OVERALL EQUIPMENT EFFECTIVENESS

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Abstract—Under current economic conditions, severe global competition and postponement of new equipment purchases are causing business executives to be sensitive about all aspects of manufacturing operational costs. In this context Overall Equipment Effectiveness (OEE) has become a hot topic among many manufacturers. It provides a simple way to "keep score" of manufacturing performance, and lean manufacturing initiatives.

Keywords— Lean production, Six sigma, Plant efficiency, Production equipment, Maintenance, Reliability

INTRODUCTION

Overall Equipment Effectiveness (OEE) is a hierarchy of metrics which focus on how effectively manufacturing equipment is utilised. The results are stated in a generic form which allows comparison against benchmark defined for the industry. Comparisons can also be made in between shifts, products, machines, departments, lines and plants etc. In simple words, "Overall Equipment Effectiveness shows the effectiveness of a machine compared to the ideal machine as a percentage."

Overall equipment effectiveness is a measure of total performance- the degree to which the asset is doing what it is supposed to do. The effectiveness of equipment is the actual output over the reference output. Equipment Effectiveness shows how effectively the equipment is utilized. The value of the OEE is a measure for the effectiveness of the equipment in the available time for production. Overall Equipment Effectiveness shows the effectiveness of a machine compared to the ideal machine as a percentage. Ideal machine means the machine that produce maximum output at best quality. It doesn't have any loss or breakdowns. So it is only an imaginary machine. OEE compares the equipment with the same ideal equipment gives a numerical value as a percentage.

The OEE is quantified as

$$\text{OEE} = \frac{\text{FULLY PRODUCTIVE TIME}}{\text{PLANNED PRODUCTIVE TIME}}$$

Planned Productive time is the time in which normally production is planned or realized. Fully productive time is the time which remains after subtracting all losses in a production system. Therefore OEE is the ratio between Fully Productive Time and Planned Production Time.

Literature Review

OEE is defined as a key metric in Total Productive Maintenance (TPM) and Lean Manufacturing programs that gives a consistent way to measure the effectiveness of TPM and other initiatives by providing an overall framework for measuring production efficiency. Company-wide TPM is concerned with eliminating all forms of waste. OEE shows how well a company is utilizing its resources, which include equipment, labour and the ability to satisfy the customer in terms of delivering quality products.

Overall Equipment Effectiveness (OEE) is a way to monitor and improve the efficiency of your manufacturing process. Developed in the mid 1990's, OEE has become an accepted management tool to measure and evaluate plant floor productivity. OEE is broken down into three measuring metrics of Availability, Performance, and Quality. These metrics help gauge your plant's efficiency and effectiveness and categorize these key productivity losses that occur within the manufacturing process. OEE empowers manufacturing companies to improve their processes and in turn ensure quality, consistency, and productivity measured at the bottom line.

Simple OEE: How many good parts versus bad parts a machine has produced.

OEE Terminology

This section describes the various plant manufacturing terms that make up Simple OEE and the three metric values (Availability, Performance, Quality) used in the calculation of Simple OEE.

(1) RUN TIME (Availability Metric) - The total production time that the machine has been running and producing parts.

(2) SETUP TIME (Availability Metric) - The period of time on the machine required for an operator to perform all the necessary tasks to produce the first good part.

(3) DOWN TIME (Availability Metric) - The period of time the machine is not available for production due to maintenance or breakdown
.

(4) TOTAL TIME (Availability Metric) - The total accumulated machine time of (Run Time + Down Time + Setup Time).

(5) TARGET COUNT (Performance Metric) - the number of parts or cycles that should be completed at a particular point within the shift, day, or production run.

(6) TOTAL COUNT (Performance & Quality Metric) - The total number of parts, good and bad, that are produced on a machine.

(7) GOOD COUNT (Quality Metric) - The input count for any part produced to manufacturing specifications on the machine.

(8) AVAILABILITY = Run Time / Total Time

(9) PERFORMANCE = Total Count / Target Count

(10) QUALITY = Good Count / Total Count

Objectives of OEE

1. To identify a single asset (machine or equipment) and/or single stream process related losses for the purpose of improving total asset performance and reliability.

2. To identify and categorize major losses or reasons for poor performance. OEE provides the basis for setting improvement priorities and beginning root cause analysis.

3. To track and trend the improvement, or decline, in equipment effectiveness over a period of time.

4. To hidden or untapped capacity in a manufacturing process and lead to balanced flow.

5. To develop and improve collaboration between asset operations, maintenance, purchasing, and equipment engineering to jointly identify and eliminate (or reduce) the major causes of poor performance since "maintenance" alone cannot improve OEE.

SIX BIG LOSSES

Defining the Six Big Losses

One of the major goals of TPM and OEE programs is to reduce and/or eliminate what are called the Six Big Losses – the most common causes of efficiency loss in manufacturing. The following table lists the Six Big Losses, and shows how they relate to the OEE Loss categories.

Table 1 – OEE and Six big losses

OEE Losses	Six Big Losses
Down Time Loss	Breakdowns
	Setup, warm up time and adjustments
Speed Loss	Small stops and obstructions
	Operator inefficiency and decreased speed
Quality Loss	Rejects in early production period
	Rejects in stable production period

Addresing the six big losses

Now that we know what the Six Big Losses and some of the events that contribute to these losses, we can focus on ways to monitor and correct them. Categorizing data makes loss analysis much easier, and a key goal should be fast and efficient data collection, with data put to use throughout the day and in real-time.

 Breakdowns

Eliminating unplanned Down Time is critical to improving OEE. Other OEE factors cannot be addressed if the process is down. It is not only important to know how much Down Time your process is experiencing (and when) but also to be able to attribute the lost time to the specific source or reason for the loss (tabulated through Reason Codes). With Down Time and Reason Code data tabulated, Root Cause Analysis is applied starting with the most severe loss categories.

 Setup and Adjustments

Setup and Adjustment time is generally measured as the time between the last good part produced before Setup to the first consistent good parts produced after Setup. This often includes substantial adjustment and/or warm-up time in order to consistently produce parts that meet quality standards.

Tracking Setup Time is critical to reducing this loss, together with an active program to reduce this time (such as an SMED - Single Minute Exchange of Dies program). Many companies use creative methods of reducing Setup Time including assembling changeover carts with all tools and supplies necessary for the changeover in one place, pinned or marked settings so that coarse adjustments are no longer necessary, and use of prefabricated setup gauges.

 Small Stops and Reduced Speed

Small Stops and Reduced Speed are the most difficult of the Six Big Losses to monitor and record. Cycle Time Analysis should be utilized to pinpoint these loss types. In most processes recording data for Cycle Time Analysis needs to be automated since cycles are quick and repetitive events that do not leave adequate time for manual data-logging.

By comparing all completed cycles to the Ideal Cycle Time and filtering the data through a Small Stop Threshold and Reduced Speed Threshold the errant cycles can bautomatically categorized for analysis. The reason for analyzing Small Stops separately from Reduced Speed is that the root causes are typically very different, as can be seen from the Event Examples in the previous table.

 Startup Rejects and Production Rejects

Startup Rejects and Production Rejects are differentiated, since often the root causes are different between startup and steady-state production. Parts that require rework of any kind should be considered rejects. Tracking when rejects occur during a shift and/or job run can help pinpoint potential causes, and in many cases patterns will be discovered.
Often a Six Sigma program, where a common metric is achieving a defect rate of less than 3.4 defects per million "opportunities", is used to focus attention on a goal of achieving "near perfect" quality.

COMPONENTS OF PLANT OPERATING TIME

OEE analysis starts with Plant Operating Time. It is the amount of time the facility is open and available for equipment operation. It is the maximum amount of time and is a constant. A day always consists of 24 hours of 60 minutes each. A week always consists of 7 days of 24 hours. A year always consists of 52 weeks. It is also called Theoretical Production Time. This Plant Operating Time consists fully productive time and different losses like speed and quality loss.

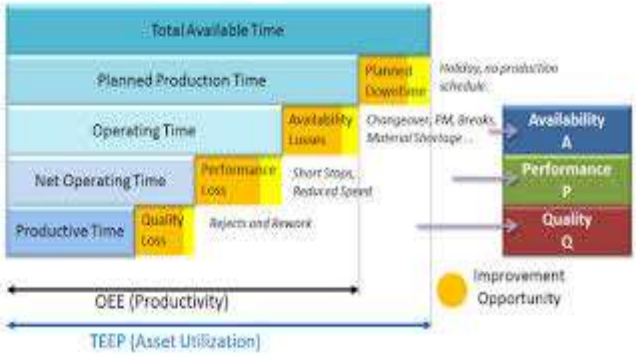

Fig: 5- COMPONENTS OF PLANT OPERATING TIME.

Planned Production Time
When a category of time called Planned Shut Down is subtracted from Plant Operating Time, the remaining is Planned Production Time. The planned shutdown includes all events that should be excluded from efficiency analysis because there was no intension of running production. E.g. Breaks. Lunch breaks, scheduled maintenance or periods where there is nothing to produce. Planned Production Time is also known as Available Production Time. OEE begins with Planned Production Time and scrutinizes efficiency and productivity losses that occur, with the goal of reducing or eliminating these losses. OEE starts with Plant Operating Time and end up at Fully Productive Time, showing the sources of Productive loss that occur in-between.

Operating Time
From Planned Production Time, Down Time loss is subtracted to get Operating Time. Downtime losses includes any events that stop planned production for an appreciable length of time (usually several minute-long enough to log as a traceable event). Examples include equipment failures, material shortages, and changeover time. Change over time is included in OEE analysis, since it is a form of downtime. While it may not be possible to eliminate changeover time, in most cases it can be reduced. The remaining available time is called operating time. It is also known as Gross Operating Time.

Net Operating Time
From Operating Time, speed loss is subtracted which includes any factors that causes the process to operate at less than the maximum possible speed while running. Examples include machine wear, substandard materials, miss-feeds, and operator inefficiency. The remaining available time is called Net Operating Time.

Fully Productive Time
From Net Operating Time, Quality Loss is subtracted which accounts for produced pieces that do not meet quality standards, including pieces that require rework. The remaining time is called Fully Productive Time. The goal is to maximize Fully Productive Time. It is also known as Valuable Operating Time.

Plant operating Time= Fully Productive Time + Quality Loss + Speed Loss + Down Time Loss + Planned Shutdown.
A graphic representation of components of Plant Operating Time is shown in Figure above.

OEE FACTORS

The OEE calculation is based on the three OEE factors; Availability, Performance and Quality. They are also called Effectiveness Factors.

The availability portion of the OEE Metric represents the percentage of scheduled time that the equipment is available to operate. The Availability Metric is a pure measurement of Uptime that is designed to exclude the effects of quality, Performance, and scheduled Downtime Events.
It is calculated by

$$\text{Availability} = \frac{\text{Operating Time}}{\text{Planned Production Time}}$$

When downtime losses are zero, the availability is 1 or 100%, the gross operating time equals the available time for production. i.e. Operating time equals Planned Production time. 100% availability means the process has been running without any recorded stops.

o Performance

Performance takes into account Speed loss. Performance is the ratio between Net Operating Time and Operating Time.

$$\text{Performance} = \frac{\text{Net Operating Time}}{\text{Operating Time}}$$

The performance portion of the OEE Metric represents the speed at which the equipment runs as a percentage of its designed speed. The Performance metric is a pure measurement of speed that is designed to exclude the effects of Quality and Availability. Performance does not penalize for rejects, which means even if the work is rejected or it's a rework, it will be included in the planned and actual hours accordingly.
It is calculated as:

$$\text{Performance} = \frac{\text{Ideal Cycle Time}}{(\text{Operating Time / Total Pieces})}$$

Ideal Cycle Time is the minimum cycle time that your process can be expected to achieve in optimal circumstances. It is sometimes called Design Cycle Time, Theoretical Cycle Time or Nameplate Capacity.

Since Run Rate is the reciprocal of Cycle Time, Performance can also be calculated as:

$$\text{Performance} = \frac{(\text{Total Pieces / Operating Time})}{\text{Ideal Run Rate}}$$

Performance is capped at 100%, to ensure that if an error is made in specifying the Ideal Cycle Time or Ideal Run Rate, the effect on OEE will be limited. 100% Performance means the process has been consistently running at its theoretical maximum speed

o Quality

The Quality portion of the OEE metric represents the Good Units produced as a percentage of the total units produced. The Quality metric is a pure measurement of process yield that is designed to exclude the effects of Availability and Performance. Quality is the ratio of Fully Productive Time to Net Operating Time.

$$\text{Quality} = \frac{\text{Fully Productive Time}}{\text{Net Operating Time}}$$

It is calculated as

$$\text{Quality} = \frac{\text{Good Pieces}}{\text{Total Pieces}}$$

100% Quality means there have no reject or rework pieces. The three effectiveness factors offer a second way to quantify the OEE;

$$\text{OEE} = \text{Availability x Performance x Quality}$$

Therefore OEE is the product of its effectiveness factors; Availability, Performance and Quality. The individual value of the three effectiveness factors lies between 0 and 1. The study of each of these effectiveness factors will improve the Overall Equipment Effectiveness.

During analysis, the analyst can concentrate each category of losses separately. Availability takes into account Downtime losses, Performance takes into account speed losses and quality factor takes into account Quality loss. The main aim of OEE measurement is to reduce these losses and by analysis and improving the factors, the losses can be reduced or eliminated and OEE can be improvement. The use of effectiveness factors helps with prioritizing the size, but does not indicate the financial consequences that can differ per factor. The OEE factors and their losses are shown in the figure below.

OEE CALCULATION METHODS

OEE is a percentage of an equipment which shows its efficiency or effectiveness. Different input data is needed for calculating OEE. The aim of OEE measurement and analysis is to reduce the equipment losses to zero and has been recognized as a necessity for many organizations.

There are mainly 3 methods for finding OEE.

1) Direct Method
2) OEE Factors Method
3) Software Method

For all these methods, the input data is same. The difference is the approach to the problem. Basically Software Method also uses OEE Factors Method.

** Direct Method**

Direct Method uses the basic formula for finding OEE.

$$\text{OEE} = \frac{\text{Fully Productive Time}}{\text{Planned Production Time}}$$

It involves finding the Planned Production Time and Fully Productive Time from the given input data. Planned Production Time can be found out by subtracting Planned Shutdown from Plant Operating Time. Plant Operating Time: Calendar time 24 hours/day, 7 days/week, 365 days/year, 60 minutes/hour, 60 seconds/minute. Planned Shutdown includes lunch breaks and tea breaks, shift change, planned maintenance etc. Fully Production time can be found out by subtracting Downtime loss, Speed loss and Quality loss from Planned Production time. Downtime loss should be given in the input data. Speed loss can be calculated from ideal production rate and actual production rate. Quality loss can be calculated from no. of defective products. All of these are losses.

OEE Factors method.

The OEE calculation is based on the three OEE Factors of Availability, Performance, and Quality. If there are no losses then the OEE equals 100%, or the “ideal” automation equipment. The product of these three factors equals the OEE value:

This method is a little complex and is not used practically. The main disadvantage of this technique is that analysis from the results is very limited. Because the output is the OEE percentage alone. In other two techniques, the result has more information which aids in further analysis.

Table 2- OEE Calculation using Factors

OEE = Availability Rate x Performance Rate x Quality Rate (%) **Elements of OEE Calculation**	**Element Formula**
Availability Rate Availability Rate is the time the equipment is actually producing products versus the maximum theoretical time that it could have been producing. Less than 100% Availability Rate indicates Downtime Loss.	**Availability Rate (%)** = Operating Time / Loading Time = Operating Time / (Operating Time – Unscheduled Time) = [(Operating Time – Unscheduled Time) – (Breakdowns + Idle Time + Line Restraints)] / (Operating Time – Unscheduled Time)
Performance Rate Performance Rate is the actual output compared to the maximum theoretical output (expected output given the theoretical maximum speed of the equipment and the actual production time). Less than 100% Performance Rate indicates Speed Loss.	**Performance Rate (%)** = Actual Output / Maximum Theoretically Output
Quality Rate Quality Rate is the good output (amount of good products) compared to the actual output. Less than 100% Quality Rate indicates Quality Loss.	**Quality Rate (%)** = Good Output / Actual Output = [Actual Output – (Scrap + Rework)] / Actual output

Software Method
This is an automated method. This involves the use of computers in calculating OEE. The basic approach is same as the OEE Factors Method but Software Method is more accurate and more flexible. All modern firms use this method. Software method can be done with the same input data which is required for other two techniques.

There are two types of OEE Software:

1. Spreadsheets
2. System Software

1. Spreadsheets
Spreadsheet makes calculating OEE easier but unfortunately, it won't help with collecting the data. Manual collection and processing of data for OEE calculation is time consuming and ensures that it is always out of date.

2. System Software
System software collects data in real-time directly from the equipment. It saves the time needed to manually collect the data leaving staff available to do more productive work. The data is highly accurate compared to manually collected data and it is available immediately OEE IMPACT, VISUAL OEE, OEE TOOLKIT, PROVIDEAM are examples for System Software.

SAMPLE PROBLEM
Some data about an equipment is given. Calculate Overall Equipment Effectiveness using all three methods.

Shift Length = 8 hours
Tea breaks = 10 minutes x 2
Meals break = 1 hour
Downtime = 10% of shift (48 hours)
Idle Run rate = 5 pieces/minute (Cycle time = 0.2min/pieces)
Total pieces produced = 1600
Rejected pieces = 52
Assure the equipment works only under the supervision of its operator.

Direct Method
According to Direct Method,

OEE = Fully Productive Time / Planned Production Time

Planned Production Time = Plant Operating Time – Planned Shutdown
Plant Operating Time = 8 hours x 60 = 480 minutes.
Planned Production Time = 480-80 = 400 minutes.

Fully Productive Time = Planned Production Time – (Downtime + Speed + Quality losses)
Downtime loss = 10% of shift length = 480 x 0.10 = 480 minutes

Speed loss = (Ideal Production- Actual Production) x Cycle time
Ideal Production = Ideal run rate x Operating Time
Operating Time = Planned Production Time – Downtime loss
= 400-48 = 352 minutes.

Ideal Production = (5 pieces/min) x 352 minutes = 1760 pieces.
Speed loss = (1760 – 1600) x 0.2 minutes = 160 x 0.2 = 32 minutes

Quality loss = No. of rejected items x Cycle time = 52 x 0.2 minutes = 10.4 minutes.

Fully Productive Time = 400 – (48+32+10.4) = 309.6 minutes

OEE = 309.6/400 = 0.774
Overall Equipment Effectiveness = 74.4%

OEE Factors Method

According to this method,

OEE = Availability x Performance x Quality
Availability = Operating Time / Planned Production Time
Operating Time = 352 (Calculated earlier)
Planned Production Time = 400 (Calculated earlier)
Availability = 352/400 = 0.88
Performance = (Total pieces / Operating Time) / Ideal Run Rate = (1600/352)/5 = 0.9091
Quality = Good Pieces / Total Pieces = (1600-52) / 1600 = 0.9675

OEE = 0.88 x 0.9091 x 0.9675 = 0.774

Overall Equipment Effectiveness = 77.4%

Software Method

A sample spreadsheet is used for calculating OEE. The input data is entered into the required fields of the worksheet. The spreadsheet calculates OEE factors simultaneously while entering data. The three factors Availability, Performance, Quality are calculated and OEE is also calculated. These values are also compared with World Class OEE so that the analyst can know the present condition of the equipment. The screen shot of the Excel Calculator is given below.

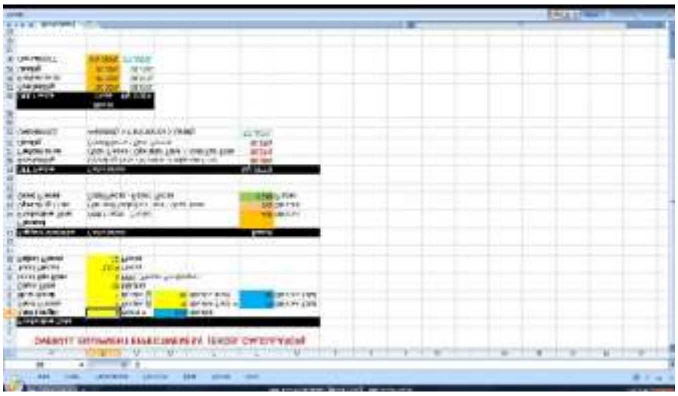

Fig: 15- Screenshot of Excel Calculator.

Using OEE Data and Calculation to Improve Equipment Effectiveness

An example OEE data (14 Major Losses) and OEE percentage calculations for one day (24 hours) of "Machine D" operation are shown below in Table. The loss data is listed along with comments on the reasons for the loss.

Table 3- Example OEE Data and OEE Percentage Calculation

Major Equipment Losses	*Data*	*Comments & Calculations*
A. Planned shutdown losses:	(Hours)	**Gross Time: 24 hours (or minutes)**
1. No production, breaks, shift change...	**2.66**	**Meeting & shift change**
2. Planned maintenance	**2.00**	**Monthly PM**
B. Downtime losses:	(Hours)	**(or minutes)**
3. Waiting for operator	**1.66**	
4. Failure or breakdowns	**1.33**	**Mechanical drive coupling**
5. Setups & changeover	**1.16**	**2 size changes**
6. Tooling or part Changes	**0.83**	**Screw station bits**
7. Startup & adjustment	**1.00**	**1st shift Monday**
8. Material Flow: Input (No material)	**0**	**Waiting for raw materials**
9. Material Flow: Output (Kanban full)	**0**	**Output not needed; no room in queue**
Sub Total Availability Losses: (A + B hours)	**10.64**	**24 hrs – 10.64 = 13.36 13.36 ÷ 24 x 100 = 55.67%**
C. Performance efficiency losses:	(Count)	
10. Minor stops	**10 events**	**Jams!**
11. Reduced speed or cycle time	**100 vs. 167 units**	**Design rate: 12.5 units/hour**
Sub Total Efficiency Losses:		**100 ÷ 167 x 100 = 59.88%**
D. Quality & yield losses:	(Count)	
12. Scrap product / output	**2**	**Waste, non-salvageable**
13. Defects, rework	**1**	
14. Yield / Transition	**5**	**Startup & related**
Sub Total Quality & Yield Losses:	**8**	**100 – 8 = 92 good units 92 ÷ 100 x 100 = 92.00%**

Overall Equipment Effectiveness %	**55.67 x 59.88 x 92 = 30.66%**

Example discussion: Historically, "Machine D" OEE percentage averaged 40.2% year-to-date, 35.06% in the prior day, but now has slipped to 30.66% in the current day as shown in the Table 1example. "Machine D's" OEE percentage obviously shows a declining trend. These OEE percentage can be charted by the month, week, day, and shift. A review of "Machine D's" current day OEE percentage should direct the Focused Improvement Team to further analyze the types or reasons for the performance decline. Improvements could be made in availability, efficiency, and/or quality losses. The current OEE data (information), shown in the Table, is sufficient to begin comparisons to prior OEE data and root cause analysis activities. The question "What changed?" should guide the improvement efforts.

World Class OEE

OEE is essentially the ratio of Fully Productive Time to Planned Production Time. In practice, however, OEE is calculated as the product of its three contributing factors:

OEE = Availability x Performance x Quality
This type of calculation makes OEE a severe test.
For example, if all three contributing factors are 90.0%, the OEE would be 72.9%. In practice, the generally accepted World-Class goals for each factor are quite different from each other, as is shown in the table below.

OEE Factor World Class

- Availability 90.0%
- Performance 95.0%
- Quality 99.9%
- Overall OEE 85.0%

Of course, every manufacturing plant is different. For example, if your plant has an active Six Sigma quality program, you may not be satisfied with a first-run quality rate of 99.9%.

Worldwide studies indicate that the average OEE rate in manufacturing plants is 60%. As you can see from the above table, a World Class OEE is considered to be 85% or better. Clearly, there is room for improvement in most manufacturing plants.

Cautions for Using OEE

Based on the wide spread and diverse understanding and use of OEE, there are several cautions regarding its use:

1. The calculated OEE (OEE percentage) is not intended for use as a corporate or plant level measure. OEE percentage is a rough measure of selected equipment effectiveness only.

2. Calculated OEE is not valid for comparing or benchmarking different assets, equipment, or processes. OEE is a relative indicator of a specific single asset effectiveness compared to itself over a period of time. However, OEE can be used to compare like equipment in like situations producing like products or output.

3. OEE does not measure maintenance effectiveness because most of the loss factors are outside the direct control of the maintainers.

4. There appears to be no valid specification of "world-class OEE." However, 85 percent OEE has been cited frequently. Also, "maximizing OEE" may not be justifiable. Optimum levels of OEE largely depend on the capability or capacity of the asset, the business demands, and whether it is a constraint in the process flow.

5. OEE percentage calculations are not statistically valid. A calculated OEE percentage assumes that all equipment-related losses are equally important and that any improvement in OEE is a positive improvement for the business. This is generally not the case. For example, the calculated OEE percentage does not consider that a one percent improvement in quality may have a bigger impact on the business than does a one percent improvement in availability. Also, in the OEE calculation, three different units of measure are falsely considered as the same –chronological time, units per time, and counts of units produced – and are converted to percentages for comparison. OEE percentages can actually improve while actual quality losses increase significantly. OEE percentages can actually decline while output improves – efficiency and quality losses are reduced and the same planned output is generated in less time thereby lowering the "availability" percentage – three shifts of output in two shifts.

BENEFITS OF OEE

Implementing an adequate OEE system brings immediate financial benefits to manufacturing operations. Some of these benefits are listed below.

1. Reduced Downtime Costs
When a critical machine is inoperable, it brings downstream operations to a standstill. This can negatively affect delivery commitments to the customer, which in turn impacts cash flow and revenue

2. Reduced Repair Costs
OEE enables predictive maintenance that can dramatically reduce repair costs. As the historical database of downtime reasons grows, the maintenance department can discern trends to predict an impending failure. Also, by interfacing the OEE system to a CMMS (Computerized Maintenance Management System) system, the maintenance department can take proactive steps to do predictive maintenance.

3. Increased Labor Efficiencies
Due to current economic conditions, most manufacturing companies have downsized considerably. Consequently, manufacturers are eager to optimize the productivity of their existing workforce. An OEE system helps, because it not only captures operator downtime reasons, but also productivity data. With this information, management can better judge the proper allocation of resources based on personnel productivity. When the business climate improves, an OEE

system could enable managers to identify additional capacity within the existing workforce instead of hiring new labor.

4. Reduced Quality Costs

As indicated in the introductory section, Rate of Quality is a percentage of good parts produced versus the total parts produced. Thus, an OEE system must capture the quantity of total parts produced, the number of scraps and defects and the reason for defects. Because this information is captured at a specific machine or line level, this capability actually captures quality in the context of the part produced. By tracking context-rich quality data using OEE, production managers can identify root causes and eliminate further costs associated with rework and scrap. Improving the focus on quality at every stage of production also reduces warranty costs. In the previously cited Industry Week survey, world-class manufacturers benefit from first pass yields of 97% (median value), while scrap and rework are 2% (median value) and warranty cost is 1%.

5. Increased Personnel Productivity

An OEE system enables the shop floor to go paperless. Typically, facility operators and supervisors spend an enormous amount of clerical time recording, analyzing and reporting downtime reasons and root causes on paper, then further explaining these reports to management. An OEE system captures and reports downtime and efficiency automatically. This saves time lost in non-value added reporting activities and allows personnel to focus on more valuable tasks. With OEE, everyone from the plant floor to the boardroom is more informed, more often, more easily.

6. Increased Production Capability

The net effect of reduced machine downtime, higher productivity of operators and reduced defects is the ability to achieve higher production levels with the same amount of resources.

CONCLUSION

The definition and use of Overall Equipment Effectiveness over the years has been widely debated. Many practitioners have found that OEE has several uses and definitions which have led to considerable confusion when comparing machine-to-machine, plant-to-plant or company to company. Unfortunately, OEE was not designed to make comparisons from machine to machine, plant-to-plant, or company-to-company, but it has evolved to these common levels of misuse. OEE is not a statistically valid metric, but it has been used as such for years.

OEE does not diagnose a specific reason why a machine is not running as efficiently as possible, but it helps to categorize the areas for initiating the equipment improvement.

Modified Overall Equipment Effectiveness helps to analyze short time losses and long time losses separately. Also it adds one more factor in calculation, Usability. It helps in more specific analysis of losses and for initiatives to reduce these losses. But Modified OEE is still in development stage.

REFERENCES

[1] Anil S. Badiger, „A proposal: evaluation of OEE and impact of six big losses“, Int. J. Process Management and Benchmarking, Vol.2, No. 3, 2008, pp 234-248.

[2] Ravikumar M. M., „Improving Equipment Effectiveness“, Int. Business Management, Vol. 3, No.2, 008, pp 91-96.

[3] Francis Wauters, „White Paper on Improving Plant Performance: OEE“, ABB Inc, June 2002. www.abb.com

[4] „The Fast Guide to OEE“, Vorne Industries, 2008. www.vorne.com

[5] Robert M. Williamson, „Whitepaper on OEE Implementation“, Strategic Work Systems Inc, 2004. www.swspitcrew.com

[6] http://www.bestmanagementarticles.com

[7] http://www.maintenanceworld.com

[8] http://www.managementparadise.com

[9] http://www.oee.com

[10] http://www.oeetoolkit.com

[11] http://www.scribd.com