

# OEE thoughts...

A review of OEE considerations by Paul Dean CEng, Shire Systems Limited

## Background

### Two roads to manufacturing excellence

Manufacturing excellence solutions can be considered to fall into one of two categories:

- 'Lean' manufacturing. Lean uses a varied toolkit of productivity improving techniques and methods that are selected and applied to suit individual needs - in consideration of the manufacturing context and current management maturity of the organisation. Lean is agile – it can be implemented quickly, it does not cause much disruption, it is generally affordable and provides quick payback.
- Manufacturing Execution Systems (MES). These systems seek to optimise workflow by imposing strict business rules through computer control of the manufacturing process. The MES approach is heavy – it is expensive, disruptive to implement and takes a long time to deploy (just like an ERP system). It is generally unsuited to the majority of small to medium-sized enterprises.

Shire is interested in the 'lean' manufacturing alternative. Whilst Manufacturing Execution Systems also use the OEE metric, they are systems apart and do not figure in Shire's software development plans.

### History of OEE and 'lean'

OEE is an essential metric and basic methodology for manufacturers pursuing a 'lean' manufacturing strategy - that is 'zero waste' in their 'value streams'. OEE follows the well-founded principle: 'If you can't measure it, you can't manage it'. Some advocates are fond of the view 'if you're not taking score, you're only practicing'.

The OEE measure emerged from the Japanese production-focused, equipment management framework of TPM (Total Productive Maintenance). The initial aim of TPM was to eliminate the 'six big losses' and subsequently the 'eight wastes'. TPM was first adopted and developed in Toyota's automotive plants, eventually evolving into the world-renowned Toyota Production System. By optimising the technical/human contribution to production, Toyota created an organisational culture that focused on the systematic identification and elimination of all waste from their production process (elimination of the '8 Wastes'). Engineering, process and organisational change was used to maximise yield, minimise cost and time-compress the supply chain by completely excluding non-value-added activities and 'not-right-first-time' events. TPM converged with the complementary '6 Sigma' quality movement, which sought to achieve no more than 3.4 defects per million in production and other processes (in statistical terms, 6 standard deviations).

James Womack, Daniel Jones and Daniel Roos coined the term 'lean production' in their 1990 book *The Machine that Changed the World: The Triumph of Lean Production* to describe the manufacturing framework established by the Toyota Production System. Lean production - and 'lean thinking' - represented a paradigm shift away from the post war production methods and management mindsets of America and Europe. Paradoxically, all the know-how that went into the design of the TPM framework came from American management thinkers and social scientists. The Japanese merely took the existing body of academic knowledge and applied it to manufacturing management practice.

Throughout the 1990's the lean production concept was progressively embraced by organisations aspiring to the competitive advantage it offered. TPM and OEE is now pervasive in the automotive, electronics, aerospace and many other industries throughout the world. Nakajima's OEE measure has become the de facto manufacturing performance metric for manufacturers intent on 'sweating their assets' and achieving 'zero defects' in production.

OEE, together with TPM's comprehensive toolkit of enabling techniques, was a key factor behind Japan's industrial strength and mighty economic performance in the 1980s and 90s. Today, as global cost pressures bite, no manufacturer supplying into the global marketplace can ignore using OEE within a 'balanced scorecard' of corporate performance measures. Whilst at first the choice of only the largest manufacturers, intensifying competitiveness and supply chain pressures are leading increasing numbers of small and medium-sized companies to implement lean systems and use OEE.

## **The case for OEE**

### **The frenetic production environment**

The production environment is dynamic and often frenetic. As part of their normal day the production team is continually presented with one problem after another. Expediency favours quick fixes and resolutions are often achieved without addressing root causes. When the root causes of today's problems are not confronted and their resolution at least initiated, then those problems remain unresolved and stay in your in-tray. Tomorrow the pile gets higher as tomorrow's batch are stacked on top. As unresolved problems pile up, we all know that morale can spiral downwards.

A common phenomenon in some industries is the 'product from hell' - the jobs that cause spirits drop just by their appearance on the production planning board. The anticipation of the hassles they will bring is sometimes enough to compel certain individuals to stay off sick!

What stops us getting to the root of these recurring day-to-day problems? Its not because there is a lack of will, its because information is lacking. There's just no clear visibility of what is really happening and why its happening – useful information is not to hand and, frankly, there is just no time to backtrack through events to sort out what happened and why. On the brighter side, each deficiency, concern or problem is also an opportunity for increased productivity and profitability - and personal well-being and satisfaction from their resolution!

### **Equipment failure is just one factor**

Chains of machinery and equipment, with their multiplicity of possible failure modes, go to make up a manufacturing production line. Some JIT (Just in Time) 'discrete part' manufacturers set up their operations to pursue 'single piece flow', attempting to emulate the continuous flow of a process plant. In single piece flow and process environments, the effect of a single failure is amplified - a failure within one machine can result in stoppage of the whole line, with all the disruption and on-cost this implies for the business. The traditional way to monitor these events is through the computerised maintenance management system. Unfortunately this allows only a limited view of events.

Equipment failure is just one category in the total profile of possible failures of the production process. To manage production effectively - to take control of the total process - its necessary to collect and analyse information on total events, not just equipment-related ones. 'Why are we off-line now?' 'Why aren't we producing more?' 'Why do we have so many rejects?' Common questions - the answers to which do not necessarily involve equipment failure or equipment deficiencies. The root cause of low or lost production may be people, maintenance, materials, procedures, inspection, transport, product design – a host of influences. Any single factor or the right combination of factors can result in a production stoppage, rate loss or off spec product.

### **OEE provides the answers**

How can we begin to understand what's going on in the production arena? How can we collect and analyse such diverse information? How can we take control? The CMMS can't do it all, as it is not process-centred. So, what's needed? The answer to this question is OEE.

OEE has the capability of reporting on all the causes of production downtime, production rate loss and product rejects. OEE systems enable the precise identification and ranking of manufacturing performance constraints wherever they are rooted: equipment, people, materials, methods, etc.

OEE provides clear visibility of what's going on in production and is a powerful lever of control. Using OEE, the reasons for processing problems and production deficiencies can be uncovered and corrective action initiated. OEE allows the critical few problems to be filtered from the morass of the many and their root causes located and addressed. OEE provides acute awareness of what is really going on on the shop floor. OEE provides the visibility and clear information on which to act decisively.

Besides the production gains, positive action brings with it a huge increase in the production team's morale. The resulting 'can do' attitude can transform motivation and energy throughout the organisation, amplifying the gains.

### **OEE speaks to everyone**

OEE information provides 'ah-ha' insights that can galvanise shop floor teams and management echelons to improvement action:

- At shop floor level, OEE facilitates small group problem solving initiatives and promotes healthy, profitable competition between production teams
- At executive level, OEE directs the focus of management attention to where it can deliver greatest returns and allows 'what if?' strategic decision making – 'How can we get a rapid 1% increase in OEE to satisfy our profit target?' 'By how much do we need to raise production line OEE to avoid having to buy that extra work centre to satisfy the new sales demand?'

Unlike CMMS, where the business case for system investment is 'regulatory compliance' or the promise of increased uptime, OEE is very much about best production process, increased profitability - and economic survival. A manufacturer is obliged to adopt OEE when he needs to be:

- competitive in the face of lower-priced prime quality goods in the global marketplace
- a 'world class' manufacturer (for example, a tier one supplier to a global company may have to demonstrate a world class OEE of 85% or more as a condition of their supply contact).

Hence, the stakeholders receiving prime benefit, and who should be most receptive to the implementation of OEE, are senior production managers, business managers and board members.

### **Clear visibility**

### **OEE system considerations**

#### **Human aspects of 'lean'**

Many aspects of the lean solution are more human-centred than technical. The implementation of lean and its TPM/OEE components so as to 'sustain the gains' presupposes a certain organisational mindset, attitude and competence. Organisations must have a culture hospitable to lean, including a well-motivated, appropriately trained workforce. Such organisations are identifiable by their paradigm shift to employee empowerment and teamwork, that is, Total Employee Involvement (TEI). In addition to technical and team skills, training initiatives in these organisations will have addressed the conceptual skills of situation analysis and problem solving and interpersonal skills that improve the efficiency of communication and harmonious but challenging teamwork.

#### **OEE system look and feel & the 'visual factory'**

As manufacturing performance improvement lies significantly in the hands of shop floor personnel, their enthusiasm for the look and feel of their OEE tool is crucial to the success of the organisation's lean initiative. An OEE tool must grab attention and engage the interest of those that matter – or it won't galvanise action. A good OEE system must present data as compelling information to those that have to use it.

All the rules of the 'visual factory', an established technique in the lean toolkit, must be applied to the design of an OEE system's GUI and reports. Visual factory techniques seek to build worker participation through shared information. Visual factory information is 'in your face' – bold, colourful, pictorial, metaphoric, compelling and delivering an unmistakable message. In reporting systems, instant drill-down capability is an essential requirement of lean.

#### **Manual versus automated data collection**

Manual OEE data collection is inevitably prone to human error and lapses. It is therefore desirable to automate OEE data collection as much as possible. This assures more accurate and complete data, whilst saving time on administration. Manual data collection is inconsistent with the waste elimination doctrine of lean. Lean doctrine frowns on double handling of data and unchallenged acceptance of

human error – lean calls for the elimination of non-value-adding tasks and ‘mistake proofing’ (‘poka-yoke’).

High-speed production lines and other automated machines lend themselves to automatic data collection. It is a relatively simple matter for a machine’s on-board automation system or SCADA system to share its data with an OEE system. The global automation suppliers like Invensys and Rockwell have lucratively augmented their automation systems with high value-added OEE extensions.

Machines without automation can be retrofitted with a simple automatic data collection system to track their stoppages and reduced cycle times. Data can be fed to the OEE software by means of photocells or proximity sensors linked to a data collector.

### **OEE or bust?**

Manufacturing competitiveness is a race in which only the leanest stand a chance. When a manufacturer seeks improvement and competitive advantage through lean techniques his competitors will not be standing still. The benchmark standard for winning performance is rising continually. The average incidence of lean best practice will necessarily increase amongst survivors in the ever-diminishing population of small to medium sized manufacturers. Manufacturers determined to stay competitive in the race must use OEE. These systems will have to become the norm for manufacturing viability.

### **What of the spreadsheet alternative?**

OEE calculation is basically simple and straightforward. However, as the number of monitored machines grow in number, its complexity can achieve nightmare proportions because of the enormous amount of data that has to be correlated.

Spreadsheets can be used for OEE data recording and analysis. However, this approach is cumbersome, especially as the number of monitored machines grow. With spreadsheets, the information presented is, arguably, dry, flat and uninspiring – especially in the crucial view of the shop floor teams whose contribution is paramount to OEE improvement. To achieve the production outcomes that they aspire to, manufacturers who are now using spreadsheets will sooner or later have to migrate to slicker OEE systems, with their visual appeal, drill-down and fast answer capability. Hard-pressed, time-poor production teams also deserve to have the proper tools for the job!

## **Shire OEE**

### **Simple system with manual and automatic data collection**

Shire will aim at a simple product to be used for performance improvement at a single site. The first release of the product will accommodate manual data entry. The second release will have automatic data entry features.

## Appendix

### OEE : Overall Equipment Effectiveness & the six big losses

#### Improving production efficiency by ‘attacking the hidden losses’ using OEE

The OEE metric has been developed by the JIPM (Japan Institute for Plant Maintenance). It is one of the 5 pillars within the TPM (Total Productive Maintenance methodology). It is now the accepted measure of manufacturing plant productivity (machine, work cell, work centre or line) and is used to enable ‘lean’ manufacturing and ‘six sigma’ quality improvement strategies . The methodology distinguishes 6 loss types (‘the six big losses’) in 3 categories: availability, speed losses and quality rate. The method's strength is that it makes the losses more visible and allows them to be quantified. This provides the opportunity to control the losses so as to improve productivity, quality and profitability.

#### The ‘six big losses’

**1. Breakdowns/Machine failures**

Downtime because of machine failures

**2. Setup and adjustment**

For example between product types, including ‘warmup time’ and ‘running in time’ after the actual changeover. Changeover time is included here and not in the planned downtime.

Changeover time can be reduced by applying SMED (‘Single Minute Exchange of Dies’ – a TPM methodology for quick changeover. (SMED thinking can be seen, for example, in a Formula 1 pit stop).

**3. Speed losses (idling)**

Speed losses are caused when a machine runs more slowly than its ‘nameplate rated’ speed or optimal/maximum speed.

**4. Small stops**

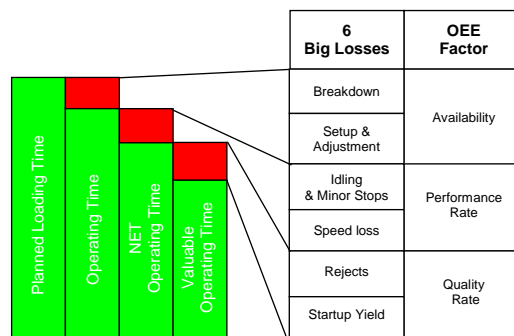
When these have not been caused by logistics. Small stops are typically shorter than 5-10 minutes. Small stops are typically minor adjustments, for example cleaning, removing a jam up, etc by the operator. This in contrast with machine/equipment failures, generally requiring resolution by a maintenance technician.

**5. ‘No good’ production in normal running**

This includes all rejected units (scrap) and rework units produced during normal production, that is, after the running in/warm-up period.

**6. ‘No good’ production at start up**

This includes all rejected units and rework units during startup/running in/ warmup



## **OEE calculation**

The OEE metric is calculated as follows:

### **Availability**

= (Planned production time - Unscheduled Downtime)/Planned production time

The *Production time* = Planned production time – Downtime

### **Performance**

= Cycle time x number of products processed/ Production time

Now remains the *Net Production time* (= time products are produced)

### **Quality Rate**

= (Total No of units of processed products – No of units of ‘no good’ products)/(Total No of units of processed products)

**OEE = Availability x Performance x Quality Rate**