Overall Equipment Effectiveness

OEE - sweating manufacturing assets against the clock to maximise the output of prime quality product
This slideshow will briefly cover…

- Overall Equipment Effectiveness & the OEE metric
- The Six Big Losses
- The ‘Hidden Factory’
- Theory of Constraints - *manufacturing bottlenecks & pinchpoints*

It’s purpose is to merely place things in context. Further reading is required for an in-depth understanding of OEE.
OEE fundamentals

*OEE is data driven*

Good data collection and analysis are key requirements for a successful OEE project.
OEE fundamentals

OEE is data driven

Good data collection and analysis are key requirements for a successful OEE project.

If you can’t put a number on it, you can’t measure it – and, if you can’t measure it, you can’t manage it!
OEE fundamentals

OEE is data driven

Good data collection and analysis are key requirements for a successful OEE project

...plus, if you’re not keeping score, you’re only practicing!
OEE fundamentals

Manufacturing assets must be sweated!

Manufacturing equipment must run flat out at face plate rating – with vertical start-ups and shutdowns, minimal stops and no defects in production output.
OEE fundamentals

Manufacturing assets must be sweated!

Manufacturing equipment must run **flat out at face plate rating** – with **vertical** start-ups and shutdowns, **minimal stops** and **no defects** in production output

*The only rest is when the whistle blows…*
OEE fundamentals

Manufacturing assets must be sweated!

Manufacturing equipment must run **flat out at face plate rating** – with **vertical** start-ups and shutdowns, **minimal stops** and **no defects** in production output

Beware of ‘twilight’ production and reworking
OEE fundamentals

Manufacturing assets must be sweated!

Manufacturing equipment must run *flat out at face plate rating* – with *vertical* start-ups and shutdowns, *minimal stops* and *no defects* in production output

An IDEAL!
The world class benchmark is 6 *Sigma*
OEE fundamentals

*Manufacturing assets must be sweated!*

Manufacturing equipment must run **flat out at face plate rating** – with **vertical** start-ups and shutdowns, **minimal stops** and **no defects** in production output.

An IDEAL!

The world class benchmark is **6 Sigma**

3.4 defects per million ‘opportunities’
The OEE Metric
The OEE metric
As far as capital manufacturing assets are concerned...

- Time is money!
- Time ‘lost’ is money down the drain
- Time must be strictly accounted for
The OEE metric

\[
OEE = \frac{\text{ACTUAL quantity of good products produced}}{\text{Total quantity that COULD BE produced}} \times \text{In the scheduled production time (loading time)}
\]
The OEE metric

OEE = \frac{\text{ACTUAL quantity of good products produced}^*}{\text{Total quantity that COULD BE produced}}

* In the scheduled production time (loading time)

COULD = \text{without losses due to:}
- Start-ups
- Downtime
- Low speed
- Shutdowns
- Changeovers
- Lack of supplies
- Quality defects

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The OEE metric

\[
\text{OEE} = \frac{\text{ACTUAL quantity of good products produced}^*}{\text{Total quantity that COULD BE produced}}
\]

Resulting in \textit{LOW}
- Output
- Overall efficiency
- Yield
- First-time pass rate
- Quality
- OTIF delivery
  (‘on time & in full’)

\textit{scheduled production time}
\textit{(loading time)}

Factors due to:
- Downtime
- Speed
- Shutoffs
- Changeovers
- Lack of supplies
- Quality defects
- Start-ups

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The OEE metric

\[
\text{OEE} = \frac{\text{ACTUAL quantity of good products produced}}{\text{Total quantity that COULD BE produced}} \times \text{In the \textit{scheduled production time} (loading time)}
\]

OEE is calculated by measuring the ‘Six Big Losses’
The Six Big Losses
The Six Big Losses

1. Equipment Failure
2. Setup & Adjustments
3. Idling & Minor Stoppages
4. Reduced Speed
5. Scrap & Rework
6. Startup Low Yield
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SMED

Minimise
The Six Big Losses

1. Equipment Failure
2. Setup & Adjustments
3. Idling & Minor Stoppages
4. Reduced Speed
5. Scrap & Rework
6. Startup Low Yield

‘Single Minute Exchange of Die’
The Six Big Losses

1. Equipment Failure
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SMED

‘Single Minute Exchange of Die’

Benchmark: Formula 1 pit stop!

F1 workflow also used to ‘turnaround’ Jumbo jets and plan complex surgical procedures
The Six Big Losses

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These are real killers – they combine insidiously to trash production performance - *and yet tend to be ‘accepted’*
The Six Big Losses

1. Equipment Failure
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Computerised Maintenance Management Management (CMMS) helps with this

These are real killers – they combine insidiously to trash production performance - *and yet tend to be ‘accepted’*
The Six Big Losses

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The OEE factors

Availability
Performance Rate
Quality Rate
The OEE Calculation
Overall Equipment Effectiveness = Availability × Performance Rate × Quality Rate
OEE calculation

Consider an example

Say

Availability = 70%
Performance Rate = 80%
Quality rate = 90%
OEE calculation

Consider an example

Say
- Availability = 70%
- Performance Rate = 80%
- Quality rate = 90%

Then, OEE = 50%
OEE calculation

Consider an example

Saying:
- Availability = 70%
- Performance Rate = 80%
- Quality rate = 90%

Then, OEE = 50%

In reality this is towards the lower limit – OEE performance is generally in the range 40% to 80%
Consider an example

Say

Availability = 70%
Performance Rate = 80%
Quality rate = 90%

Then, OEE = 50%

This means that half the built and maintained factory isn’t contributing
OEE benchmark targets - *World Class*

- Batch processes > 85%
- Continuous discrete processes > 90%
- Continuous processes > 95%

Best petrochem sites achieve 99.9%
OEE benchmark targets - *World Class*

- Batch processes > 85%
- Continuous discrete processes > 90%
- Continuous processes > 95%

1st tier suppliers to major companies are obliged to maintain a minimum OEE level as a condition of contract.
OEE calculation example

**Equipment**

- Calendar Time
- Operating Time
- Net Operating Time
- Valuable Operating Time
- Defect Losses
- Speed Losses

**6 ‘Big Losses’**

1. Equipment Failure/Shutdown
2. Production Setup & Adjustment
3. Idling & Minor Stoppages
4. Reduced Speed
5. Defects in Production
6. Reduced Yield

**Calculation of the OEE**

- **Availability:** \( \text{calendar time} - \text{downtime} \times 100 \) calendar time
  
  *Example:* Availability = \( \frac{460 \text{ mins} - 60 \text{ mins}}{460 \text{ mins}} \times 100 = 87\% \)

- **Performance:** \( \frac{\text{theoretical cycle time} \times \text{produced amount}}{\text{operating time}} \times 100 \)
  
  *Example:* Performance = \( \frac{0.5 \text{ mins/unit} \times 400 \text{ units}}{400 \text{ mins}} \times 100 = 50\% \)

- **Quality Rate:** \( \frac{\text{produced amount} - \text{defect amount}}{\text{produced amount}} \times 100 \)
  
  *Example:* Quality Rate = \( \frac{400 \text{ units} - 8 \text{ units}}{400 \text{ units}} \times 100 = 98\% \)

**Overall Equipment Effectiveness (OEE)**

\[ \text{OEE} = \text{Availability} \times \text{Performance Rate} \times \text{Quality Rate} \]

*Example:* \( 0.87 \times 0.50 \times 0.98 \times 100 = 42.6\% \)

Ref: Nakajima, 1984

8 hour shift with half hour break = 7½ production hours
The Hidden Factory
The Hidden Factory!

*OEE can quickly reveal the size of the ‘hidden factory’…*
The Hidden Factory!

*OEE can quickly reveal the size of the ‘hidden factory’…*

If the OEE is 50%, half the ‘factory’ isn’t contributing…
The Hidden Factory!

...but still consumes resources
The Hidden Factory!

*which still consumes resources*
The Hidden Factory!

...which still consumes resources
The Hidden Factory!
The Hidden Factory!

BIG burden!
NO production!

The 'Hidden Factory'
OEE and the Theory of Constraints

- OEE must be applied to manufacturing bottlenecks & pinchpoints – *not in general like with Kaizen*

- Define the hierarchy of critical processes and bottlenecks and attack in priority order

- As with RCM, beware of ‘analysis paralysis’ - *just get on with it!* – a bias for action is needed
OEE and the Theory of Constraints

Attacking the Points of Constraint – the manufacturing bottlenecks & pinch points - to maximise performance

Achievable manufacturing performance

Manufacturing performance gap

Present manufacturing performance

Focused OEE projects

Conventional continuous improvement initiative

Do nothing – the suicide scenario!

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OEE and the Theory of Constraints

Attacking the Points of Constraint – the manufacturing bottlenecks & pinch points - to maximise performance

Achievable manufacturing performance

Present manufacturing performance

Top ranked bottleneck FIRST!
OEE and the Theory of Constraints

Attacking the Points of Constraint – the manufacturing bottlenecks & pinch points - to maximise performance

Achievable manufacturing performance

Present manufacturing performance

Performance

Top ranked bottleneck FIRST!

It’s not rocket science. Get going!

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