OEE: AN INVITATION TO DO BETTER

Arch Systems

OEE calculation- a powerful tool to increasing value for electronics manufacturers

As manufacturers respond to evolving work-from-home requirements, decision-makers and managers worldwide are relying on technology to keep operations running. Increasingly, they're relying heavily on technology systems that provide remote visibility into all parts of their organization. When it comes to the factory floor, a fundamental piece to any such system is overall equipment effectiveness (OEE). Calculating an OEE that actually represents reality is no small task. However, once accomplished, that calculation is a powerful tool for increasing value.

So, what is OEE?

Overall equipment effectiveness is the de-facto standard used by most manufacturers as the key performance indicator for productivity. Its goal is to measure the percentage of time that a machine or manufacturing line is truly productive. An OEE of 100% will mean that a machine operated for all planned time (Availability) producing at full speed (Performance) with no defects (Quality).

The OEE Formula

OEE is computed with the following formula:

OEE = Availability × Performance × Quality

Availability shows us the percentage of effectiveness lost due to unplanned downtime or major stoppages, so

Availability = actual uptime / planned uptime

An example of calculating availability is this:

- Planned production time for an injection molding machine is 2 shifts of 8 hours each, with two 30-minute breaks in between: 16 – 1 = 15 hours of planned production
- During the actual day, 1 hour is wasted because of a material pellet shortage and another 1.5 hours is wasted because a replacement mold must be fetched at one point and a spare was not ready

$$Availability = \frac{15hr - 2.5hr}{15hr} \text{ x } 100\% - 83.3\%$$

Performance shows us the percentage of effectiveness lost due to the machine operating at less than the optimal possible speed or equivalently due to minor stoppages for that machine. This is the ratio between the number of produced units and the maximum number of units the machine should have been able to produce at full speed. Continuing with our example:

- Actual uptime for the day was 12.5 hours, as above
- The target rate of the machine is 120 units per hour or 120 UPH
- The actual number of parts produced was 1000 units as counted at the end of the day.

$$Performance = \frac{1000\ units}{12.5hr \text{ x } 120UPH} \text{ x } 100\% = 66.7\%$$

Full performance would have been 1,500 UPH, so 1,000 units is 66.7% performance.

Quality shows us the percentage of effectiveness lost due to defective parts or scrap. This is the ratio between the number of good parts produced and all the part produced. In the example:

- We inspect all 1,000 molded plastic parts and discover that 72 do not pass the quality inspection
- For the sake of this calculation, no units are reworked, all 72 are scrapped

$$Quality = \frac{1000 - 72}{1000} \times 100\% = 92.8\%$$

So, overall OEE is: OEE = 83.3% x 66.7% x 92.8 % = 51.6%. This tells us that 48.4% of the potential production capacity was wasted.

Using OEE to optimize productivity

For those just starting a digital transformation process, the ideal OEE number for any specific industry, process, or machine may be hard to know in advance. Industry 3.0 technology cannot reasonably achieve 100 percent OEE. Quality and performance losses will continue to occur because machines and materials are not perfect. In addition, outdated technology will continue to create downtime throughout the day. Many Industry 4.0 technologies aim to attack these inefficiencies.

So, what is valuable to compare?

Calculate OEE to identify baselines and room for improvement, then track it to see how much impact you can have. Compare OEE against your own best times, your own day-by-day and week-by-week pace. Just be aware of what you are comparing to what; just like runners comparing performance, it isn't that helpful to compare your fastest mile going up a slope on a hot day at high altitudes to someone else running on a flat surface at sea level. Comparing your own time doing the same slope last week, or comparing to others that ran the same slope with a similar demographic to you, or comparing to the best and worst time or the variance of those, can all be very valuable. Teams likewise can use OEE to focus on constant improvement with periodic check-ins at day, week, and month intervals to improve.

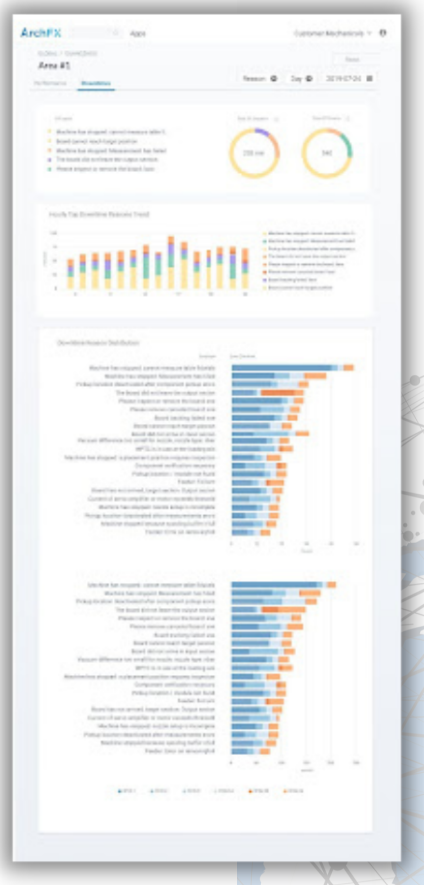
Precisely because OEE is most useful for benchmarking effectiveness, it is critical to be able to track OEE data accurately and automatically over time. Only when factories consistently track and incorporate the OEE of different machines, lines, and shifts over longer periods of time can they begin to make substantial improvements.

Centralized aggregation matched with distributed transparency

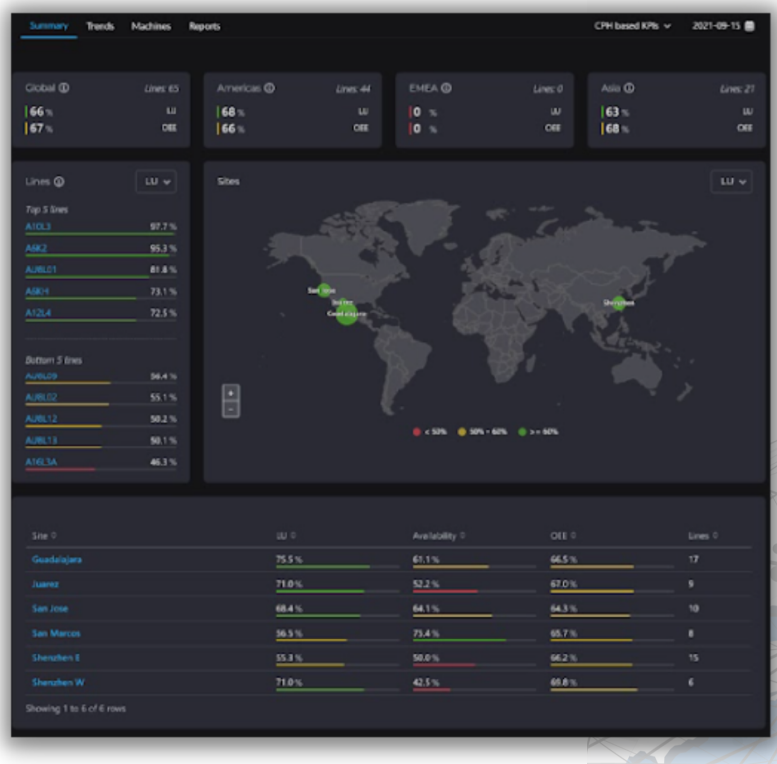
One of the most common issues cited by employees of large companies is a lack of transparency that could allow rapid, distributed decision-making. At the same time, disconnected information is commonplace, with everyone viewing and controlling their own set of information and coming to their own operational conclusions. This results in organizational resistance. Much like a rowing team, if everyone rows together, the path is straight and direct. If everyone rows to their own rhythm, they're rowing at odds, and the boat simply twists and rotates against itself, translating all that effort into waste instead of progress.

Best-in-class organizations share one important trait: transparency. Issues aren't hidden. On the contrary, they get exposed. Cooperative teams find both short-term and long-term solutions more rapidly. For large organizations with multiple sites, it is especially critical that metrics like OEE be shared across functional silos and best practices shared across teams. Equally important is a shared understanding of how to interpret the metrics so everyone speaks the same language.

An effective OEE tracking solution, by nature, needs to be centralized, using web technologies for access to a single source of ground-truth data for everyone. Having a centralized system ensures that the source data is standardized as well as the handling and presentation of data. This does not mean that everyone can see everything. A reasonable set of role restrictions is critical to maintain confidentiality and allow business leaders to feel safe sharing both up and down. But every site and area leader must be able to see everything for their site and area. This data must be the same data those above and below them are looking at. Just as companies have moved to global web-based HR systems, it is best to move to a global system for OEE and manufacturing efficiency- this is everyone rowing together to drive the boat ahead.



Automatic data gathering



No system is good if the data going in is bad. Like they say, "Garbage in, garbage out." One of the biggest buzzword myths circulating now is that AI allows bad data to be turned into good data, like worthless metals changed into gold by some sort of alchemy. On the contrary, AI eats data, and it is what it eats. For any future advanced analytics you imagine as a starting point, the AI is the data.

To have good data for a modern OEE tracking system, every time a machine finishes a part, it should automatically communicate with your OEE solution to record it. Often this is the hardest area for factories to deal with. It is not easy to pick a single visualization scheme that fits all needs, but it's perhaps ten times harder to find a single vendor that can connect to *any* type of machine. It is common for a factory to have many different machine vendors, often with a combination of legacy and modern machines. Implementing a solution with a collection of machine connectors that make it easy to extract the required data that include software-based solutions for modern machines as well as hardware-based solutions for legacy machines is critical.

Configurability, MES Tools, and Security

While the OEE formula is intended to be a standard, different companies may have small variations in the way it is interpreted. This is perfectly fine, so long as they use that same interpretation across the whole company and over time. Adopting a standard tool will achieve this alignment.

Many companies already rely on a Manufacturing Execution System (MES). It is possible to use an MES as an OEE tracking tool if three conditions are met: (1) the MES is already in place, (2) all the factory machines are already connected to the MES, and (3) the same MES is in place across the company. Most of the time, however, this is not the case.

Importantly, key performance indicators like OEE are highly confidential as they can tell the story of the health of a company. It is, therefore, extremely critical that an OEE tracking system has the proper security features such that data can be departmentalized as needed.

Takeaways

Overall equipment efficiency (OEE) is a foundational metric to measure the effectiveness of a manufacturing machine, line, or larger area. It is calculated by taking the product of availability — the ratio of used time to planned time, performance — the ratio of actual output count to possible output count, and quality — the ratio of good parts to total parts built.

Key attributes of a good system include:

- Centralized data aggregation
- Transparency, matched with proper enterprise security
- Automatic data collection, matched with the ability to accept temporary or ongoing manual data entry
- Configurability of metric definitions
- Ability to deploy advanced analytics on the data
- Open systems for easy integrations or future migrations

One major challenge of OEE tracking systems is sourcing the right data. One key to breaking that barrier is to aggregate data on top of the various MES instances. Another is to install a broker-based system below the MES to talk directly to machines and pass data to locations including the MES, an OEE tracking tool, and other analytics systems. as well as to an OEE tracking tool and other software and analytics systems.

A global OEE tracking tool is known to bring five to ten percent productivity gains to manufacturers that have not yet adopted one. It does so by creating transparency of the most important problems to be solved and driving rapid and aligned decision-making to address those problems. With a spirit of continuous improvement, OEE can be benchmarked against prior historical improvements and used to continue any honing process.

The challenge of OEE is an invitation to better, more modern data handling across the organization. The infrastructure required to provide OEE can also provide other benefits; with local data rolled up to a central broker, the data team can perform deep analytics about performance, maintenance, and other questions that arise. Answers are not just “we are better than last quarter,” but, “this is what we need to do to be better next quarter.”