including reducing their maintenance inventory costs by 25%, and as part of the TPM system a comprehensive review of preventative maintenance routines and systems resulted in the removal of 1,750 hours per year of non-value-adding work, releasing those same hours for additional production and/or continuous improvement activity.

Having started TPM back in 2005 the company now clearly recognises that TPM – in the sense of getting operational basics in place – has allowed them to gain the confidence to continuously strive towards operational excellence and hence the Shingo Award recognition for their efforts.

Perhaps most importantly, because of consistent leadership and direction, TPM has allowed the company to take its vision and values off of the noticeboard and hand it to its employees, and say with conviction: 'Here you are; with this TPM process you can make a difference and be able to continuously challenge and improve the way we do things here.'

10.5.3 **Case study C: medical devices**

TPM's role in its continuous improvement journey

This company is a subsidiary of one of the world's largest and most diverse healthcare corporations, manufacturing hip, knee and shoulder replacements, comprising over 1500 stock keeping units. The processes are organised into value streams based on the product type. There are five main value streams on the site.

In 2003 the company began to introduce lean tools such as Kanban systems, OEE, VSM and supplier integration.

This led to some significant lead-time reduction and cost improvements, but there was acknowledgement that this tool-based approach was not sustainable or culturally ingrained.

In 2005 there was an unexpected increase in demand which the plant was not in a position to respond to. This highlighted the need for a more responsive and flexible manufacturing facility. To succeed in this new environment the company needed to build a high-performance culture based on continuous improvement. In 2006, the plant began a cultural, physical and organisational transformation. The company created a vision for 2010 based on doubling capacity, while maintaining the same headcount and floor space. The transformational map was constructed under four work streams – a lean programme, change management, new product introductions, and compliance excellence.

In 2007 machines were physically moved from grouped processes to a value stream (VS) layout to promote flow and enable pull within each area. This involved the relocation of over 400 pieces of equipment.

During this transitional phase the organisation structure was changed from functionally based to a value stream structure. This meant the creation of a VS manager with overall responsibility for the VS and a support team with shared objectives. The support teams were then relocated into custom-made 'pods' – office units for manufacturing support staff located within the VS. The space for these pods was created from the space saved through the lean layout. As the VS structure progressed this led to aligned goals and objectives and a profit and loss account by value stream, which enabled better decision making.

In 2008 the plant introduced a TPM-based approach that they chose to call 'Total asset care' (TAC) to highlight the teamworking aspects between the maintenance engineer and the front-line operator.

After scoping the initial application of TAC to their critical assets in terms of the people, money and time resources compared to an expected realistic business result, the company held a one-day TAC 'buy-in' session with the site leadership team. This session concluded with an exercise to pinpoint the potential contribution of TAC to help deliver their business drivers. The result of 81% significance shown in Figure 10.36 gave the necessary momentum to launch the TAC programme with a series of TAC pilot projects focused on business-critical 'pinch-point' assets.

Business Drivers	Potential Impact of TAC
Zero Accidents	1 to 2
Zero Close Calls / Recalls (Quality)	3
Productivity (15% up Yr on Yr)	3
100% Adherence to Plan	2 to 3
Reduced Overall Plant Operating Cost	2
Reduced Inventory	2
Teamwork / Engagement (Credo Results)	3
Total Score	**17 / 21 = 81%**

0 = None 1 = Some 2 = Significant 3 = Major

Figure 10.36: Ensuring ongoing commitment from the site leadership team

In preparing all employees to take the TAC philosophy on board as a critical part of the business transformation strategy, Figure 10.37 was used as the centrepiece to highlight these six points in a series of site-wide TAC awareness sessions:

- We cannot become a sustainable organisation without having operational basics in place
- This requires standardisation, 5S, process control, reliable data collection and workplace design to give reliable equipment
- The TAC approach partners closely with 5S, OEE and health & safety
- TAC is a basic foundation for creating sustainable and reliable FLOW
- The three-cycle approach taps into the expert knowledge that exists throughout our workforce
- TAC establishes the correct relationship between people and their equipment to create 'ownership'.

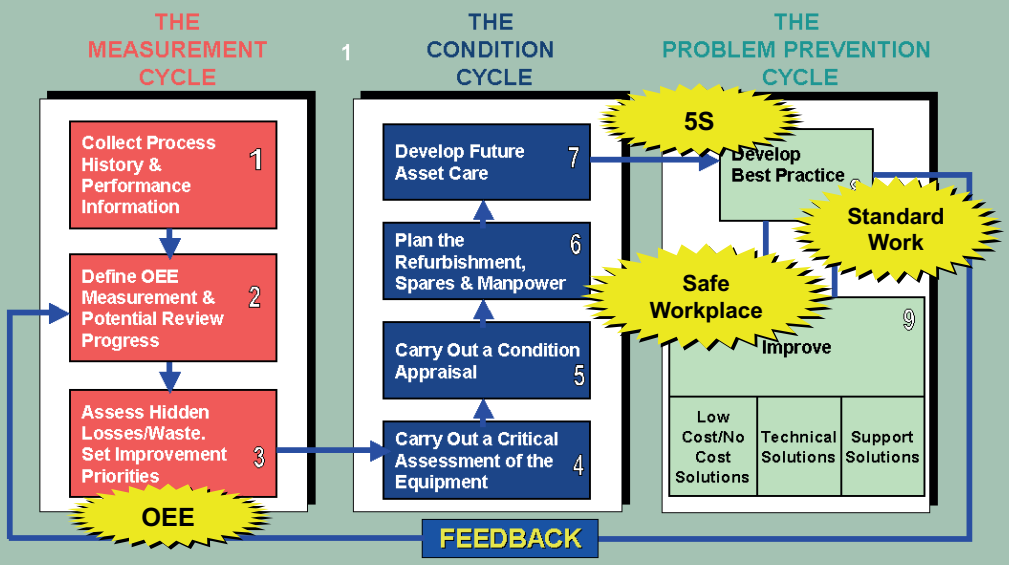


Figure 10.37: The three-cycle TAC process

Summary of TAC-related highlights

As shown in Figure 10.38 the initial TAC pilot projects to Milestone 1 maturity delivered significant financial benefits of c. $600k plus a new furnace capital cost avoidance of c. $1m. After two years, through Milestones 2, 3 and onwards towards Milestone 4, the validated cost benefits had accumulated to over $5m.

TPM Pilot Benefits after 9 months (and at c .2 years)

■ Reduced Maintenance spend	$ 68,000
■ Reduced Non core Hours Over Time	$ 238,000
■ Less Consumables	$ 57,000
■ Additional Annualized Savings	$ 241,000
■ TOTAL	$ 604,000
■ Plus Cap Ex Cost Avoidance	$1,074,000

After c.2 years ,accumulated cost avoidance = $5.37 million

Figure 10.38: Benefit accrual from TAC system application

One of the company's key ongoing learning points was to better understand the dynamics of applying OEE to a series of machine assets in a particular value stream, and hence to appreciate the dynamics of a moving 'pinch point' as improvements are implemented daily. The improved understanding and learning experience of OEE is illustrated and described in Figure 3.4 in Chapter 3.