Overall Equipment Effectiveness (OEE)

One of the most important metrics in Lean Manufacturing is Overall Equipment Effectiveness (OEE), which is calculated as a percentage value that is function of ***Performance, Availability and Yield.***

OEE = P x A x Y

Performance **Availability** **Yield**

Performance – Is the machine performing at the right speed?

Availability – Is the machine available to produce parts?

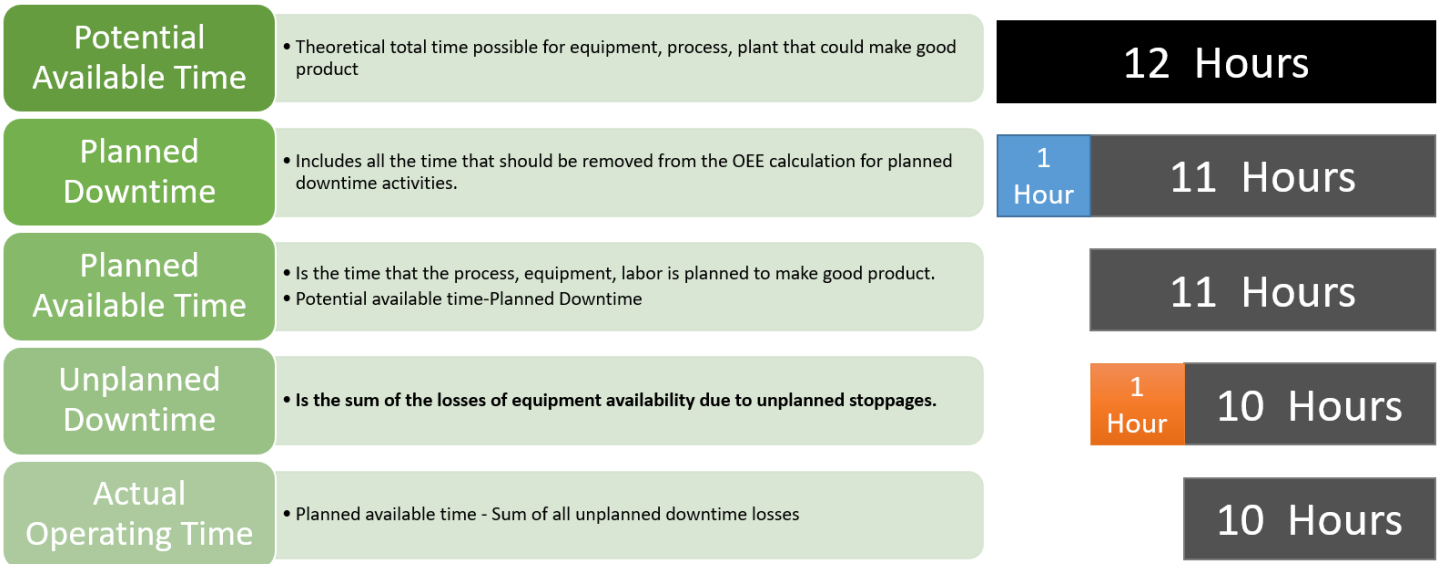
Yield – Is the machine producing good parts?

To calculate the overall effectiveness of your equipment you must calculate the performance, availability and yield of your equipment. Let's start with Availability first.

Availability

Availability Reflects capacity (and effectiveness) losses due to equipment failures, setup and adjustments. To calculate availability, you must be familiar with different time elements associated with your equipment.

Remember, **the planned downtime** is not included in the availability calculation.



$$\boldsymbol{Availiability} = \frac{\boldsymbol{Actual\ Run\ Time\ (Actual\ Operating\ Time)}}{\boldsymbol{Planned\ Run\ Time\ (Planned\ Available\ Time)}}$$

$$\boldsymbol{Availiability} = \frac{\boldsymbol{Actual\ Run\ Time}}{\boldsymbol{Planned\ Run\ Time}} = \frac{10\ Hours}{11\ \text{Hours}} = 90.9\%$$

The interpretation for this result is that, over the course of this shift, the equipment was available 91% of the time. The other 9% of the time the equipment was down or unavailable.

In terms of continuous improvement, it's important to collect data on why the equipment was not available, so that you can investigate the root cause and improve the process.

Performance

Performance reflects losses due to idling, stoppages and slower machine pace.

The two main components in Performance include your **actual output**, in comparison to your **theoretical output**.

$$\boldsymbol{Performance} = \frac{\boldsymbol{Actual\ Output}}{\boldsymbol{Theoretical\ Output}}$$

Actual output is easy, the operations team simply reports the total quantity of units produced.

For example, let's say operations reports 11,000 units produced.

The **theoretical calculation** requires some calculation. This is a function of the cycle time associated with the equipment, and the planned run time.

$$\boldsymbol{Theoretical\ Output} = \boldsymbol{Equipment\ Speed} * \boldsymbol{Planned\ Run\ Time}$$

To calculate the equipment hourly capacity, we must know the equipment's cycle time. For example, if an equipment has a cycle time of 3 seconds per part, that means that the equipment should product 20 parts per minute.

3 seconds per part → 20 parts per minute → 1,200 parts per hour

Then, if the equipment runs for 10 hours, the theoretical output would be 12,000 parts.

$$\boldsymbol{Performance} = \frac{\boldsymbol{Actual\ Output}}{\boldsymbol{Theoretical\ Output}} = \frac{11{,}000}{12{,}000} = 91.7\%$$

You can also calculate performance using time, instead of output, using the following equation:

$$\boldsymbol{Performance} = \frac{\boldsymbol{Actual\ Output} * \boldsymbol{Ideal\ Cycle\ Time}}{\boldsymbol{Operating\ Time}}$$

$$\boldsymbol{Performance} = \frac{11{,}000\ parts\ * 3\ seconds\ per\ part}{10\ hours} = \frac{11{,}000\ * 3\ seconds}{10 * 60 * 60} = \frac{33{,}000\ seconds}{36{,}000\ seconds}$$

$$\boldsymbol{Performance} = 91.7\%\ or\ 92\%$$

Yield

Yield reflects **losses due to process defects and reduced product yield.**

- Can be calculated as the ratio of **good parts/total parts built.**

This obviously requires some inspection to count the good parts, and the total parts.

$$\boldsymbol{Yield} = \frac{\boldsymbol{Good\ Parts\ Produced}}{\boldsymbol{Total\ Parts\ Produced}}$$

Let's say that we produced a total of 11,000 parts, and only 10,000 of them are good parts.

$$Yield = \frac{Good\ Parts\ Produced}{Total\ Parts\ Produced} = \frac{10{,}000}{11{,}000} = 91\%$$

Final OEE Calculations

All of these metrics (Yield, Performance and Availability) are calculated a decimal value or a percentage, and are combined to calculate the OEE of a piece of equipment.

$$\boldsymbol{OEE = P * A * Y}$$

$$OEE = 91\% * 92\% * 91\%$$

$$\text{OEE } = 76\%$$

Below you can visualize how each of the elements of loss (availability/performance and yield) contribute to the overall lost capacity of the equipment.

In terms of evaluating these results, world class OEE is generally considered to be 85%.

To improve your OEE, you should look at each component (Performance, Availability or Yield), to determine which element is contributing to the losses.

Then you can go through the DMAIC process to improve either the performance, availability or yield of the equipment.

Nowadays, several automated manufacturing pieces of equipment can be programmed to calculate OEE and track Performance, Availability and Yield.

This is data that sets the ground for a controllable environment such as Visual Factory.

Data Collection for OEE

A critical element of OEE is data collection. We must start with data to calculate availability, performance and yield.

This data collection should capture any downtime associated with breakdowns, change-overs, minor stoppages along with quality losses due to defects.

With this information, you can calculate the OEE for your equipment, which in turn should highlight opportunities for improvement.