THE HIDDEN PITFALLS OF DOING ‘BACK OF THE ENVELOPE’ CALCULATIONS TO DETERMINE YOUR CURRENT OEE

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The Problem

Many manufacturing companies have been measuring the Efficiency of their Lines and Work Cells in such a way as to “mask” many of the causes of lost efficiency. Over a period of years, management focuses on the numbers being reported, and is no longer thinking about what is included or excluded from the measurement. One of the reasons OEE (Overall Equipment Effectiveness) is such a valuable measure, is that it allows you to look at all sources of lost time and lost production. So OEE has emerged as the leadingapproach for accurately measuring the true plant productivity.

What is OEE?

By definition, OEE is the product of Availability, Performance, and Quality percentages:

OEE = Availability * Performance * Quality

Each one of these OEE components represents losses that result in loss of Operating Time. We begin with Total Available Time and subtract timeAvailability (Downtime), Performance (Speed), and Quality (Reject/Rework) Very quickly, one can see the effects of these losses on production time. Clearly, Productive Time becomes a fraction of Total Available Time. By using understanding all of our losses, we can take the actions necessary to increase Productive Time as much as possible.

FIGURE 1 illustrates the time losses due to various OEE Categories.

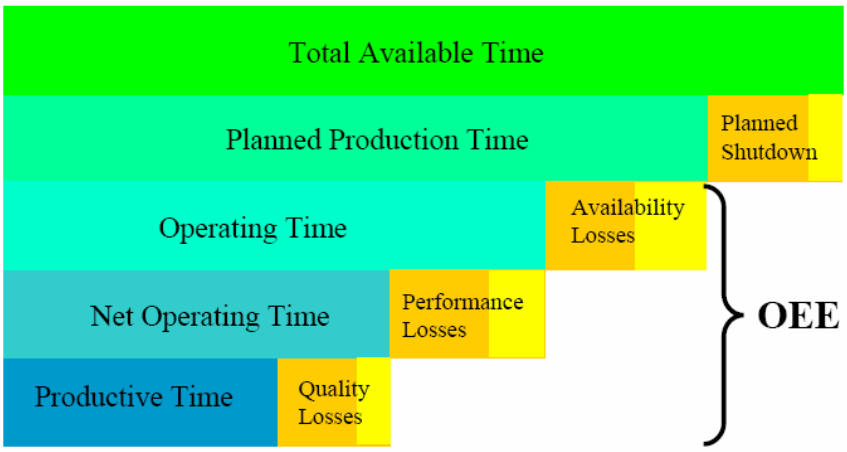

FIGURE 1 – Time Losses

Please note that the Planned Shutdown Time, or time when the productive capacity is not needed, is not normally included in the OEE calculation**.**

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OEE Component	Is a measure of…	Example of Typical Losses
Availability	Downtime Losses	Availability is typically reduced by nonproduction tasks, such as: ▪ Changeovers ▪ Sanitation / Cleaning ▪ Lunch/Breaks ▪ Preventative Maintenance ▪ Meetings ▪ Training ▪ Startup/Shutdown ▪ No components ▪ Facility Problem (no power, air, refrigeration, etc.) ▪ Capital Project
Performance	Speed Losses	Performance is reduced by: ▪ Running a production system at a speed lower than the Theoretical Run Rate for that SKU on that Line / Machine /Work Cell. By short stop failures such as jams, overloads, running out of components, or other faults that can be cleared without maintenance intervention. Many lines have 1000 or more short stops per week which results in a massive reduction in output.
Quality	Defect Losses	Quality is reduced by any part that is rejected or must be reworked

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Automated Calculation of OEE

With modern software tools, the information available in the PLCs can be leveraged to produce sophisticated real-time reports that allow manufacturers to fully understand all of their sources of lost productivity and to motivate the plant team to continually optimize OEE. Figure 2 below provides an example of the types of reports that can be generated by these systems.

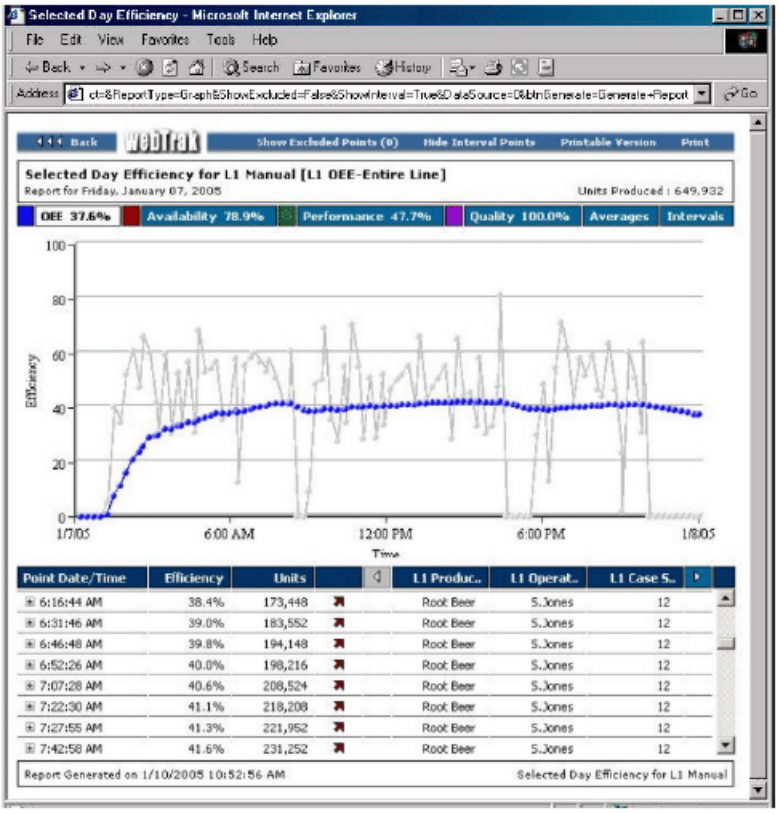

FIGURE 2 – Example of Real-time OEE Report

Back of the Envelope Calculation of OEE

Given that many manufacturing companies believe they are running at an Efficiency of 85 to 90% (which is true, the way they currently measure efficiency), it is very helpful to get an idea of the true potential for improvement by performing a rough Back of the Envelope Calculation of the current OEE. The back of the envelope calculation will lack the detail (breakdown of Availability, Performance, and Quality and the detailed reasons behind all the stoppages) but it will provide a good idea of where your production lines really stand at the moment. This back of the envelope calculation is astoundingly easy to perform. The thought process is described below and the Table in Figure 3 is provided as an example:

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- Line: Select a Line, Work Cell, or Machine to perform this calculation on. Select one that you will have accurate production numbers for.
- OEE Calculation Time Period: Select a period of time that is long enough to account for any major periodic Availability related downtimes that will occur. For instance, if your line runs continuously for 2 days and then must be stopped for a CIP (sanitation) for 4 hours every 3ird day, then run your calculation over the 3 day period.
- Time Not Scheduled. During the OEE Calculation Time Period, you need to determine how many minutes the line was not scheduled to be used for any productive purpose (changeover, sanitation, PM, etc. are productive purposes). This is the time that you had no production requirements.
    - For instance, if your plant only works 2 shifts, then 3ird shift time would be looked at as “Not Scheduled.”
    - On the other hand, if 3ird shift was used for Preventative Maintenance, then this would be viewed as scheduled time.
- Theoretical Rate: You will need to know the real Theoretical Rate of the Line based on the equipment specifications for each SKU run on the line during the OEE Calculation Time Period being measured. This is the rate the equipment was to provide when purchased, not the rate that operators may currently be running the equipment at. This can be in any units (cases/hr, units/min, feet/min, lbs/hr, etc.).
- Good Product Produced. For each SKU, you will need to know the quantity of Good Product Produced in units equivalent to your Theoretical Rate units (i.e. be consistent with your units, cases, individual units, pallets, etc.).
- If all the SKU’s run during the OEE Calculation Time Period have the same Theoretical Rate, then you have all the information you need to complete the calculation! See the Table below for an example.

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OEE Item	Example Value	Explanation
Line or System Name	Packaging Line 3	Canning Line
Current Average Reported Line Efficiency	88%	This is using the "traditional" way of measuring the efficiency where availability and short stop failures are not counted against efficiency
OEE Calculation Time Period	4,320 minutes	3 days
Time Not Scheduled	1,230 minutes	Plant operates 2 shifts per day, so over 3 days, the line should be unused a total of 24 hours (1,440 minutes), but looking at time cards, with overtime, the actual time not scheduled is 20.5 hours.
Planned Production Time	3,090 minutes	Planned Production Time = OEE Calculation Time Period – Time Not Scheduled = (4,320 – 1,230)
Theoretical Rate for SKU #1	500 cans per minute	This is the run rate for the 12oz can of Chicken Broth, where this product was run for the entire 3 days.
Good Product Produced during Planned Production Time (1st pass yield)	994,980 cans	This number comes from production reports, it is not calculated. If the production reports are in cases, then you must convert to cans (match the units of the Theoretical Rate).
Calculate the OEE	64.4% OEE	(994,980 cans) * 100% / (500 cans/min * 3,090 minutes)

FIGURE 3 – Example of Back of the Envelope OEE Calculation

In a slightly more complex case, let's assume that 2 different products (SKUs) were run during the three days, each with a different theoretical rate. In this case, we need to know the Planned Production Time, the

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Theoretical Rate, and the Good Product Produced for each SKU. Then the OEE calculation is weighted based on the planned production time of each product, for example:

OEE = (Good Cans Produced of SKU A + Good Cans Produced of SKU B) * 100% /((Theor Rate SKU A * Planned Production Time SKU A) + ((Theor Rate SKU B * Planned Production Time SKU B))

Leveraging Small OEE Improvements to Generate Huge Business Opportunities

Let's extend the example of our Canned Food Plant. Let's say that the plant had an initial OEE of 66.5% prior to implementing an automated OEE and Downtime measurement system and an improvement initiative.

- By reducing setup times (small investments in tooling, establishing best practices, and training) the Availability improves from 80% to 85%.
- By identifying and resolving the most (5) most serious causes of short stops, the Performance improves from 84% to 86%.
- By identifying the number one cause of rejects and resolving it, the quality improves from 99.0 to 99.2%.
- Compounded, these small improvements have the net effect of improving the OEE from 66.5% to 72.5%!

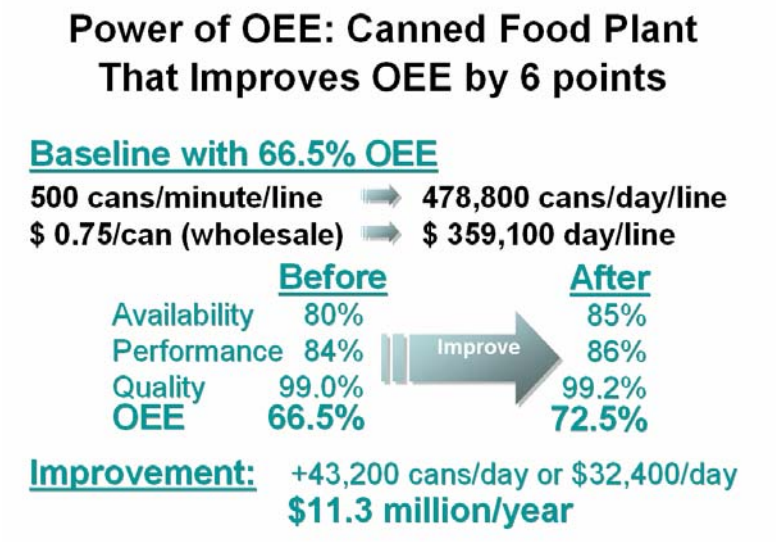

FIGURE 4 –OEE Improvement Example

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This 6 point improvement of OEE is a 9% improvement over the original value, and therefore the line can produce 9% more product in the same production time, or if more capacity is not needed, then the production schedule can be cut back by 9%. In a plant that is operating 24x7x350 days, this allows the reduction of 95 shifts per year, or 2nd and 3ird shift on nearly every Sunday. Figure 5 quantifies the potential benefits.

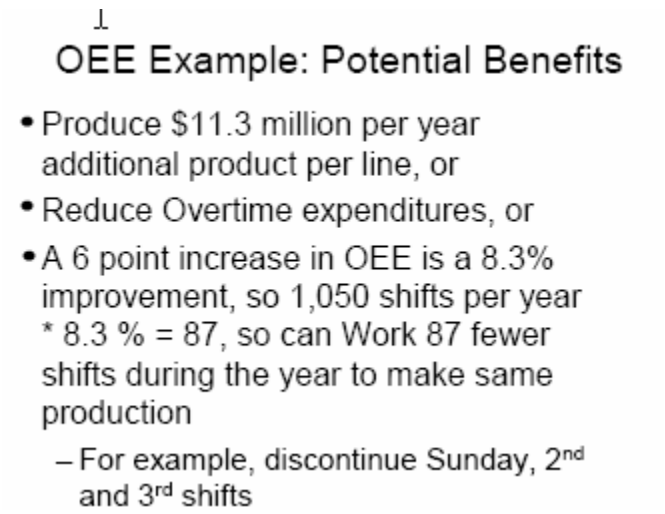

FIGURE 5 –OEE Improvement Example – Potential Benefits

The Bottom Line

Many companies routinely hit capacity constraints, and immediately consider adding overtime for existing workers, hiring workers for a new shift, or buying a new line. Relatively few companies have made the more modest investment that is required to optimize the performance of their existing lines. This investment pays huge dividends by reducing process variability, reducing changeover times, improving operator performance, reducing overtime expenditures, unleashing hidden capacity, and allowing deferral of major capital investments. These are measurable benefits that will substantially improve the bottom line of your production operation.

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