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We're all in a race—*a race to improve competitiveness*. Our racecars and our plant's equipment are sometimes running "balls to the wall" (so to speak), but we often lose sight of how well we're doing with our maintenance and reliability programs. We can measure a lot of things, but does overall equipment effectiveness (OEE) truly indicate how well our equipment is performing?

What first began as a very simple concept has morphed into one of today's most misused and misunderstood equipment reliability metrics. OEE's original intent involved measuring machine performance improvement over time by way of three data sets: Availability, Performance Efficiency and Rate of Quality. Seems straightforward enough. I've written about OEE several times in the past decade, but it bears repeating—*especially after my last column on hidden losses*. And there's more to the story, too...

In the early days of Total Productive Maintenance (TPM) in America (around 1986-1990), we learned TPM was about "improving equipment effectiveness." In fact, the acronym "IEE" was floated among the early purveyors in this country. IEE (improving equipment effectiveness) didn't stick: OEE did. Since then, these three vowels have led managers, consultants, authors, speakers and continuous-improvement experts down a road to mass confusion and disagreement.

In case you haven't noticed, we frequently have a tendency to confuse the original meanings and usefulness of lots of things. It seems to be especially true with acronyms—*those shorthand abbreviations for a series of words that are meant to communicate a powerful concept*. "Overall equipment effectiveness" has fallen prey to a fuzzy interpretation because the roots were severely pruned back, shortened and grafted into a new species of modern metrics.

Interpreting 'balls to the wall'

"Balls to the wall" has also fallen prey to fuzzy interpretation over the years. What does it really

mean? If you're guessing, you may be thinking it has something to do with "going flat out" in terms of speed or effort. You're right. Sometimes, you might also hear "balls out" in reference to performance—*much like Star Trek's engineer Scotty telling Captain Kirk, "I'm giving you all she's got down here."*

These phrases seem to have originated around the following operations in the mid- to late-1700s:

- Grain-grinding windmills controlled the space between the millstones with governors.
- Governors limited the speed of water wheels.

Watt-type centrifugal governor (1788) on a Boulton and Watt steam engine at the Science Museum, London (click here for link) In 1788, James Watt applied the principle to control the speed of the double-acting steam engine that he and his business partner Matthew Boulton introduced. By stabilizing their speed, Watt's fly-ball-governor design prevented these engines from running too fast and self-destructing. This governor usually consisted of two heavy steel or brass balls attached to a vertically rotating shaft. As the engine sped faster, centrifugal forces would cause these balls to spin outward in a wide circle around the shaft, whereupon they would pull a "governor" ring upward. Gravity would then pull the rotating balls back down. Because the governor was connected to a throttle valve, the engine speed would basically be limited and controlled. The "balls to the wall" (or "balls out") scenario

was when the engine was running flat out, at the point there was no more power to be had. The governor balls were spinning as fast as they could—
spinning horizontally, to the walls.

This graphic characterization was not exclusive to steam engines, though: It was used in connection with early steam-powered locomotives, as in "throttles wide open, giving all she's got!" World War II fighter pilots also used the term "balls to the wall" in regard to pushing ball-topped throttle levers all the way forward, to the firewall of the aircraft. It meant, in no uncertain terms, that they were going as fast as they could.

While today's "balls to the wall" connotation may have a similar meaning to that of 300 years ago, the true meaning is often lost—*much like the meaning of OEE in many plants today.*

Measuring equipment improvement

OEE is a basic concept to help answer this question: "How's the equipment doing now?" In other words, in general (overall) is the equipment doing what it's supposed to be doing? If not, where's the problem and what could be causing it? Is it unplanned downtime or scheduled shutdown losses (availability losses)? Is it running inefficiently, stopping for short times or idling (efficiency losses)? Is it running but producing defects and scrap (quality/yield losses)?

When improvements get underway, the OEE questions come into play again: "How's the equipment doing now compared with the last time we looked?" Review availability, efficiency and quality/yield losses. What's changed? In the beginning, OEE was just that simple—*comparing one machine's performance against itself over a period of time (i.e., measuring equipment effectiveness).*

Calculating overall equipment effectiveness

Supposedly to make things easier, the OEE concept was turned into a formula: Availability % (x) Efficiency % (x) Quality/Yield %. These three factors resulted in a product also called "OEE." Here's where it starts getting squirrely. Somewhere in the historical evolution of OEE, we began seeking ways to make our "score" higher—*imagine that!* Nobody likes a low score, right? So, IF, just IF we factor out "planned shutdown" time, and even time for "planned maintenance," and then while we're at it, let's also factor out "lunch and break times" and "meeting times"... The assumption here? This type of "non-productive" equipment downtime should not be affecting our performance score.

When this selective calculation began, OEE took a giant leap for mankind: It started becoming a key performance indicator (KPI) for the maintenance department! OUCH! What does an OEE score have to do with the maintenance department? Not much, since most of the causes of the true losses are outside the direct control of the maintenance department and its staff. OEE is about EQUIPMENT effectiveness, not MAINTENANCE effectiveness. OK, some folks got it and realized that OEE was about measuring EQUIPMENT effectiveness as part of Total Productive Maintenance—*an equipment-management strategy that engages everyone in the organization, especially those who can influence the root causes of the "major losses" or causes of poor performance.*

Yet we still see OEE scores (percentages) being used as a KPI in plants on their "lean journeys." The theory is that a low OEE must signify a problem to be eliminated or a loss or a "waste" to be targeted. But when you dig deeper into the OEE score, it really gets complicated.

OEE as it relates to efficiency

Efficiency refers to cycle times, design capacity or speed. Thus, whenever product changeovers are performed on a machine, the "efficiency" basis for OEE must also be adjusted to reflect the different cycle times for each specific product. Some take longer than others.

In lean plants, the speeds and cycle times often change to match the daily order quantities to be fulfilled. The TAKT time concept (from the German word "Taktzeit," which translates to "cycle time") is used to match the pace of production with customer demand. Consequently, the OEE score (percentage) will change when the TAKT time changes and whenever the product changes.

In these cases the cycle times used to determine efficiency losses are not fixed. They are highly variable. SO, for true OEE the actual basis for determining efficiency must change for each product.

The following Leonardo Da Vinci quote typically comes to mind at this point in the discussion of OEE:

"Simplicity is the ultimate sophistication."

What began as a SIMPLE way to think about major equipment-related losses seems to be spinning rapidly out of control, "balls to the wall!" OEE was supposed to measure machine performance improvement over time. Its use, though, has often derailed the pure fascination with eliminating equipment problems and losses.

Beware of the fallacy of OEE scores and percentages. They can be misleading, perverted, misused, misapplied and misinterpreted—*and then believed to be one of the purest equipment maintenance metrics of modern time.* But don't get me wrong: Measuring overall equipment effectiveness is very worthwhile. Just keep the factors and associated losses separate (i.e., availability, efficiency and quality/yield losses). Then add metrics for utilization, mean time between failures (MTBF) or mean time between maintenance (MTBM), mean time to repair or restore (MTBR) and some type of cost metric like equipment care and maintenance cost per unit produced, or the big one: Return on Net Assets (RONA). (IMPORTANT: Please don't try to factor all those together into one big "killer metric!")

Here's another rule of simplicity, often attributed to the Greek mathematician, Archimedes of Syracuse (287-212 BC)...

"Never guess at it when you can calculate it.
Never calculate it when you can measure it."

When calculating OEE, the result is at least six levels removed from the actual cause of the actual loss, which is the beginning of the improvement: eliminating major causes of poor performance. Measure and Pareto-chart the equipment-related losses (I use a list of 14 major ones). Focus on the left side of the chart; these are the major losses. Why calculate when you can (and should) be measuring?

What would it be like if our plants and facilities—*equipment-intensive operations*—were "balls to the wall" in the quest for productivity? For reliability? We would tap all that hidden capacity and outperform any other competitor or nation, anywhere in the world. We can do it if we truly want to. **MT**

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