Automation World PACKAGING WORLD Design World

# Hands-on guide to OEE

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TACTICAL BRIEF

PR.AW.02

# Automation Solutions – OEE is Key

**Scott Carlberg, Motion Product Marketing, Yaskawa America, Inc.**

Today's CPG manufacturer is faced with a number of difficult challenges. The manufacturer's ability to drive the cost per packaged unit down while maintaining the flexibility to innovate and integrate new packaging solutions is crucial to the ultimate success and profitability of their product. An engineering team's ability to take a packaging concept devised by marketing and implement it quickly (using existing machinery without sacrificing product run rate) can mean the difference between success and failure of a product.

New requirements from retail outlets of consumer products are driving new packaging innovations from manufacturers. Retailers are evolving, resulting in the need for more customized solutions. In order to compete in today's highly competitive marketplace, retailers have been forced to reduce back room space and as a result, costly overhead. On-hand inventory needs to move from the retailer's loading dock to their shelves as quickly and efficiently as possible. Retail-Ready packaging and customized pallets containing different varieties of product are examples of solutions that help the retailer remain competitive.

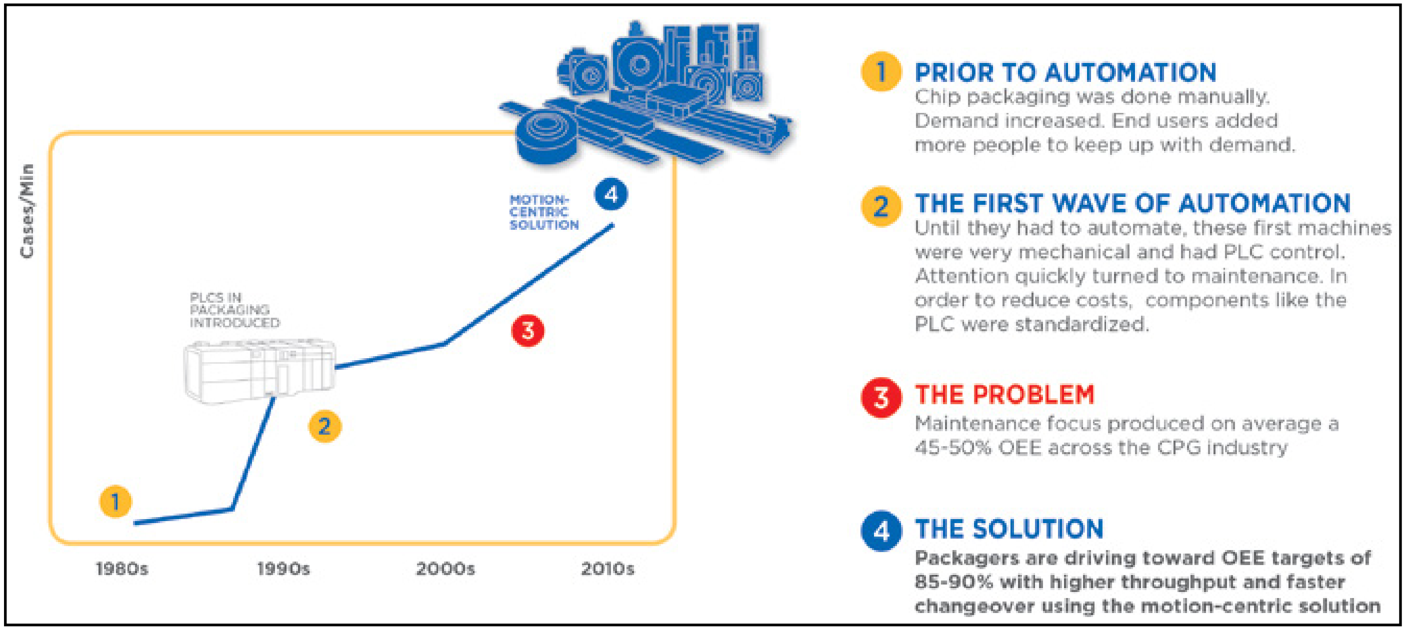
The requirements of today's consumer are also driving innovation from the CPG manufacturer. Buying tendencies vary based on the age, social and economical status of the consumer. A 17-year old is not likely to purchase toothpaste that is marketed for a senior citizen even though the actual product may be identical for both consumers. Manufacturers sometimes package the same product three or four different ways, each targeting a very specific consumer market segment. Consumers spanning multiple age groups and segments are demanding organic products that have much shorter shelf lives. This ultimately increases the importance of getting the product from the manufacturing line to the consumer as quickly as possible. Many consumers demand packaging materials that are sustainable and eco-friendly. These types of materials can be thinner, softer, and more fragile which creates new challenges for the CPG manufacturer.

In order to succeed in the current consumer market, manufacturers must address all of these requirements while maintaining a reasonable cost point for their product. Advances in automation over the past 25 years have allowed manufacturers to become very proficient at mass production of a particular product. The introduction of new customization requirements has had a significant effect on the overall production efficiency. As a result, many manufacturers are investing heavily to improve the OEE of their entire packaging line. OEE is a quantitative measurement of Overall Equipment Effectiveness that takes all of the following into account:

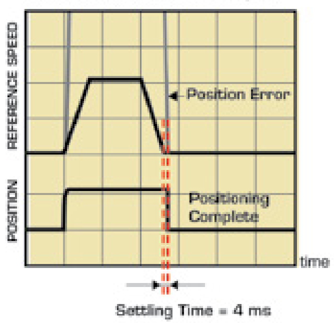
- Performance – the ratio of actual run rate / ideal run rate
- Quality – the ratio of good units / total units
- Machine Availability – the ratio of operating time / planned production time

This OEE calculation can be used as a snapshot of the effectiveness of an entire packaging line.

The traditional approach for optimizing OEE on a packaging line consists of using a PLC based model from a single source automation supplier. This approach focuses heavily on maintenance in an attempt to limit downtime. An alternate and potentially more successful approach is based on a motion-centric model with a focus on productive outcome. The key is to not only focus on keeping the machine running, which directly affects the Machine Availability variable in OEE, but to address all of the OEE variables with a motion-centric solution that is flexible enough to allow for new packaging innovations.



Servo Adjustment Example




Benefit of Reduced Settling Time

Pick and Place Example with 50 ms Settling Time

| Axis Length | Move | Settle | Move | Settle | Time Per Part | Parts Per Minute | Parts Per Hour | Price Per Part | Revenue Per Hour |
|---|---|---|---|---|---|---|---|---|---|
| X = 200 mm | 0.5 s | 0.05 s | 0.5 s | 0.05 s | – | – | – | – | – |
| Z = 100 mm | 0.2 s | 0.05 s | 0.2 s | 0.05 s | – | – | – | – | – |
| Total | 0.7 s | 0.1 s | 0.7 s | 0.1 s | 1.6 s | 37.5 | 2250 | $0.1 | $225.00 |

Pick and Place Example with 4 ms Settling Time

| Axis Length | Move | Settle | Move | Settle | Time Per Part | Parts Per Minute | Parts Per Hour | Price Per Part | Revenue Per Hour |
|---|---|---|---|---|---|---|---|---|---|
| X = 200 mm | 0.5 s | 0.004 s | 0.5 s | 0.004 s | – | – | – | – | – |
| Z = 100 mm | 0.2 s | 0.004 s | 0.2 s | 0.004 s | – | – | – | – | – |
| Total | 0.7 s | 0.008 s | 0.7 s | 0.008 s | 1.416 s | 42.37 | 2542 | $0.1 | $254.24 |

| | |
|---|---|
| Revenue Per Hour | $29.24 |
| 16 Hours | $467.84 |
| 6 Days | $2,807.04 |
| 50 Weeks / Year | $140,352.00 |

### Performance

Performance of a packaging line is often dependent on the motion control solution. The throughput of the packaging line is a critical piece of the overall line performance. The throughput of each individual process can be impacted by the capability of the specific motion control solution chosen. Some of the more sophisticated motion control electronics employ advanced servo algorithms that assist in decreasing settling time of discrete machine movements. Even a small decrease in the settling time of each discrete machine movement in a production cycle can result in a significant reduction in overall production cycle time. Ultimately this leads to more units being shipped per hour and a lower overall cost per unit.

The efficiency of machine changeovers also affects the overall throughput and consequently the overall performance of a packaging line. Machine changeovers are dramatically simplified through the use of robotics. Typical processes at the end of the manufacturing line (picking, packing and palletizing) tend to have a lot of variability due to differences in customer requirements. Industrial robots are inherently designed for flexibility and are a perfect fit for these types of applications. By eliminating rigid automation equipment in favor of customizable robotics, the manufacturer has a virtually limitless array of application solutions at its

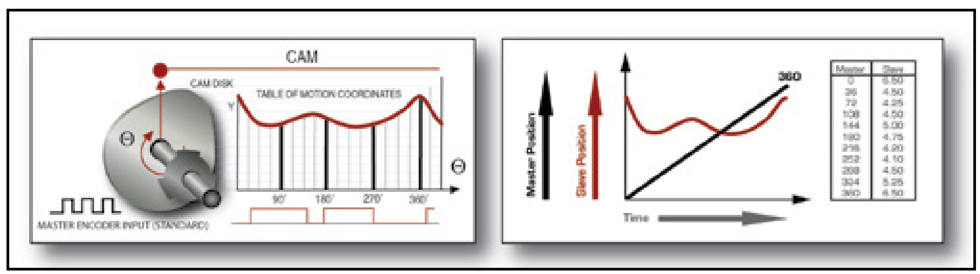
**Continued**

## Automation Solutions – OEE is Key


disposal. Optimal performance is attained via the quick changeover capability of robotics.

### Quality

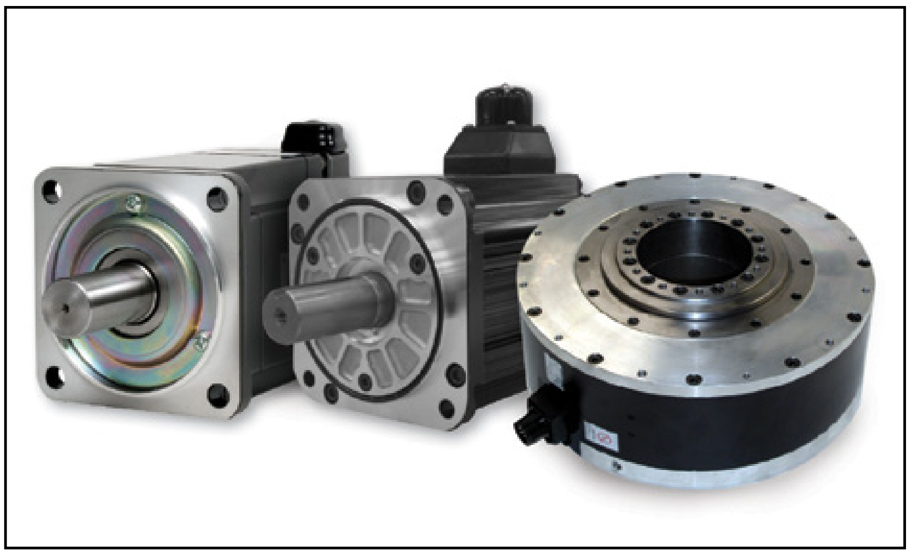
Yaskawa America has developed a variety of reusable code libraries, called application toolboxes, for its controllers. These toolboxes can be imported into user programs as a User Library to form the foundation of a complete, customized solution. They also save time for developers who would otherwise have to start programming from scratch. An onboard OPC server can be used to stream large data arrays for thousands of individual recipes to the controller via HTTP communications. This allows the CPG manufacturer to effectively manage thousands of product SKU's. These large data arrays, each consisting of thousands of points, are managed by camming and kinematic toolboxes that are specific to typical packaging applications. These toolboxes streamline the implementation of complex machine move profiles with a resultant motion path that is extremely smooth and



efficient. Ultimately, this results in higher throughput and reduced wear on mechanical components on the machine. This functionality contributes to both the overall quality of the packaged product as well as decreased overall cost per unit.

### Machine Availability

Machine availability can be greatly improved simply by the specification of machine components that do not fail. Yaskawa recently performed an internal study to determine the out of box failure rate over a period of time where 100,000 motors were shipped. Some motor manufacturers set failure rate goals around 0.5% (which in



this case would be 500 motors). Of the 100,000 motors that Yaskawa shipped, 7 came back for warranty repair.

The flexibility of the automation solution can also impact machine availability. As discussed above, custom packaging requirements and shorter manufacturing runs are becoming the norm for today's CPG manufacturer. Changeover time between production runs can significantly impact overall line efficiency. Industrial robots lend themselves to this type of required flexibility. They have the ability to move from one job to another with only a program change. Mechanical adjustment and machine reconfiguration can be almost completely avoided in this scenario.

Giving the production manager the ability to monitor his or her production line from anywhere at any time can be a key contributor to increased uptime. Machine controllers with an integrated web server offer access to real time status and diagnostics from any device that can access the internet. This provides the user the ability to load modifications or enhancements to a machine's control program (from the machine builder or integrator) without having to purchase and control any development software.

Many automation products are now equipped with built in preventative maintenance tools. Variable frequency drives are de-

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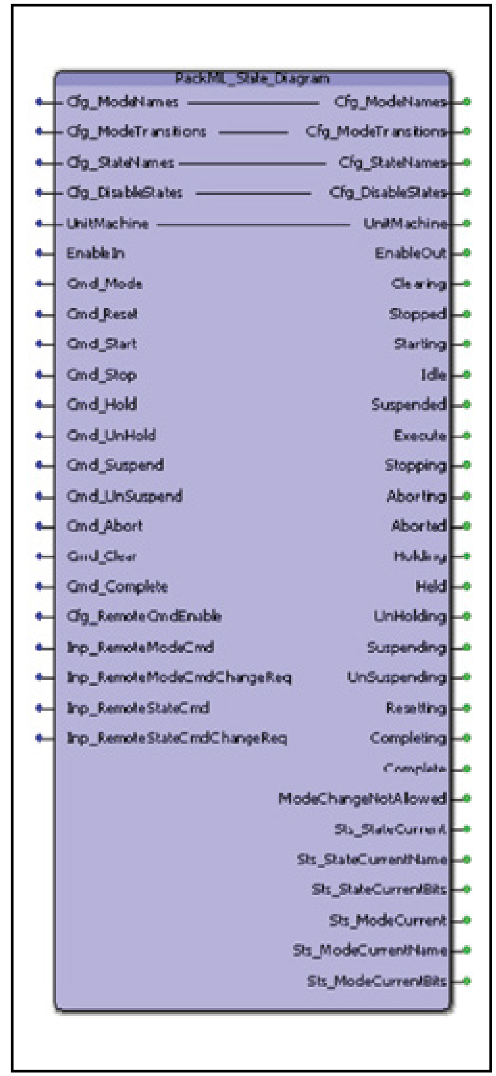
signed with life monitors that proactively provide the maintenance team with information that will help avoid downtime. The drive sends out notifications and warnings when consumable components like cooling fans, DC bus capacitors, inrush relays, and IGBTs are nearing the end of their predicted lifespan so that they can be replaced prior to failure during operation.

Monitoring all of the individual variables that makeup the OEE calculation in a consistent and repeatable manner can sometimes be as important as the work done to improve the manufacturing process. Among the application toolboxes Yaskawa has developed is the PackML toolbox, which is designed to help packaging end users manage and measure the effectiveness of their packaging line. This development consists of a PackML project template and toolbox containing core code for using the PackML machine state diagram. Using this globally standardized machine code architecture helps the end user reduce the amount of time and expense involved in integrating machines from different suppliers into a cohesive production line. Utilization of the PackML toolbox also simplifies the process of data collection for the measurement of OEE.



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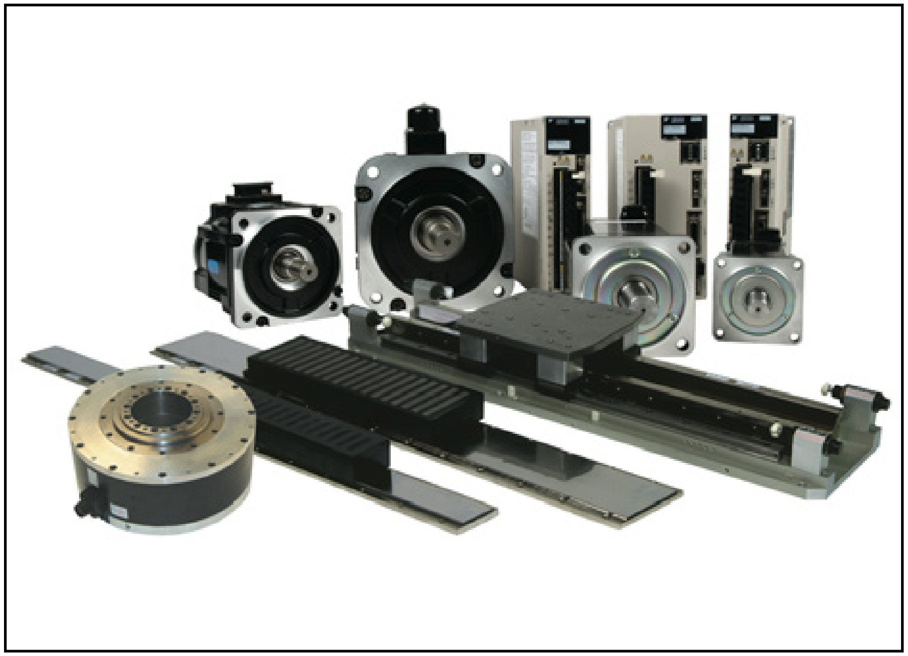
## Automation Solutions – OEE is Key

### The Result

Most often the OEE bottleneck is directly related to the automation solution that has been implemented on the packaging machine or line. This automation bottleneck can not only impede the end user's ability to increase the effectiveness of the manufacturing line, it can also limit the end user's ability implement new and innovative packaging designs. Therefore, it is extremely important to work with an automation supplier that has experience working with packaging end users to solve OEE bottlenecks. For more information on Yaskawa's products, tools, and engineering capabilities please visit www.yaskawa.com.



# A view from AIOE on how OEE drives business benefits

**Mark Hanley is Asset Reliability Manager at Land O' Lakes, Inc. He's also part of the Operations Reliability Solutions Group at the Alliance for Innovation & Operational Excellence. We talked with him recently about Overall Equipment Effectiveness (OEE).**

**By Pat Reynolds, VP Editor**

***Packaging World:***
Is it easy to define OEE?

**Mark Hanley:**
Basically it's a way of looking at availability, performance, and quality to determine how efficient your manufacturing is. But variations do exist out there. For example, should periods of no demand be included in OEE calculations? What about planned downtime? Or should we multiply 24 hours by 7 and calculate OEE based on a 168-hour work week? These inconsistencies complicate measurement. One of the things we're trying to do through AIOE is to get some commonality in place.

**Sometimes there is a tendency to view OEE as some sort of geeky IT kind of thing. Does it really relate to business benefits and cash flow and things like that?**

Yes, it does. But how do you calculate those benefits? How do you demonstrate to management the value of a 1% improvement in OEE? I've fought tooth and nail to raise OEE's visibility in places I've worked at in the past. One thing that helps is remembering that it's not the OEE number itself you're after. It's use of that number to help guide your improvement efforts.

**Aren't people already overwhelmed with data? Do they really need more?**

It does no one any good to get buried in data. It will only make you confused and inactive. What our AIOE group is trying to do is bring some structure to it all so that data collection leads to actionable items. It comes down to yield. If I put 100 units into the front end of a line and I only get 80 acceptable units out the back end, what happened? Not knowing gets expensive fast, because now you've invested labor, materials, and time into building those unacceptable units.

**Who should drive OEE improvement efforts in a plant?**

You really should have someone to champion it, and in my opinion that someone should be from Operations. One of the misunderstandings in all of this is that people tend to think of availability as purely a maintenance issue. It can be, but it's not solely owned by maintenance.

# 'Why is PackML important, why is OEE important, and how can they work together in your machine-control scheme?'

**That's the question Doug Meyer posed at Pack Expo 2013, just before he revealed the answers to attendees of his presentation on the topic…**

Doug Meyer, motion project manager with Yaskawa America' drives and motion division, explained how the global PackML standard, with its modular architecture and programming methodology, can enhance the successful rollout of OEE or Overall Equipment Effectiveness. PackML, he explained, provides a consistent look, feel and execution method across all machines with greater ease for maintenance and troubleshooting machines; and software 'hooks," or a common means, for performing data collection.

## How PackML enables OEE

Meyer summed-up the management benefits of PackML's use as an OEE enabler as providing a standard way to extract data from each of the pieces in your line, and "to be able to identify bottlenecks, and be able to calculate a number that you know will be consistent, not only in your plant, but in your other facilities in the U.S. or around the world." He was referring to an OEE number, that single-digit calculation that merges quality, production and machine/process availability into a single, continuous improvement-oriented index of operational health.

PackML helps standardize OEE efforts by instilling a standard that lets companies know that the data from machine to machine, and plant to plant, can will

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## ‘Why is PackML important, why is OEE important, and how can they work together in your machine-control scheme?’

be collected, verified and viewed in a uniform and efficient manner. From there, OEE can proceed more effectively to help identify bottlenecks on the line and more specifically, the root causes of inefficiency behind those bottlenecks, Meyer explained.

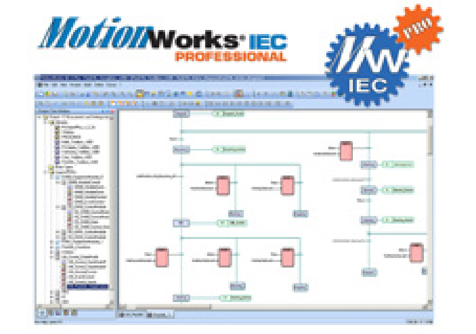
Part of the presentation delved into the modes, functions and states of the software standard. But in general, he said, “the whole point” of the standard is that it’s based on modular, reusable code. “So ideally, software modules can be created that match, and appear graphically, to match the actual machine layout in a plant. Using the standard to automate machinery and lines saves significant coding time due to re-use, replacing much of the traditional programming chores with configuration and graphical tools that greatly simplify the time and effort of maintaining an OEE program.

### For further study...

For those looking to learn more, Meyer noted that PackML includes user guides, toolboxes, templates and other elements to help engineers create software control applications that match their real-world machines. The standard in turn speeds efforts to establish data collection and OEE data connections.

For further OEE education, Meyer suggested attendees visit www.OEE.com for good, basic primer and additional OEE learning tools. OEE is “different” from the “long parade of manufacturing buzzwords and systems over the years,” says , says Vorne Industries, which administers the site, because it “truly reduces complex production problems into simple, intuitive presentation of information” to help “systematically improve your process with easy-to-obtain measurements.”

### MotionWorks IEC Programming Software




**MotionWorks® IEC, Yaskawa’s IEC61131-3 programming environment, encourages the programmer to optimize the usage of several programming languages within one development package. Ladder logic, structured text, PLCopen function block, sequential function chart, and instruction list programming are all supported. Libraries of reusable code for camming, gearing, PackML, and others reduce development time and improve machine commissioning time.**

# How to Calculate Overall Equipment Effectiveness: A Practical Guide

By Paul J. Zepf, M.Eng. P.Eng., CPP Zarpac, Inc.

## OEE Overview and Efficiency versus Effectiveness

There is a lot of confusion out there about OEE (Operational Equipment Effectiveness) and about the words efficiency and effectiveness. Let us look at these things in an objective and clear manner.

Is OEE just a nice-to-have? No, it is a simple yet powerful roadmap that helps production floor people and management to visualize and eliminate equipment losses and waste.

OEE is not a fad. First of all, OEE has been around for decades in its elemental form. The words efficiency and effectiveness have been around longer, but have only been used in a confused manner in the last decade or so. To start, we have to make a clear distinction between *effectiveness* and *efficiency* before we can discuss OEE.

Effectiveness is the relation between what theoretically could be produced at the end of a process and what actually came out or was produced at the end of the process.

If your machine or system is capable of making 100 quality products an hour, and it makes only 70, then it is 70% *effective*, but we do not know how *efficient* it was, because nothing is said about what we had to put in (how many operators, energy, materials, etc.) to get the 70% effectiveness.

So if a machine or system runs 50% effective with 1 operator and becomes 65% effective with 2 operators, the effectiveness goes up 30% (yes, 65 is 30% more than 50…) but its efficiency dropped down to 50%, based on labor!

The same goes for *yield* or more commonly known as *quality* (basically saleable product). If you are bottling a beverage, all filled, labeled and capped bottles could theoretically be perfect, so the quality would be 100%. But if you throw away half the filled bottles because of packaging or material defects, your yield or quality is only 50%. In this example you would be 100% effective but only 50% efficient.

## A simple example

Basically OEE is about (as the name says) effectiveness: it is the rate between what a machine theoretically could produce and what it actually did. So the fastest way to calculate it is simple: If you take the theoretical maximum speed (for example 60 products per minute) you know that at the end of a 480 minutes shift there should be 28,800 units.

**Continued**

## How to Calculate Overall Equipment Effectiveness: A Practical Guide

1 shift = 8 hours = 480 minutes

Maximum production speed = 60 products per minute

480 x 60 = 28,800 units

Then we need to count what we produced at an end point in the production process such as what's on the pallet going to the warehouse. If there are only 14,400 good products on the pallet your effectiveness was 50%, right?

Not rocket science so far.

### The A-P-Qs of OEE

Why does the OEE formula in Figure 1 include availability (A), performance (P) and quality (Q)? What do these words mean and what value do they bring? They'll help us find where those other 14,400 products that should have been on the pallet disappeared to.

OEE raised the bar and moved us away from the traditional efficiency calculation as a measure of production line output that was easily manipulated to show mediocre lines running at efficiencies up to 150%.

Here is the power of OEE. OEE, when broken into its three main components, is going to track down where we lost it. Every day that we run 50% OEE, we can lose units in different ways, and every loss has its own cost structure.

If we lose 14,400 products because the machine ran flawlessly, with no quality loss but at half the maximum speed, that's completely different from producing 28,800 products at full speed, and then dumping 14,400 out-of-spec products into the landfill.

Effectiveness is:

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## How to Calculate Overall Equipment Effectiveness: A Practical Guide

**Making the right thing** – the right product or SKU at the right speed (Performance)

**Making it the right way** – no rework, no defects, no waste (Quality)

**Making it at the right time** – producing as planned, keeping the machine up and running, minimizing time losses (Availability)

So how do we find out what we lost and where? And how do we prevent it from happening in the future?

### Availability

Going back to the bottle example, let's track down a normal day. A standard shift takes 480 minutes. Our operators take 10+30+10 minutes in breaks as well as do 2 changeovers of 35 minutes each and lose 60 minutes of machine downtime during the shift. The rest of the time the machine is in the running mode.

Breaks = 10 minutes morning + 30 minutes lunch + 10 minutes afternoon = 50 minutes

Changeovers = 2 x 35 minutes = 70 minutes

Machine downtime = 60 minutes per shift

Total = 180 minutes lost time

This means we lost 180 minutes and there are only 300 minutes left to be effective. Even if we run the rest of the time at full speed with no quality losses, we can never be more than 62.5% effective during this shift. This ratio we call 'Availability' or how time is used.

480 minutes – 180 minutes = 300 minutes

300 ÷ 480 = 62.5% Availability

Let's see how we spent that 62.5% of our time that is available …

## Performance

Let us also assume our packaging system has an ideal cycle time or takt time of 1 second per bottle, which is 60 bottles per minute. (Takt time, derived from the German word Taktzeit which translates to cycle time, sets the pace for industrial manufacturing lines.)

This means in the remaining 300 minutes, the machine or system can make 300 x 60 bottles = 18,000. So if at the end of this shift the machine would have made 18,000 bottles during the time it was running, it performed at 100% speed. If production would be at a slower speed, let us say the cycle time would be 1.5 seconds, it would slow down the maximum speed by 2/3, and thus its performance would become 66.7%. The actual output now at 66.7% performance is 12,000 bottles.

300 minutes @ 1 second per bottle = 300 x 60 bottles = 18,000 units

1.5 seconds per bottle = 1 ÷1.5 = 2/3 = 66.7% Performance

66.7% x 18,000 bottles = 12,000 units

Running at 66.7% performance in this case equates in time to losing another 300 x 33.3% = 100 minutes or the line ran on average 2/3 x 60 = 40 bottles per minute.

If at this point all output would be within specification or saleable, what would be the effectiveness?

From the 480 minutes we lost 180 minutes in ‘not running’ and 100 minutes due to ‘too slow a cycle time’; so (480-(180+100))/480 = 41.7% so far.

(480 minutes – (180 minutes + 100 minutes)) ÷ 480 – 41.7% Efficiency

## Quality

Whether this is the actual effectiveness depends on how many bottles were within specification. If from the 12,000 bottles, there were 3,000 out of specification, then the quality rate of those bottles was (12,000-3,000)/12,000 = 75% or converting to minutes would be 3000 bottles / 60 bottles per minute = 50 minutes lost due to quality.

(12,000 – 3,000 defects) ÷ 12,000 = 75% Quality

3,000 bottles ÷ 60 bottles per minute = 50 minutes lost Quality

In other words, we lost 180 minutes by not running; from the remaining 300 minutes we lost 100 minutes by slow running; from the remaining 200 minutes we lost 50 minutes making scrap. As a result the line yielded 150 minutes of perfect running at quality and at rate.

Theoretically we could make 480 x 60 = 28,800 bottles. At the end there were 9,000 bottles that were saleable, so the Overall Equipment Effectiveness was 31.25%.

9,000 ÷28,800 = 31.25% OEE

Availability (62.5%) x Performance (66.7%) x Quality (75%) = 31.25%

## Time equals money

OEE is purely time based (time converted), but since 1 takt time equals 1 bottle, OEE can be calculated in bottles for ease of use. Most operators will not say 'Today I ran at a takt time of 1.5 seconds but instead "today I ran 40 products per minute" — which is the same thing. Likewise, "I stopped for 5 minutes" is the same as "I lost 200 potential bottles I should have made".

OEE helps to create this kind of awareness; with operators, with engineers, with logistic departments, and with anybody else involved in the value adding process. It gives a common language to everybody involved in manufacturing and leads to effective and efficient improvements.

## The straightforward approach to OEE

OEE and its basic approach have been around for decades in other industries and have recently moved into the packaging area. Although the concepts are fairly simple, their definitions and application have varied considerably, preventing any ability to use them as benchmarks and performance tools within and between plants, let alone between companies. The idea is to present a common definition and straightforward spreadsheet format to bring about clear, common approach.

## A practical definition of OEE

OEE is the Overall Equipment Effectiveness of a defined production process during the defined operative period or mode in which all activities related to production, personnel and inputs are accounted for during all producing or dependent activities within a defined scheduled time or operative mode time. The defined production process is the start and end boundary under review such as depalletizing to palletizing or making it through to warehousing.

OEE is defined as the product or cost function or interplay of all availability or uptime of the operative mode multiplied by the performance or actual resultant production speed (from actual dialled rate and ramping rates) divided by the normal or steady state speed

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## How to Calculate Overall Equipment Effectiveness: A Practical Guide

and then multiplied by the quality or the output of quality product divided by the input of the critical component or aggregate of all the inputs (components consumed, lost, reworked, destroyed or unaccounted for during the production process). For a diagram, please refer back to Figure 1, page 30.

Quality is a fraction that is 1 minus the waste (waste and rework). Rework is usually considered within quality, but is the most difficult to segregate out. Quality does not typically relate to defective components not staged to the production line, but once staged to the production line they have to be considered. This forces out pre-checks, because once it hits the production line, there are time and impacts to the ongoing production process such as removing and replacing staged defective products, materials and supplies.

### Scope of analysis

Although OEE could be done on a machine-by-machine or product-by-product basis or shift-by-shift bases it is usually the amalgamation of one week's or one month's production of a given size and product (by machine or line), because looking at smaller slices may not give statistically relevant data for decision making. Trends or specific comparisons could be done, along with looking at a month's worth of production runs of the same product, family of products or extremes of product sizes and formulations.

Looking at less than 10,080 minutes (one week) of operating time is not significant in and of itself for decision making, but may be adequate for trends and verifications of a decision implemented earlier to insure positive directions or to ensure the anticipated results are being achieved.

The reason for this definition of operative mode is to capture all activities required to ensure the production process could be carried out. Some companies in the past hid their changeover, PM, holidays, training and cleaning by doing it in the so-called unscheduled production time or dumping it on a particular off time, but really it is part of the nature of the production process.

The production scheduled time is the time period in which allotted defined products are to be produced, but process dependent activities or situations must be done or considered beforehand (such as holidays) to ensure the schedule can be met or be reasonable.

The calendar hours or calendar time are the sum of operative mode activities and potential mode activities that make up a week (10,080 minutes) or month (average 43,800 minutes) or defined period in which the asset as a functioning production element exists in the plant.

If any asset is removed from the process in such a way as to make the process for a given product not viable then the expected OEE number is considered zero.

This also applies to product recalled from the market that is reworked or scrapped. A total recall in reality yields zero OEE for the period that produced the recalled product. A partial recall will only deal with the loss of the defined Lot or Batch within the total, but will depress the OEE for that period considerably.

Any scheduling and labor considerations are considered integrated within OEE. One could expand out from OEE with other ratios such as schedule capability in which labor and scheduling times are evaluated and their interplay is calculated as ratios or costs to operations, but OEE keeps a top line view that fits for the vast majority of industries and conditions in a simple but powerful way.

High OEE numbers are indicative of high schedule fulfillment and optimized labor. Schedule fulfillment and optimized labor are a byproduct of the optimized process. OEE is the roadmap for insight, direction and verification of all other activities such as continuous improvement, lean, six-sigma and upper level accounting information. It gives the correct window in viewing the Cost of Quality.

## OEE and the cost of quality

The "Cost of Quality" isn't the price of creating a quality product or service. It is the cost of not creating a quality product or service (For details visit the ASQ – American Society for Quality).

Every time work is wasted, there is a loss that results in the "Cost of Quality" escalating. When talking about waste, we can define or look at many definitions, variations or types of wastage such as: waste of waiting, over-production, inventory or work-in-process, transport, motion, input defects, producing defective products, unnecessary process steps, delaying

In looking at operations, OEE simply gives the clear and powerful picture window view of the ability to sustain quality production or how availability (time), quality (good product) and performance (speed) interact. The Losses portion is the fraction of the time that is lost due to the inability of the production process to be consistent and under control. These losses relate to time down or downtime, rate losses in the process and the scrap and rework generated during the operative mode.

The operative mode is not only the planned scheduled production time but that time that encompasses the nature of the production process and its supporting activities that are connected, dependent or required to be done to ensure the timely production of the scheduled product. This means that apportioned preventive maintenance, changeovers, cleaning and/or sanitizing are included.

## The concept of Downtime as understood in availability

For simplicity and order, the downtime of any machine or system can be divided into two parts – *planned downtime* events and *unplanned downtime* events.

*Planned* events can be defined as those events in which no output of saleable product results and which management has control over the timing and extent of the activity; mandates them or the country's regulations define part or all of them.

Holidays are always mandated activities dictated by management, government or both. One could argue that holidays should be left out, but that is incorrect, since it is a management decision to not use that time during a normally operative mode and it is not proper to slip it into the potential mode.

One can break down planned events into as many categories as one likes. Beware, when holidays are included in the analysis, some days or weeks or months will show depressed numbers and need to be highlighted. Because of this, there is a tendency to not include them. But one should include them as they happen.

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One can break down *unplanned* events into as many categories as one likes, but the most common ones are the unit ops or machines. The unit ops could be further subdivided into primary and secondary machines, zones, faults, etc.

*Primary machines* (PM) are unit ops that are capital equipment that has a direct involvement in assembling the package such as unscramblers, rinsers, fillers, cappers, labelers, cartoners, case packers, palletizers, etc.

*Secondary machines* (SM) are minor unit ops that convey, manipulate, collate, inspect, code or mark the package such as conveyors, combiners, dividers (when separate from a primary unit op), coders (laser, inkjet, impression, etc.), checkweighers, X-ray, Gamma inspection, independent fill, cap or label detection, rejection units (independent of the major unit op, etc.

Most companies, especially companies with no or poor ability to identify unplanned downtimes or losses, should use the OEE macro analysis and use the lumped or aggregate estimate number until improved data acquisition approaches the estimate number. All times should be in minutes not hours, with precision down to a tenth of a decimal, for a more granular view of the problem.

One can also look at unit ops as VE (value enabling), VA (Value Producing or Value Added) and NVA (no value added, such as a conveyor that simply needs to get product from point A to point B without inducing any quality defects).

### A proven technique in manufacturing comes to packaging

Typically OEE is confined to the production or packaging process, but does not need to be. Making, distribution, etc. could be included or viewed separately, but the boundaries must be clearly defined and the approach standardized across all lines and plants. Exercise caution when using and/or comparing inter-company OEE values because they maybe useless if the boundaries are different.

In fact, OEE was embraced by manufacturing industries, from automotive to electronics, long before it trickled down to packaging. It is a proven technique, with extensive resources available in the marketplace, and a useful methodology that can be applied to the smallest operation with manual data collection to the largest organization with sophisticated OEE software tools and automated data acquisition systems. And OEE is one of the major applications justifying the investment to implement PackML (Chapter 5).

# Benefits of PackML and when to use it on your line

## What is PackML?

PackML stands for the Packaging Machinery Language. It provides a standardized way to collect uniform data across machines, lines, shifts, plants, and business units. This uniformity is essential to productivity-enhancing initiatives such as Overall Equipment Effectiveness (OEE) analysis and to simplify MES functions. It is being incorporated into ISA 88, the standard that for nearly two decades has proven its viability in the process control world.

### PackML:

- Standardizes commonly used machine modes, states, and tag names, plus a modular approach to machine control code. PackML does not impinge on a machine builder's intellectual property, it simply standardizes aspects of communication the way that Ethernet TCP/IP did for non-real-time networking.
- Benefits packagers who include it in their electrical specifications and requests for quotation. The greatest benefits come from integrating entire packaging lines so that individual machines, machine-to-machine communications, and line control and data acquisition are standardized.
- Makes it easier for end users to get consistent data out of machines on a packaging line from different OEMs with different control systems.
- Reduces the learning curve for plant personnel by providing a common look and feel. PackML is independent of the control system vendor or programming language in use. It integrates readily to business systems with OPC, and promotes standardized, flexible data sets.
- Makes the machine builder's initial investment reusable across machines, which reduces subsequent software development costs and time to market, while reducing the amount of customized code to test and thereby increasing reliability. It predefines machine interface, integration, and start-up. It also simplifies after-sale support.

### When does it make the most sense to include PackML in your specification?

- When ordering a new packaging line
- When retrofitting an existing line
- When gathering production data for OEE or MES in a multivendor environment
- When implementing Six Sigma or lean manufacturing projects

Currently, the OMAC PackML committee has an initiative to document potential cost savings for implementing PackML simultaneously with best practices for software modularity.