Overall Equipment Effectiveness: Monitor and Improve Your Manufacturing Processes

At a Glance:

- This paper defines Overall Equipment Effectiveness (OEE) and describes the components and relevance of this metric.
- By analyzing production metrics of availability, performance, and quality, management can pinpoint factors causing lost time and low OEE.
- The Plex Manufacturing Cloud provides traceability tools to not only measure OEE but to resolve the lost time issues it signifies.

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White Paper

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Summary

Manufacturers looking to optimize production processes and profitability are turning to Overall Equipment Effectiveness (OEE) measurement and analysis. Their goal is to reduce lost production time and improve performance. OEE sheds light on the percentage of production time that is truly productive, using the latest in advances in sophisticated measurement and analysis tools. Included here are the calculations that form the basis of OEE and a look at ways to obtain real-time insight into activities and performance by machine, worker, shift, material, and supplier.

Manufacturers face a challenging competitive landscape with the constant pressures of global competition, escalating material and labor costs, changing customer mandates, and variable market demand.

These ever-increasing pressures to cut cost, as well as improve quality and performance, have led today's manufacturers to OEE as a powerful metric that can help them increase production efficiency and profitability.

After all, if a machine is running at sub-optimal effectiveness, the entire enterprise is wasting resources and operating at a sub-par level of performance, with a resulting negative impact on profitability.

OEE Defined

Technically, OEE is the ratio of fully productive time to planned production time. This paper includes a more detailed look at the calculations behind this definition including the significant metrics of machine availability, machine performance, and output quality. Yet in the simplest terms, OEE is the percentage of production time that is truly productive.

For example, if OEE is 50 percent, that means the equipment is running at only half of its theoretical potential. On the other hand, if OEE is 100 percent, that means production is running perfectly — no downtime, no slow cycles, and no defects. Looking at it another way, OEE is a "best practices" way to monitor and improve the effectiveness of manufacturing processes including machines, manufacturing cells, and assembly lines.

Compared to other initiatives — which over the years have been part of a long

parade of manufacturing buzzwords and systems — OEE truly reduces complex production problems into the simple, intuitive presentation of information. OEE helps manufacturers systematically improve the production process with easy-to-obtain measurements.

OEE is also part of the latest advances in continuous improvement and lean manufacturing programs, including Total Productive Maintenance (TPM).

OEE Analysis Enables Efficiencies

Manufacturers looking to implement OEE improvements can now access an effective suite of tools which help make a company's production assets more efficient and profitable.

These tools make manufacturers aware of production bottlenecks as they happen so they can shift production to optimize their efficiency and throughput. For instance, the measurement tools enable management to easily identify when one machine is dragging down the entire facility, and when other machines have excess capacity that could be tapped easily and inexpensively.

Measure for Success

It's a simple truth that one can't improve what one doesn't measure. OEE is a measure of the effectiveness of manufacturing operations — from a single piece of equipment to an entire manufacturing plant. It provides a complete picture of where productive manufacturing time is being lost.

> "OEE is the ratio of fully productive time to planned production time."

OEE is simple and practical. It takes the most common and important sources of manufacturing productivity loss, places them into three categories (availability, performance, and quality) and distills them into metrics that are used to measure the current state and how that state can improve.

OEE is frequently used as a key metric in TPM and lean manufacturing programs, providing a consistent framework and method for measuring the effectiveness of these programs.

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Significant Metrics

As a standard measure of performance, OEE brings together the three significant production metrics:

- Availability
- Performance
- Quality

These straightforward production metrics focus on the underlying causes of productivity loss and are based on the following formulas:

- **Availability** is the ratio of Operating Time to Planned Production Time (Operating Time is Planned Production Time less Downtime Loss).

  Therefore, Availability is calculated as the ratio of Operating Time to Planned Production Time. 100 percent Availability means the process has been running without any recorded stops.

- **Performance** is the ratio of Net Operating Time to Operating Time (Net Operating Time is Operating Time less Speed Loss).

  Performance is calculated as the ratio of Ideal Cycle Time to Actual Cycle Time or, alternately, the ratio of Actual Run Rate to Ideal Run Rate. 100 percent Performance means the process has been consistently running at its theoretical maximum speed.

- **Quality** is the ratio of Fully Productive Time to Net Operating Time (Fully Productive Time is Net Operating Time less Quality Loss).

  Quality loss is the ratio of Good Pieces to Total Pieces. 100 percent Quality means there have been no “reject” or “rework” pieces.

Calculating Loss

Using the previous calculations as a foundation, it is possible to measure the exact lost time — such as downtime — experienced by equipment. This enables management to pinpoint the factors that contributed to that loss.

- **In terms of Availability,** Operating Time takes into consideration Downtime Loss and is calculated as follows:

  Operating Time = Planned Production Time – Downtime Loss

- **In terms of Performance**, Net Operating Time takes into consideration Speed Loss and is calculated as follows:

  Net Operating Time = Operating Time - Speed Loss

- **In terms of Quality**, Fully Productive Time takes into consideration Quality Loss and is calculated as follows:

  Fully Productive Time = Net Operating Time – Quality Loss

Tools of OEE

Taking these calculations into consideration, it is imperative for a manufacturer to implement a reporting system that provides automatic, real-time OEE reporting to measure downtime loss due to breakdowns, set-ups, and adjustments; speed loss due to small stops and reduced speed; and quality loss due to startup rejects and production rejects.

Manufacturing ERP software solutions such as Plex Cloud ERP help by providing real-time insight into activity and performance by machine, by worker, by shift, by material, and by supplier.

Plex provides OEE measurements, with detailed tracking of everything a manufacturer receives, makes, and ships. This information enables management to reduce product defects and recalls.

"OEE is a measure of the effectiveness of manufacturing operations."

OEE and Traceability

OEE also depends on an accurate traceability system that tracks individual containers and components as they flow through the manufacturing process,

and can isolate problems with pinpoint precision.

This system must provide detailed historical information related to production, inspection, genealogy, and usage.

World-Class OEE Rates

Recent studies indicate that the average OEE rate in manufacturing plants is 60 percent. As shown below, a world-class OEE is considered to be 85 percent or better.

OEE Factor	World Class
Availability	90.0%
Performance	95.0%
Quality	99.9%
OEE	85.0%

Plex provides powerful but simple-to-use functions to measure OEE and maximize uptime and productivity. Since equipment effectiveness affects shop floor employees more than any other group, Plex enables them to track OEE and plan and implement equipment and workflow improvements to improve efficiency.

OEE reporting and analysis — available from the shop floor to the top floor — helps a company avoid costly breakdowns, develop a knowledge base of technical experience, and respond quickly to maintenance problems.

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