Chart Your Progress

Measuring overall equipment effectiveness can make the most of your operation's resources.

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Overall Equipment Effectiveness (OEE) has emerged as a metric that manufacturers use to drive continuous improvement. In the past, it was typical to find plants within the same company that used slightly different calculation methods. Lack of a standard metric made it harder to drive improvement within companies. The need for a better metric and the development of standard downtime tracking systems have led to market-wide acceptance of OEE to describe, determine and communicate manufacturing system performance.

How can the OEE metric be applied within your organization? The key is to understand the OEE time chart (see **Figure 1**), which shows the relationship between the key parameters for calculating OEE. Use this chart to predict the effect potential improvements will have on a system so you can prioritize improvement activities. Finally, measure the system to determine if improvements were successful.

> Using the OEE charts, we were able to show the impact of not having enough operators.

To fill out the time chart and determine OEE, first determine the amount of time the system is available to manufacture product, which is the Scheduled Production Time (SPT). SPT is calculated using the formula: SPT = TT – [IT + PDT]. Each of these terms is defined below.

- Total Time (TT) is all the available time for the period of interest. It's typically one week, or 168 hours.
- Idle Time (IT) is when no work is planned on the system, including maintenance. It's also known as lights out. In the above example, this is normal weekend shutdown, which accounts for 48 hours.
- Planned Downtime (PDT) is the amount of time allotted for non-production activities such as preventive maintenance and cleaning. For this example, these tasks are done on third shift throughout the week and account for 40 hours.

The recorded TT, IT and PDT are now used to calculate SPT.

SPT = TT(168) – [IT(48) + PDT(40)] = 80 hours

OEE is the measure of how well SPT is exploited by using manufacturing assets. It is impacted by the production losses associated with availability, performance and quality. These time losses are harder to measure than IT and PDT. Availability Loss (AL) can be measured manually through observation, or by an automated downtime system such as PlantMetrics.

Performance Loss (PL) needs to be measured automatically at the system constraint. This accounts for the production that is not realized because the system is running below target rate. Finally, Quality Loss (QL) is factored in for any product that does not meet quality standards. The product of these factors is the system OEE.

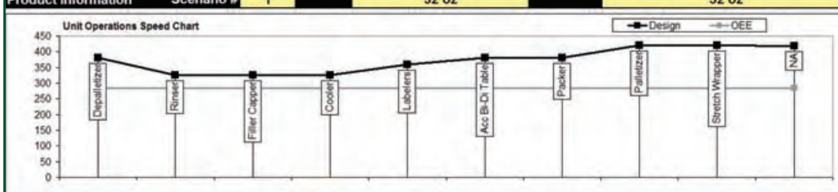
OEE = AL x PL x QL

Or, in our example, 99 percent x 99.5 percent x 90 percent = 88 percent

		Hours	Time Allocation for a Week					
(PT / TT)	42.0%	168.00	Total Time 24x7 (TT)		Asset View			
(PT / PPT)	58.8%	120.00	Planned Production Time (PPT)		Lights On Time			Idle Time (IT) ... Lights Out
(PT / SPT)	88.2%	80.00	Scheduled Production Time (SPT)		OEE		Planned Downtime (PDT) ... Changeover, PM's, Lunch...	
		72.00	Net Production Time (NPT)			Availability Loss (AL)		
		70.57	Productive Time (PT)	Quality Loss (QL)	Performance Loss (PL)			
			Lost Hours	(0.71)	(0.72)	(8.00)	(40.00)	(48.00)
			Percent Loss	99.0%	99.0%	90.0%	66.7%	71.4%

Figure 1. Understanding measurements in the OEE time chart can help you predict the effect potential improvements will have on a system.

Product Information | Scenario # 1 | 32 oz | 32 oz



Total Run Time 900 | Constraint Speed 325 | Fill-in all of the blue cells. | Availability (%) 83.4%

Availability Calculations: This is where the downtime impact of the machines is calculated to determine the availability. | With Accumulation (%) 87.4%

	Machine	Single Machine: Surge Spee 12 Bottles (upm)	Cases (cpm)	All Machines: Number of Machines (#)	Maximum Capacity (upm)	% Over Speed (%)	Single Machine: Repair Time MTTR min	sec	Runtime MTBF (min)	# of Stops a Shift (#/shift)	Downtime Impact Summary: Total Shift Downtime (Total min)	% Of Total Downtime (%)	% Of Total Time (%)	Sub System Availability (%)
1	Depalletizer	380	31.7	1	380	117%	3		90.0	9.7	29.03	18.1%	3.2%	96.8%
2	Rinser	325	27.1	1	325	100%								100.0%
3	Filler Capper	325	27.1	1	325	100%	2	10	60.0	14.5	31.37	19.5%	3.5%	96.5%
4	Cooler	325	27.1	1	325	100%								100.0%
5	Labelers	180	15.0	2	360	111%	1	45	45.0	19.3	33.69	21.0%	3.7%	96.3%
6	Acc Bi-Di Table	380	31.7	1	380	117%								100.0%
7	Packer	380	31.7	1	380	117%	1	30	35.0	24.7	36.99	23.0%	4.1%	95.9%
8	Palletizer	420	35.0	1	420	129%	2		120.0	7.4	14.75	9.2%	1.6%	98.4%
9	Stretch Wrapper	420	35.0	1	420	129%	3		180.0	4.9	14.75	9.2%	1.6%	98.4%
10	NA	419	34.9	1	419	129%								100.0%

Figure 2. Specific machine information, such as this sample of bottling machine metrics, is gathered while performing a system audit to allow a comprehensive analysis of a system's OEE.

You also can try the E²M/Polytron OEE calculator at www.polytron.com/shared/OEE_Calculator.aspx.

E²M/Polytron uses this OEE analysis method when optimizing systems. **Figure 2** is a table of a typical bottling line's machine metrics. This machine information is gathered while performing a system audit to perform a comprehensive analysis of a system's OEE. This tool then predicts how changes to the availability, performance, quality and unit operations Mean Time Between Failure (MTBF) and Mean Time to Repair (MTTR) will affect the system's overall OEE.

Here are three examples of how this method has been used:

>> Our customer needed more capacity because they couldn't keep up with demand. They felt that AL represented their biggest opportunity for their 20-year-old line. After observing and measuring the system using our portable automated collection unit, we found that the operations team already had the older equipment working as well as could be expected.

Without replacing existing equipment, the most cost-effective opportunity turned out to be in the Planned Downtime (PDT) category. The customer was stopping the line during an eight-hour shift for 105 minutes of breaks and lunch. This reduced the available SPT by 20 percent.

We recommended that they add one operator per shift to allow coverage through breaks. This provided them with an extra shift of production each week, equivalent to a 13 percent increase in throughput.

>> Solution Provider Program

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>> Another customer appeared to be achieving good results but wanted to improve a line that was already running at 85 percent efficiency. We found the system OEE was actually 50 percent.

An operating policy decision was the culprit. Because operations would not be penalized for downtime when they were waiting on mechanics, operators tended to call mechanics more than was necessary.

The need for a better metric and the development of standard downtime tracking systems have led to market-wide acceptance of OEE.

This stretched the mechanics too thin, resulting in longer downtimes across all of the lines. This downtime was not reported on the operations report; it was written off on maintenance. We were able to focus on the true problems to get more cases out the door faster.

>> At another company, we audited two lines that shared operators. Using the OEE charts, we were able to show the impact of not having enough operators. One operator ran two tray packers that were about 20 feet apart. The repair time on one averaged 30 seconds; the repair time on the other averaged two minutes. This resulted in a 5 percent OEE loss on the line with the two-minute repair time.

Rather than hire an additional operator, the customer added an auditory alarm to the neglected tray packer. This approach decreased the average repair time to one-and-a-half minutes. This 30-second change in MTTR increased the system OEE by 2 percent.

Polytron, Inc., a Rockwell Automation Solution Provider based in Norcross, Ga., designs and installs integrated manufacturing and packaging systems. Visit Polytron at the Automation Fair 2006 event in booth #1029.

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