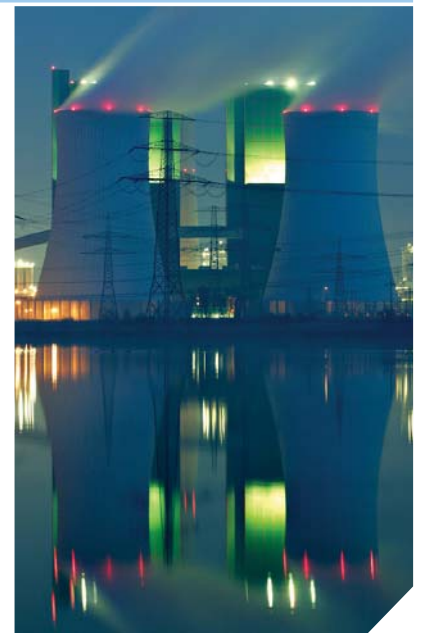


Idhammar Whitepaper – the benefits of OEE

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What would improvements in OEE be worth to your company?

WITH THE CONSTANT PRESSURES OF GLOBAL COMPETITION and the 'Wal-Mart factor' driving margins ever lower, manufacturers are forced to look for creative ways to maximize the efficiency of existing plant and minimize additional investment. In this climate OEE (Overall Equipment Effectiveness) has become a hot topic.

In its most basic form, OEE provides a simple way to "keep score" of manufacturing performance. However, the true power of OEE as a dedicated application lies in the ability to use it as a change-enabler, or tool for continuous improvement and lean manufacturing initiatives. This paper will show how small improvements in OEE can have a larger impact on profitability.



What is OEE?

THERE ARE MANY DIFFERENT APPROACHES to measuring manufacturing efficiency and generally most companies will have some measures already in place. Many now argue that none of these are as comprehensive or far reaching as the OEE score which should be considered as a fundamental KPI (key performance indicator).

Measuring performance against standard (or performance to standard), is a good way of bench-marking production levels against competitors or industry averages, as a measurement system it lacks ambition. If production teams are generally meeting their target performance rates, complacency may creep in and continuous improvement becomes lip-service only.

OEE provides a way to measure the effectiveness of manufacturing operations from a single piece of equipment to an entire manufacturing plant or several manufacturing plants in a group. In doing so OEE provides a complete picture of where productive manufacturing time and money is being lost and uncovers the true, hidden capability of the factory. It becomes the key manufacturing decision support tool for continuous improvement programmes.

OEE measurement is made up of three underlying elements, each one expressed as a percentage and accounting for a different kind of waste in the manufacturing process:

- **Availability:** a measure of the time the plant was actually available for production compared to the manufacturing requirements. Any losses in this area would be due to major breakdowns or extended set up time.
- **Performance:** the rate that actual units are produced compared to the designed output. Losses in this area would be due to slow speed running, minor stoppages or adjustments.
- **Quality:** a measure of good quality, saleable product, minus any waste. Losses for this element would be damaged rejects or products needing re-work.

OEE = Availability x Performance x Quality.

Measuring OEE can be done simply by capturing five basic pieces of information and then using spreadsheets to calculate the OEE.

1. **Planned Production Time** – the intended amount of time in which production is planned for a specific line
2. **Down Time** – the amount of time that the process is not running during the planned production time (interrupts to production)
3. **Ideal Cycle Time** – the theoretical minimum time needed to produce a single piece
4. **Total Pieces** – the total number of pieces produced during the planned production time
5. **Good Pieces** – the total number of pieces produced that meet quality standards

Using OEE – an example

Imagine a factory where a particular production line experiences 2.5 hours down time during 10 hours of planned production time; this would give us an availability figure of 7.5/10 hours or 75%.

At the same time the line, capable of a cycle time of 1000 pieces an hour is only producing 700 pieces an hour; this gives us a performance rate of 70%.

Supposing that 30 of those 700 pieces are faulty, the resulting quality element would give provide us with 96% good pieces.

Availability	Only 7.5 out of 10 hours	75%
Performance	Slow running – 700/1000 pieces an hour	70%
Quality	Is good, only 30 rejects	96%
OEE Score	Availability (75) x Performance (70) x Quality (96)	50%

Separately we may not regard each element as too significant, but taken together they result in an OEE of 50% or half of what should be expected and giving rise to 50% of potential improvements.

Working further on this example we would then need to address the two weaker elements, firstly the major breakdowns which appear to result in low availability, and secondly the causes of the poor performance rate. We must however take care not to reduce the high quality in our efforts to improve slow running.

It will be useful to add at this point, (at least to reassure manufacturing engineers), that accurate performance measurement with OEE should also be used to uncover the issues behind each loss. Significant interruptions to production are just as likely to be the result of waiting for raw materials or changeovers as equipment breakdown. Frequently People or Process issues are quicker and cheaper to resolve than equipment re-designs.

The 1% Effect

Using the example above, let's make some assumptions to illustrate the savings which could be made with just a 1% improvement to the OEE score.

- Planned production time is 10 hours
- Planned output is 1000 units per hour
- Price per unit is 5 €

	Now	1% improvement	Difference per hour
OEE	50%	51%	
Actual units/hour	700	710	10
Revenue generated/hour	3500 €	3550 €	50 €
Lost opportunity cost in revenue/hour	1500 €	1450 €	-50 €

A 1% improvement has generated 50 € per hour in additional revenue for the company, or looked at from a different perspective, it has reduced the loss due to waste by 50 €.

That's 1200 for the entire 24 hour shift, and 312,000 € over a year operating a 24 hour, five day per week shift system.

Now just imagine what the company would achieve with a 10% improvement, the realistic figure we expect to see in the first 3 months of introducing an OEE system.

Beyond spreadsheets

Companies who recognize the value of OEE usually begin with a simple spreadsheet for each production line. This approach enables the company to understand how OEE works and certainly generates the graphs required by production offices. However this approach is limited to a superficial level due to the following limitations:

1. **Data handling** – the more complex the process, the greater the number of lines/plants/sites the more complex and time-consuming the data handling becomes. It is not unusual to find manufacturing efficiency spreadsheets for OEE or other metrics that, printed out, could provide wallpaper for an entire room!
2. **Manual reporting** – spreadsheet-based reporting is yet another step in the process that can be complex to manage and requires more time to complete. Errors can also easily creep in.
3. **Limited functionality** – the theoretical minimum time needed to produce a single piece

Companies who are serious about continuous improvement and lean manufacturing quickly out-grow their spreadsheets. To make the most of OEE, powerful dedicated OEE Management Applications, such as Idhammar's OEE Management System are available.

Benefits of OEE software and systems

1. WHAT GETS MEASURED GETS MANAGED

The truth of the matter is that it is very difficult to manage or improve what you don't measure. The improvement potential that OEE highlights can surprise even the most experienced production professional and accurately measuring OEE for the first time can be a humbling experience. However, tracking OEE exposes the previously hidden manufacturing issues and enables the production team to "dig deeper", revealing opportunities to enhance availability, performance and quality.

2. EASY DATA HANDLING

The powerful drill down capability together with a built-in improvement agenda enabled individuals at all levels to gain a deeper insight into production processes, develop a greater awareness of the related commercial value and generate more robust issue management processes.

OEE systems provide a balanced approach that takes in a specific set of data and generates out clear, accurate management information.

Eliminate spreadsheets - all data is fed simply and easily into the OEE system where it is automatically manipulated to enable graphical reporting and provide the basis for further analysis.

Potential to eliminate shop-floor paperwork altogether – manual data capture and tracking is sufficient to gain significant insight and benefit from the OEE system. However, automated data capture can enhance the results still further, increasing the integrity of the data and saving shop-floor staff the time and effort involved in paper-based data capture.

Delivering useful information, rather than numerous data points – some companies have production data overload. One SCADA supplier actually offers a software tool to make sense of complex machine data generated by their own SCADA system. You may have access to information from CMMS, SCADA, machine or line PLCs, MRP and ERP systems and all may be valuable in their own right, but are unlikely to be properly focused on performance.

Idhammar's OEE Management System is based on secure SQL data engines to provide detailed analysis and drill down at the touch of a button, automatic reporting with unlimited date/time ranges, multi-user/multi-site access, and validated data entry. Systems like these eliminate the need for spreadsheets and allow the time spent in capturing and handling the data to be better used for analysis and improvement.

3. CLEAR REPORTING FACILITATES CHANGE-MANAGEMENT

Clear, accurate and real-time reports provide clear evidence of loss and make action unavoidable. Companies often spend too much time gathering data, leaving little time to react to the information that it contains. Idhammar OEE includes a powerful improvement agenda so that as incidents are identified, improvement targets and review and completion dates can be set. These tasks are highly visible and clarify improvement responsibilities.

4. TOWARD A CULTURE OF CONTINUOUS IMPROVEMENT

One of the most important principles for improving OEE is to extend visibility and accountability to the shop floor. When handled properly with shop-floor level training and reporting, many companies implementing OEE are surprised by the way in which it positively impacts company culture:

- **Collective responsibility** – shared ownership and problem solving. As production issues become visible, the causes of these issues are also more easily identified and often involve a number of different parts of the organization working together to resolve them.
- **Improved morale** – less finger-pointing. Engineering teams in particular benefit from the discovery that the biggest cause of down-time is due to change over or parts issues rather than machine problems and maintenance.
- **Enhanced motivation** – rather than meeting set performance targets, production teams are focused on achieving the next 1% improvement in their OEE.

This culture can extend beyond the boundaries of the factory. Bear in mind how powerful information will become during supplier commissioning meetings when you can show precisely what has failed and the consequent losses incurred. (Equipment makers don't like OEE; they prefer their own performance measurements!)

5. THE BOTTOM LINE – DRIVING SAVINGS AND INCREASING PROFITABILITY

Idhammar's OEE systems can help you to increase output without investing in capital plant or additional labour. Robert C Hansen (author and OEE guru) shows how a 10% improvement in OEE can result in a 50% improvement in return on assets. Hansen also shows that investment in OEE initiatives can be ten times more cost-effective than purchasing new capital equipment. In fact, many companies use OEE to ensure that existing equipment is fully utilized before new equipment is purchased.

Alternatively the system can help you to produce the same levels of output with fewer resources so enhancing your level of profitability. Some other real world examples include:

- A chemical processing plant increased OEE by 5% resulting in €400,000 increased contribution per year.
- A bottling plant discovered that each 1% increase in OEE gained €250,000 of contribution per year, they achieved a 22% increase in one key site
- A pharmaceutical company increased packaging machine OEE by 9% in 6 months gaining €315,000 per year.

Source: WCS International Ltd.

Idhammar's OEE System provides the foundation to measure, monitor and improve your OEE enabling you to discover your loss structure, convert losses to cash, cost justify improvements and monitor them to resolution.

OEE systems – the full potential

Loss Management

The companies currently benefiting from OEE systems all share certain characteristics; an obsession with performance measurement, detailed failure analysis and a focus on improvement. They also share corresponding improvements in profitability.

A loss management strategy encourages action based on the information presented by the OEE system. An agenda of improvement issues measures progress towards improvement targets, with each major improvement issues highlighted, the position recorded, a remedial activity generated and progress towards resolution measured.

The OEE system identifies maximum performance improvements from minimum data. It is locally configurable so that asset hierarchy, failure events, process data, products and all other factors can be changed as the production demands change. Powerful “what-if” analysis shows the benefits to be accrued by resolving problems and when the analysis identifies failures due to specific events, the software allows those events to be turned off to show what the OEE would be if those problems were resolved. This quantifies the effort that can be spent on fixing the problems and shows the extra revenue available.

Group-wide, standardised OEE

By keeping OEE measurement simple and standard, enables group-wide comparison of lines, plants and sites. Idhammar’s OEE Management System is already benefiting a number of larger organizations, providing the data from as many as 32 different sites in 10 geographies on a single database.

It is often a big eye-opener to companies who have been reporting metrics for many years that engineering data for production rates is non standard across lines and sites. Keeping the data simple and standard is obviously a key part of this and may require some consultancy and support to ensure that true, complete OEE data is collected in the same way by all involved.

British Bakeries – customer case study example

OEE analysis highlighted that a vacuum pipe on a key machine became blocked on average 2-3 times per day, usually once per shift. Each operator was aware of the issue, but as it only happened once on his shift it was considered a minor fault which only took about 5 minutes to clear – a routine cleaning task. The power of OEE is that it highlights this kind of issue showing that this simple loss cost 15 minutes of production per day, 105 minutes per seven-day week and 420 minutes or 7 hours of lost production each month.

The site was one of 17 similar plants in a UK group of companies with each one operating continuously for 145 hours per week. Further OEE analysis showed that the same issue existed at all 17 plants with the following impact:

Lost productivity per day	255 minutes
Lost productivity per week	1785 minutes
Lost productivity per month	7140 minutes
Lost productivity per year	85680 minutes, 1428 hours or 60 days!

An additional clean vacuum pipe was placed close to the machine and was exchanged at convenient pre-determined intervals without loss of production. The spare vacuum pipe cost less than €20.

HOW MANY OF THESE MINOR FAULTS EXIST IN YOUR ORGANIZATION?

Once gathered, group-wide OEE data provides management decision support information, greater visibility leading to added production flexibility and facilitates the sharing of best-practices across the group.

Environmental efficiency – energy & water savings

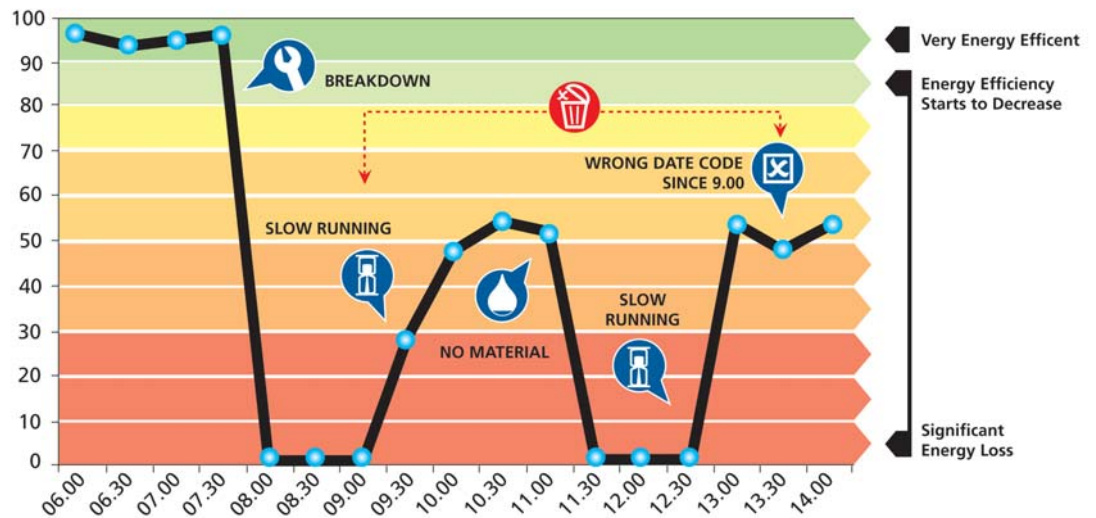
A greater general awareness of environmental issues, together with rising energy costs and increased Government targets, has caused manufacturing energy-consumption to rise to a board-room level concern. It is no longer acceptable for companies to treat energy simply as a fixed cost of production, there is an urgent requirement to monitor and improve energy-efficiency.

Most manufacturers have already implemented a wide range of energy related programmes with varying degrees of success including: switch-off campaigns; intelligent production scheduling at a lower time-tariff; installing new energy-efficient equipment or enhancing maintenance to reduce leaks. All of these programmes are necessary for an ongoing improvement in energy consumption but they are not sufficient on their own. There is a bigger prize to be gained in operating the factory as effectively as possible to maximise energy-efficiency.

Major contributors to wasted energy include:

1. **Break down** – much of the plant; conveyors, pumps, ovens, shrink tunnels, etc. continue to cycle, wasting large amounts of energy.
2. **Start-up** – many items of plant use more energy at startup than at normal operating speed, particularly electricity, so if the plant breaks down frequently, more energy will be used.
3. **Slow running equipment** – uses the same amount of energy as equipment running at full capacity.
4. **Rejects and Scrap** – these waste all the added-value used to produce them including labour, materials and energy.
5. **Under-utilized capacity** – companies invest in additional capacity, unaware that existing lines are underperforming and could provide the production increase they are looking for. It is well proven that improvements to existing plant are 10 times more effective than the installation of new capacity and this would include energy consumption.

The results of one or more of these factors on a normal production cycle can have a dramatic impact on both the productivity and the energy-efficiency of a production line, as illustrated in the diagram overleaf.



Implementing an OEE system provides the monitoring and indicators to enhance the overall efficiency of a factory in terms of productivity, quality and energy consumption.

Automatic data capture

Implementing a dedicated OEE system will greatly enhance continuous improvement and lean manufacturing programmes regardless of the method of data collection and input. While manual data capture is far better than no data capture, automatic data capture for OEE measurement provides a step-function increase in accurate, real-time data collection that also leads to the elimination of factory-floor paperwork.

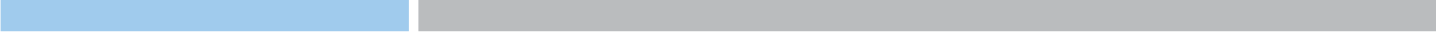
The accuracy of manual data capture with paper-based production line logs is impacted by:

- Missing or ignoring minor stoppages
- Operators, busy fixing problems, will struggle to record lost time accurately
- Recording the exact timing of production start-up is complex to do manually
- Paper-work on the factory floor can get lost, damaged and requires additional manual handling and processing

Automatic data collection becomes critical once OEE is above 65%. At this level of OEE, losses are often performance related and generally comprise a large frequency of small time periods. For example 240 stops of 15 seconds each in an 8 hour shift is still an hour lost, but is almost impossible to record accurately on paper logs. As a result the operator receives little feedback on current performance and major decisions may be made on inaccurate data.

The key to automatic data capture is to obtain accurate data without removing the involvement of the operator from the process.

Fully automatic process control systems such as SCADA (Supervisory Control And Data Acquisition) systems where the time and failure reason is pulled from the PLC, can provide some level of data but are generally limited by their event alarm lists. For example the operator, seeing a fault at the end of the line, chooses the stop the line by opening the nearest machine guard. The alarm list records 'guard open' rather than the root cause of the failure.



A dedicated data capture system can improve the accuracy and relevance of the data to the OEE system by recording the product, reject counts and failure times automatically and then involving the operator to confirm the reason for the event. This approach includes the following three benefits:

- Every loss is recorded, including minor stoppages to ensure that everything is accurately measured and monitored
- The operator is fully involved and quickly aware of the situation including real-time management information to support decision making:
 - Time to finish this product at current performance
 - Worst stoppage events this and last shift
- Completely paper-less data capture, removing paper from the shop-floor

Automatic time recording also provides a further benefit – the ability to manage plant start-ups. If we schedule the plant to start at 06:00, at exactly 06:00 the software will check for a running signal and product counts, if none are found the stop is recorded and the operator must select a reason for the 'failure'. One pharmaceutical company has saved almost 20 minutes per line, per day by addressing this type of loss.

Idhammar OEE is extremely flexible and can link to data from external event generators or other data sources as well as being able to import most common data types.

In summary

OEE IS A POWERFUL TOOL to identify previously hidden manufacturing losses and inefficiencies. Tracking OEE scores and using them to drive improvements in manufacturing processes is a vital step forward towards world-class lean manufacturing for organizations of all sizes and industries.

OEE systems, such as the Idhammar OEE Management System, provide the rich functionality necessary to expose exactly what percentage of production time is truly productive and to dig deeper to reveal the causes of lost productivity. Even increasing the OEE score by 1% can lead to dramatic savings and turn-around lost production time into a positive contribution to profit.