CAPSTONE METRICS

The Line of Sight to Manufacturing Excellence

Overall Equipment Effectiveness (OEE)

A General Discussion with Calculation Methods

Table of Contents

Overview of the System of OEE Metrics

What is OEE

In the most general sense, Overall Equipment Effectiveness (OEE) can be described as a universally accepted set of metrics that bring clear focus to the key success drivers for manufacturing enterprises. The OEE strategy is considered "best practice" and dovetails well with the Lean Manufacturing and Six Sigma continuous improvement philosophies. In fact, the OEE set of metrics can provide the key indicators of progress on the lean journey.

OEE should not be viewed as a fad or flavor of the month; the measurement technique has been in practice for many years, albeit with a narrower purpose. Historically, OEE was used as a top-level summary view of capacity and its utilization. In recent years it has reappeared but with a more valuable multi-level view of the business, placing emphasis on the underlying issues that limit performance. The resurgence of OEE is doubtless related to its ability to plainly portray the opportunities for improvement that exist for all manufacturers.

Functionally, these metrics provide the basis by which excellent manufacturers may systematically direct their business towards attainment of critical objectives…

- Ever-Improving Operating Margins
- Optimized Competitive Position
- Maximized Utilization of Capital

More specifically, OEE can be best illustrated by a brief discussion of the six metrics that comprise the system. The hierarchy consists of two top-level measures and four underlying measures.

The Two Top-Level Metrics

Overall Equipment Effectiveness (or OEE) and Total Effective Equipment Performance (or TEEP) are two closely related measurements that report the overall utilization of facilities, time and material for manufacturing operations. These top view metrics directly indicate the gap between actual and ideal performance.

- **Overall Equipment Effectiveness** (or **OEE**) quantifies how well a manufacturing unit performs relative to its designed capacity, *during the periods when it is scheduled to run.*
- **Total Effective Equipment Performance** (or **TEEP**) measures OEE effectiveness against calendar hours, i.e.: *24 hours per day, 365 days per year.*

The Four Underlying Metrics

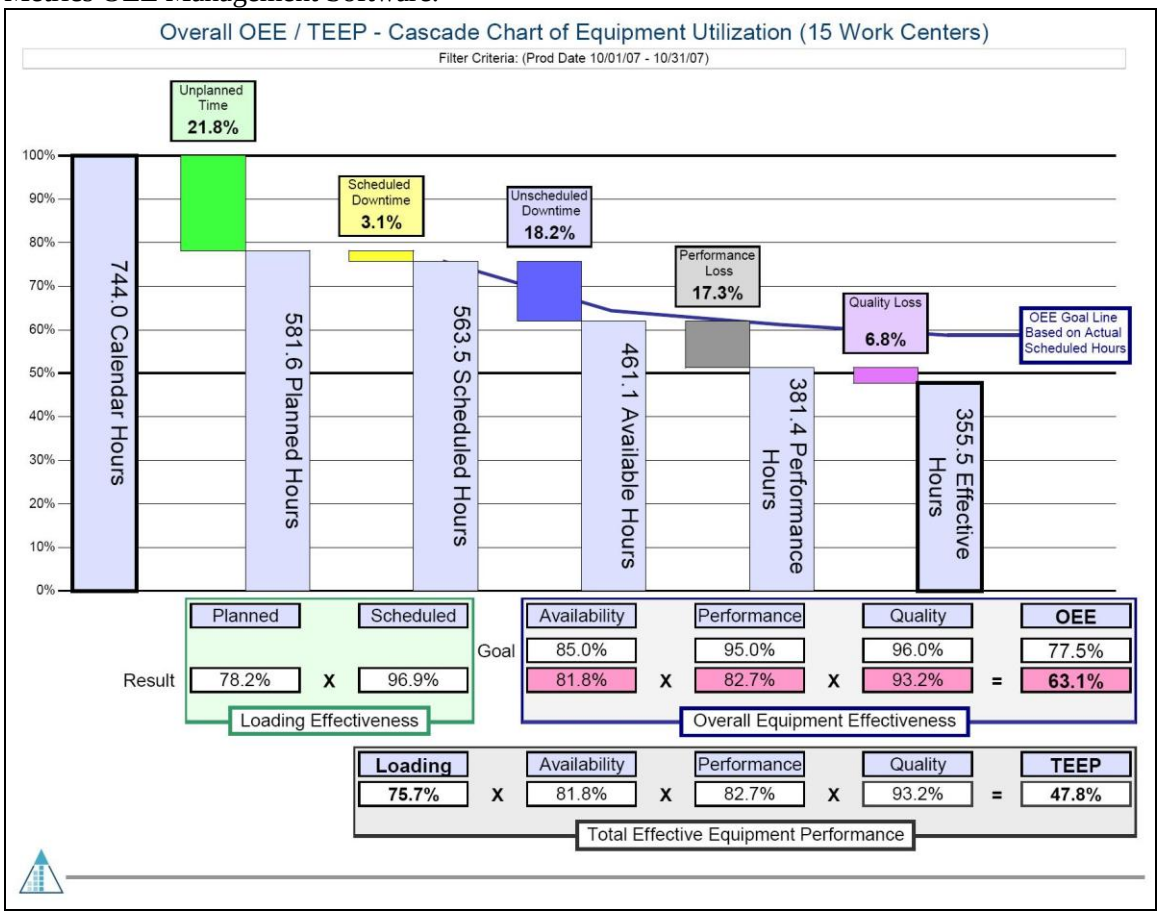
In addition to the above measures, there are four underlying metrics that provide understanding as to why and where the OEE and TEEP performance gaps exist. A comprehensive OEE measurement system, such as OEE Management by Capstone Metrics, allows this data to be the primary driver for improvement at all levels of the enterprise.

The measurements are described below:

- **Loading**: The portion of the TEEP Metric that represents the percentage of total calendar time that is actually scheduled for operation.
- **Availability:** The portion of the OEE Metric represents the percentage of scheduled time that the operation is available to operate. Often referred to as Uptime.
- **Performance:** The portion of the OEE Metric represents the speed at which the Work Center runs as a percentage of its designed speed.
- **Quality:** The portion of the OEE Metric represents the Good Units produced as a percentage of the Total Units Started. Commonly referred to as First Pass Yield.

Visualizing OEE/TEEP by use of a Cascade Chart

To more clearly understand the metrics and their roles, a Cascade Chart is useful. An example of comprehensive OEE/TEEP presentation is shown below in a sample report from Capstone Metrics OEE Management Software.



Sample Report from Capstone Metrics *OEE Management Software* ©2001-2011

The left three bars indicate what is presented to the production team in terms of scheduled time and/or booked business volume. This combination is also referred to as Loading.

The three bars on the right side display how effectively that scheduled capacity is utilized. This is

the OEE performance. Note that the blue OEE Goal Line depicts plant OEE targets based on the *actual* Loading.

In total, the six bars signify the progressive erosion of ideal capacity and the categories of loss that are responsible. The remaining utilized capacity, after losses, is reflected by the TEEP metric. It can now be seen that TEEP = Loading x OEE.

Study of the Cascade Chart reveals that each category of loss in the Capacity Stream can now be identified. Ownership of each loss will naturally flow to specific functional areas.

Calculations for OEE and TEEP

What follows is a detailed presentation of each of the six OEE / TEEP Metrics and examples of how to perform calculations. The calculations are not particularly complicated, but care must be taken as to standards that are used as the basis. Additionally, these calculations are valid at the work center or part number level but become more complicated if rolling up to aggregate levels.

OEE (Overall Equipment Effectiveness)

OEE breaks the performance of a manufacturing unit into three separate but measurable components: Availability, Performance, and Quality. Each component points to an aspect of the process that can be targeted for improvement. OEE may be applied to any individual Work Center, or rolled up to Department or Plant levels. This tool also allows for drilling down for very specific analysis, such as a particular Part Number, Shift, or any of several other parameters.

It is unlikely that any manufacturing process can run at 100% OEE. Many manufacturers benchmark their industry to set a challenging target, 85% is not uncommon.

Calculation: OEE = Availability x Performance x Quality
Example:
A given Work Center experiences:

Availability of 86.7%.
The Work Center Performance is 93.0%.
Work Center Quality is 95.0%.
OEE = 86.7% Availability x 93.0% Performance x 95.0% Quality = 76.6%

TEEP (Total Effective Equipment Performance)

Where OEE measures effectiveness based on scheduled hours, TEEP measures effectiveness against calendar hours, i.e.: 24 hours per day, 365 days per year. TEEP, therefore, reports the 'bottom line' utilization of assets.

Calculation: TEEP = Loading x OEE
Example:
A given Work Center experiences

OEE of 76.67%.
Work Center Loading is 71.4%
TEEP = 71.4% Loading x 76.7% OEE = 54.8%

Stated another way, TEEP adds a fourth metric 'Loading'.
TEEP = Loading x Availability x Performance x Quality

Loading

The Loading portion of the TEEP Metric represents the percentage of time that an operation is scheduled to operate compared to the total Calendar Time that is available. The Loading Metric is a pure measurement of Schedule Effectiveness and is designed to exclude the effects how well that operation may perform.

Calculation: Loading = Scheduled Time / Calendar Time
Example:

A given Work Center is scheduled to run 5 Days per Week, 24 Hours per Day.
For a given week, the Total Calendar Time is 7 Days at 24 Hours.
Loading = (5 days x 24 hours) / (7 days x 24 hours) = 71.4%

Availability

The Availability portion of the OEE Metric represents the percentage of scheduled time that the operation is available to operate. The Availability Metric is a pure measurement of Uptime that is designed to exclude the effects of Quality, Performance, and Scheduled Downtime Events.

Calculation: Availability = Available Time / Scheduled Time
Example:

A given Work Center is scheduled to run for an 8 hour (480 minute) shift.
The normal shift includes a scheduled 30 minute break when the Work Center is expected to be down.
The Work Center experiences 60 minutes of unscheduled downtime.
Scheduled Time = 480 min - 30 min break = 450 Min
Available Time = 450 min Scheduled - 60 min Unscheduled Downtime = 390 Min
Availability = 390 Avail Min / 450 Scheduled Min = 86.7%

Performance

The Performance portion of the OEE Metric represents the speed at which the Work Center runs as a percentage of its designed speed. The Performance Metric is a pure measurement of speed that is designed to exclude the effects of Quality and Availability.

Calculation: Performance = Actual Rate / Standard Rate
Example:

A given Work Center is scheduled to run for an 8 hour (480 minute) shift with a 30 minute scheduled break.
Available Time = 450 Min Sched - 60 Min Unsched Downtime = 390 Minutes
The Standard Rate for the part being produced is 40 Units/Hour.
The Work Center produces 242 Total Units during the shift. Note: The basis is Total Units, not Good Units. The Performance metric does not penalize for Quality.
Actual Rate = 242 Units / (390 Avail min / 60 min/hr) = 37.2 Units/Hour
Performance = 37.2 Units/Hour / 40 Units/Hour = 93.0%

Quality

The Quality portion of the OEE Metric represents the Good Units produced as a percentage of the Total Units Started. The Quality Metric is a pure measurement of Process Yield that is designed to exclude the effects of Availability and Performance.

Calculation: Quality = Good Units / Units Started
Example:

A given Work Center produces 230 Good Units during a shift.
242 Units were started in order to produce the 230 Good Units.
Quality = 230 Good Units / 242 Units Started = 95.0%

About Capstone Metrics LLC…

Capstone Metrics LLC has been providing **OEE Management Software** to outstanding manufacturers since 2001.

OEE Management Software is the premier product for companies that desire to optimize their Overall Equipment Effectiveness (OEE) results. The software is designed to integrate with Lean Manufacturing and Six Sigma efforts and has a 10 year history of continuing upgrades and improvements. Key features include: flexible and powerful reporting; ease of use; fast implementation; excellent adaptability; and low cost.

For more information on Capstone Metrics and **OEE Management Software** please visit us at www.capstonemetrics.com