# OEE—LEARN HOW TO USE IT RIGHT

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As with any metric, Overall Equipment Effectiveness (OEE)—the powerful core metric used in Total Productive Maintenance (TPM)—can be misunderstood and misused. In fact, we see it grossly misused at times.

Pointing out the potential for misuse is not sacrilegious; it's necessary. So, rather than label it a "bad metric" (and throw the proverbial baby out with its muddy bathwater), let's check the facts and the misunderstandings about OEE and see how it can truly help you.

Put simply, ***OEE assigns numerical value to improvement opportunity***. It factors in the availability, performance and quality of output of a given piece of equipment and tells you this:

*How much* ***right-first-time*** *product did this machine produce compared to what it should have produced in the allocated time?*

In other words, is a piece of equipment effective within its value stream? Does it let you meet present or future customer demand? If not (and this is critical), OEE helps you analyze the reasons why so you can address them systematically.

## How OEE Works

The OEE calculation rolls the "6 big losses" of TPM into one number that represents the effective operating rate for a piece of equipment or synchronized line—in other words, the percent of time the equipment or line is operating effectively, or its *valuable operating time*. That translates to the percentage of product produced compared to what could have been produced in the scheduled time.

**THE 6 BIG LOSSES**

| | |
|---|---|
| Availability (downtime) | 1. Equipment failure (breakdowns) |
| | 2. Setup and adjustment |
| Performance (speed) | 3. Idling and minor stoppages |
| | 4. Reduced speed of operation |
| Quality (defects) | 5. Process defects (scrap, repairs) |
| | 6. Reduced yield (from startup to stable production) |

It’s calculated like this:

**OEE (%) = Availability rate × Performance rate × Quality rate**

**Availability rate** (percentage of time the machine is ready to produce, working properly, and not in the midst of changeovers or adjustments) = ***Available time (scheduled operating time – downtime) ÷ Scheduled operating time***.

- **TIP:** Note that we normally use scheduled operating time (or “planned time”), not total time, because we might only plan to run a machine for half a shift to meet customer demand. This distinguishes efficiency from effectiveness. Effectiveness relates to customer demand. Focusing solely on the efficiency of individual pieces of equipment can lead to overproduction and excess inventory.
- **TIP:** Scheduled operating time usually does not include time set aside for planned maintenance or breaks. Other downtime is considered loss, including setup, adjustment, and breakdowns.

**Performance rate** (ratio of output produced compared to a standard) = ***Actual output ÷ Standard output.***

- **TIP:** The rule of thumb for standard output is to use the best output rate known to be produced on the machine, regardless of whether that is above or below design speed. If a machine consistently outperforms its design spec, your performance rate will exceed 100% and potentially mask availability problems. On the other hand, if the machine has never been able to achieve its design spec, it’s usually not helpful to use that as the standard.
- **TIP:** Any losses due to minor stoppages, idling, or slowdowns show up in the performance rate.

**Quality rate** (ratio of good output compared to actual output) = ***Right-first-time output ÷ Actual output***.

- **TIP:** Any defective output, including output that needs rework or repair or is scrapped during adjustment, is not counted as quality output.

## EXAMPLE OEE CALCULATION

**AVAILABILITY**

- Gross available time = 8 hours, or 480 minutes
- Planned downtime = 20 minutes
- Breaks = 0 minutes (all breaks are covered)

**Scheduled Time = 480 – 20 = 460 minutes**

- Breakdowns = 20 minutes
- Setups and adjustments = 20 minutes
- Minor stoppages = 20 minutes

**Downtime = 60 minutes**

**Available time = Scheduled time – Downtime = 460 – 60 = <u>400 minutes</u>**

**Availability rate = Available time ÷ Scheduled time = 400 minutes ÷ 460 minutes = <u>87%</u>**

**PERFORMANCE**

- Standard (ideal) output (@ 0.5 parts per minute ideal cycle time) = 800 parts
- Actual output produced (including good and bad parts) = 400 parts

**Performance rate = Actual output ÷ Standard (ideal) output = 400 parts ÷ 800 parts = <u>50%</u>**

**QUALITY**

- Actual output produced (including good and bad parts) = 400 parts
- Defective parts, rejects, and scrap = 8 parts; Good parts = 400 – 8 = 392 parts

**Quality Rate = Right-first-time output ÷ Total actual output = 392 good parts ÷ 400 actual parts produced = 98%**

**OEE = 87% Availability × 50% Performance × 98% Quality = 42.6%**

## OEE is Not TPM (and Other Misunderstandings)

OEE is the measure most closely associated with TPM, but OEE is not equivalent to TPM. At its heart, TPM is not about complex metrics; it's about developing the capabilities of people. Everyone is involved in pursuing the dual goals of zero breakdowns and zero defects. Production, maintenance, and engineering form an efficient partnership, and operators share "ownership" in equipment. The new attitudes and behaviors result in a cultural shift that improves morale, drives continuous improvement, targets total asset reliability, and supports lean initiatives.

TPM is fundamental to achieving lean flow, because flow can't happen without reliable equipment and processes. In turn, a good understanding of OEE fosters an effective TPM effort.

Because OEE packs a lot of information into one number, it's powerful. But that can also make it difficult to calculate and confusing to interpret. People commonly get into trouble when they try to:

- Use OEE primarily as a high-level KPI (key performance indicator)
- View OEE as an external measure that has meaning to customers
- Multiply OEE across several machines in a department or plant
- Calculate OEE on every piece of equipment
- Gauge themselves against a "world-class" OEE measure
- Focus on the number for its own sake instead of the improvement context
- Use OEE as a club rather than a yardstick

Let's take a look at four key ways that OEE can be used effectively to really help you.

## Key 1: Use OEE as an improvement metric

The critical value of OEE is that it helps you understand and analyze the 6 big losses. Think of it as an improvement measure, not a KPI. An operational metric like build-to-schedule is a simpler indicator of how your process is performing against schedule. Likewise, a measure like OTIF (on-time in full) lets you know whether you are meeting customer demand.

However, if you are not meeting demand because equipment is not working effectively in your value stream, you need to know why. That's where OEE comes in—it provides levels of analysis to help you improve. Was there too much downtime? Not enough production when running? Too many defects?

Jim Leflar, senior mechanical engineer at Avago Technologies, talked with us recently. He put it this way:

> *The trouble with a simple line performance metric is that it doesn't tell you where your losses are. It may tell you that you're operating at 80% or 90% of perfect, but you would have to look beyond the metric to analyze your losses. I use OEE more as a concept than as a line performance metric. We use it to teach people what loss is and how to look for it on their line.*

Leflar originally learned about the value of OEE from a Toyota engineer who was "one of the hundred nameless people who helped develop TPM in the 1970s." The engineer advised him to use a simple metric like build-to-schedule on the line, and to use OEE for teaching teams about loss. "If you are running normally, meeting schedules, you may think 'wow, I'm good; there's nothing to improve'," Leflar said. In many cases, machines may be up and running in a certain way for years, and nobody thinks about the way they perform. Things just are the way they are, and accepted as normal."

"But if we apply OEE and a focus team," Leflar said, "and take a look at each step in the line or at each machine and identify where we are not adding any value, all that is defined as a loss somewhere in the OEE metric. We can sample OEE on a given machine and rather readily identify opportunities for reducing the 6 big losses."

A simple value stream metric like build-to-schedule also will not tell you whether machines are being used effectively, because the target is based on schedule, or present demand, not on theoretical capacity. You might be running at a greatly reduced speed but still reaching your target.

OEE helps match the theoretical capacity of equipment with production demands. If you are not meeting demand and you find that equipment is underperforming (operating at a low OEE), you know you have an *equipment effectiveness problem* that can be improved. If equipment is operating at a high OEE but not meeting customer demand, you know you have a *capacity problem.* And even if you are meeting current demand, without OEE you don't know whether you have spare capacity to keep up with changes in demand.

## Key 2: OEE is best used on a single piece of equipment or synchronized line.

First of all, never try to multiply OEE rates across multiple machines, lines, or processes. You can't calculate an aggregate OEE for a plant, only an average. And while the average OEE for a plant can give you a rough idea of equipment performance (an overall low OEE is usually an indicator of poorly maintained assets), it doesn't really tell you a whole lot more than that. Nowhere is it chiseled in stone that OEE should be used across the organization, or used to compare shifts, departments, plants, or divisions. It was never intended to be used that way.

Rather, OEE is best used to measure the performance and analyze the losses on a particular piece of equipment so that they can (1) be understood and (2) be addressed. At the top level, it measures good output against planned good output, using the planned production hours and ideal cycle time. That's a measure of how the equipment is performing. When there is a problem, it provides the breakdown of availability, performance, and quality to help you hone in on the problem.

The idea is to measure OEE on your constraint piece of equipment or bottleneck and work to elevate that. Focus on improving that asset, using OEE to check and see whether you're doing the right things, and then move on. Ultimately you're going to measure OEE on everything because the whole concept behind lean is to remove your constraints. Every time you elevate one constraint it means that something else in the value stream becomes the constraint. That's where the concept of kaizen comes into play. OEE is a leading indicator that can point you in the direction where improvement is needed; then it becomes a lagging indicator to tell you whether or not you did the right thing.

## Key 3: There is no absolute that works as an OEE benchmark or target—it's relative to your situation.

Your target should not be a world-class benchmark. It's about drawing a line in the sand for a given piece of equipment (most often your constraint or bottleneck) and checking where you are relative to that line. Certain processes will never be capable of giving you a world-class number, because they weren't designed to do that. It isn't about changing a number; it's about the things we do that cause that number to change. I fully agree with Leflar's comment: "The number itself doesn't mean anything. You could be at 17%, or, as I've seen, 120%. It depends on what you define as the normal operating rate. So, it's not whether your OEE is 85% or 25%; the rate at which you improve is the real measure of world class."

## Key 4: It's a *yardstick*.

Like any other metric, OEE can be used as a club to reprimand or blame people, but it's really intended to be a yardstick for measuring improvement. Unless you use it as the latter, you will get the numbers you are looking for, but you won't get the expected results. The proper use is to get beyond blaming people and understand what needs to be changed in the process. Only then will you get the true value out of OEE (or any metric for that matter) and out of TPM.

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