Overall Equipment Effectiveness

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Overall Equipment Effectiveness (OEE)

- OEE quantifies TPM’s 6 Major Losses.
  - Breakdown losses
  - Setup and adjustment losses
    - Including Preventive Maintenance
  - Idling and Minor Stoppage losses
  - Reduced speed losses
  - Quality losses
    - Defects
    - Rework
    - Non-production activity
  - Startup losses
Components of OEE

Theoretical Running Time

Total Running Time

Breakdown Time
Setup and Adjustment Time
PM Time
Idle Time
Quality Loss
Rate Loss

Hours Per Day
Components of OEE

- Breakdown Time
- Setup and Adjustment Time
- PM Time
- Idle Time
- Quality Loss
- Rate Loss
- Theoretical Running Time

Hours Per Day

Loading Time

Breakdown Time

PM Time

Setup and Adjustment Time

Breakdown Time

Idle Time

Rate Loss

Quality Loss

Theoretical Running Time
Components of OEE

OEE = Theoretical Running Time ÷ Loading Time
Utilizing OEE

• Identify improvement opportunities
• Measure improvement
• Monitor performance
• Capacity modeling
• Evaluate TPM progress
  – Level 1
  – Level 2
  – Level 3
  – Level 4
Stratification of Losses

OEE = Availability * Speed Rate * Operating Rate * Quality Rate

- **Availability**
  - Breakdown losses
  - Setup and adjustment losses

- **Speed Rate**
  - Reduced speed losses

- **Operating Rate**
  - Idling and Minor Stoppage losses

- **Quality Rate**
  - Defect
  - Reworks
  - Non-production activity
Stratification of Losses

- Operating Loss
- Downtime
- Rate Loss
- Quality Loss

Idle No Operator

Idle No Work
Chronic and Sporadic Losses

- Chronic losses represent a greater improvement opportunity than Sporadic losses.
  - Similar to SPC focus on common cause variation.
OEE in Capacity Modeling

• For each tool set, a **TARGET OEE** is established.
  – Using assumptions for Availability, Speed Rate and Operating Rate

• **REQUIRED OEE** is calculated for each tool set using theoretical cycle times and demand.

• **UTILIZATION = REQUIRED OEE ÷ TARGET OEE**

• Target utilization of 85% to maintain reasonable cycle time.
# OEE in Capacity Modeling

<table>
<thead>
<tr>
<th></th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>Q2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>2.0</td>
</tr>
<tr>
<td>OEE Target</td>
<td>66%</td>
<td>66%</td>
<td>66%</td>
<td>66%</td>
</tr>
<tr>
<td>Required OEE</td>
<td>50%</td>
<td>51%</td>
<td>48%</td>
<td>66%</td>
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<tr>
<td>Utilization</td>
<td>75%</td>
<td>77%</td>
<td>73%</td>
<td>99%</td>
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<tr>
<td>Visits per Day</td>
<td>890</td>
<td>978</td>
<td>935</td>
<td>850</td>
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</table>
OEE Monitor


<table>
<thead>
<tr>
<th>TOOL</th>
<th>WAFER GOAL</th>
<th>WAFER ACTUAL</th>
<th>UPTIME GOAL</th>
<th>UPTIME ACTUAL</th>
<th>RATE TARGET</th>
<th>RATE ACTUAL</th>
<th>STAND BY NO OP</th>
<th>STAND BY NO WORK</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIKON1</td>
<td>5,880</td>
<td>5,784</td>
<td>96%</td>
<td>98%</td>
<td>70.0</td>
<td>68.4</td>
<td>10</td>
<td>9</td>
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<tr>
<td>NIKON2</td>
<td>5,353</td>
<td>4,985</td>
<td>96%</td>
<td>97%</td>
<td>65.1</td>
<td>62.0</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>NIKON3</td>
<td>5,554</td>
<td>5,612</td>
<td>96%</td>
<td>90%</td>
<td>68.4</td>
<td>69.1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>NIKON4</td>
<td>5,675</td>
<td>5,820</td>
<td>96%</td>
<td>95%</td>
<td>55.0</td>
<td>59.3</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

STEPPER PERFORMANCE
4/7/12 to 4/13/12
Monitor TPM Progress

• Programs
  – Autonomous Maintenance
  – Maintenance Prevention
  – Maintenance Skills

• Methods
  – Condition Based Maintenance
  – P-M Analysis
  – Initial Cleaning
  – Training
Some prefer to use Production Equipment Effectiveness (PEE)

PEE does not include time idle due to no work in the Loading Time.

Pursuing high OEE when volume does not support it can lead to lower productivity.

– Efficiency vs. Productivity
Issues with OEE

• Data collection can be cumbersome.
  – Automation
  – MES
  – MOS Study
  – Direct Observation
  – “Tom Box”

• OEE is about time, not money.

• OEE is not TPM.
  – Don’t get tied up in OEE calculations/debates to detriment of real improvement activities.
Other Measures of Equipment Effectiveness

- MTBF
- MTTR
- \# Repair Calls ÷ \# PMs
- Return on Capital
Questions?

Thoughts?
The Six Big Losses and OEE

### TABLE 1
**THE RELATIONSHIP BETWEEN THE SIX BIG LOSSES IN EQUIPMENT AND OVERALL EQUIPMENT EFFECTIVENESS**

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>SIX BIG LOSSES</th>
<th>CALCULATION OF OVERALL EQUIPMENT EFFECTIVENESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Running Time</td>
<td>1. Equipment Failures</td>
<td>AVAILABILITY = ( \frac{\text{RUNNING TIME} - \text{DOWNTIME}}{\text{RUNNING TIME}} \times 100 )</td>
</tr>
<tr>
<td>Operating Time</td>
<td>2. Setup and Adjustment</td>
<td>(e.g.) AVAILABILITY = ( \frac{460 \text{ MINS} - 60 \text{ MINS}}{460 \text{ MINS}} \times 100 = 87% )</td>
</tr>
<tr>
<td>Net Operating Time</td>
<td>3. Idling and Minor Stoppages</td>
<td>PERFORMANCE EFFICIENCY = ( \frac{\text{ACTUAL OUTPUT}}{\text{PLANNED DAILY RATE}} \times 100 )</td>
</tr>
<tr>
<td>Speed Losses</td>
<td>4. Reduced Speed</td>
<td>(e.g.) PERFORMANCE EFFICIENCY = ( \frac{0.5 \text{ MIN} \times 600 \text{ UNITS}}{400 \text{ MIN} \times 900} = 50% )</td>
</tr>
<tr>
<td>Defect Loss</td>
<td>5. Defects in Process</td>
<td>RATE OF QUALITY = ( \frac{\text{PROCESSED AMOUNT} - \text{DEFECT AMOUNT}}{\text{PROCESSED AMOUNT}} \times 100 )</td>
</tr>
<tr>
<td>Valuable Operating Time</td>
<td>6. Reduced Yield</td>
<td>(e.g.) RATE OF QUALITY = ( \frac{400 \text{ UNITS} - 8 \text{ UNITS}}{400 \text{ UNITS}} \times 100 = 98% )</td>
</tr>
</tbody>
</table>

OVERALL EQUIPMENT EFFECTIVENESS = AVAILABILITY \times PERFORMANCE EFFICIENCY \times RATE OF QUALITY \times PRODUCTS

(e.g.) 0.87 \times 0.50 \times 0.98 \times 100 = 42.6\%