Overall Equipment Effectiveness (OEE)
Taking you and your organization beyond the traditional efficiency improvements and into sustainable dramatic business improvements that increase capacity, revenue and profitability
Overall Equipment Effectiveness

Agenda Subjects

• Background and Intro
• Understanding OEE
• Addressing The Six Big Losses
• World Class Levels of OEE
• Critical Success Factors
• Closure
Overall Equipment Effectiveness

Our Clients Include:

- **LifeStream**
  - Lifestream Blood bank
  - San Bernardino/Riverside, CA
  - Blood Bank and Laboratory

- **Illumina**
  - Illumina
  - San Diego & Hayward, CA
  - DNA/Gene Assay Arrays

- **Alpha Technics**
  - Alpha Technics
  - Tecate, MX. Xiamen, China
  - Temperature Sensors

- **Dimension One Spas**
  - Dimension One Spas
  - Vista, CA
  - Hydrotherapy Spas

- **Dj Orthopedics**
  - Dj Orthopedics
  - Vista, CA & Tijuana, MX
  - Orthopedic Medical Devices

- **Teamwork Athletic Apparel**
  - Teamwork Athletic Apparel
  - San Marcos, CA
  - Apparel Distribution

- **Peregrine Semiconductor**
  - Peregrine Semiconductor
  - San Diego, CA
  - Semiconductor Wafer Fab

- **BAE Systems**
  - BAE Systems
  - San Diego, CA & Norfolk, VA
  - Defense Systems

- **L3 Communications**
  - L3 Communications
  - San Diego, CA
  - RF Communication Devices
Lean Methods:

The Beginning: The Goal

- 1984 “The Goal” Eliyahu Goldratt

- Theory of Constraints (TOC)
  - Faster response times
  - Initial focus on reducing wastes
  - Reducing lot sizes
  - Faster change-overs

- 3 Key Measurements:
  - Throughput
  - Inventory
  - Operating Expense

“An hour lost at a bottleneck facility is an hour lost for the whole factory”

Mid-sized company of $100m revenue
OEE of 85% = $15m lost revenue
Lean Processing
Blood Bank & Laboratory

- Lifestream/San Bernardino Blood Bank
- San Bernardino/Riverside, CA
- Series of Lean projects - 2013

Snippet #2

Typical Patient Processing for blood draw ~ 60 minutes

Personal experience as blood donor = aborted at 42 minutes
So… Just What is Overall Equipment Effectiveness?
What is OEE?

- “Best Practices” way to measure and improve the effectiveness of a equipment enabled process

- Simple and practical

- Key metric in Lean Enterprise
Applicability:

- Manufacturing Processing
- Pharmaceutical/Chemical Processing
- Healthcare Equipment
- Food and Beverage
- Material Handling, Cranes, Forklifts
- Information Technology Systems

Or anywhere we use equipment…
OEE versus TEEP:

- TEEP = Total Effective Equipment Performance
- OEE = performance relative to planned production time (not including breaks, scheduled maintenance, periods of no demand)
- TEEP = performance relative to all calendar hours, i.e., 24 hours per day, 365 days per year
- TEEP can be expressed as “Loading”
Overall Equipment Effectiveness

- Three Key Sub-Measures:
  - Uptime (percent)
  - Yield (percent)
  - Process Efficiency (percent)

Overall Equipment Effectiveness (OEE) = Uptime % x Yield % x Efficiency %
Calculating OEE:

• Availability
  - Percentage of scheduled time that the operation is available to operate

• Performance
  - Represents the speed at which the operation runs as a percentage of the designed speed

• Quality
  - Represents “good” units produced as a percentage of the total units started
OEE Factors:

Plots showing OEE Factors:

1. **PLANT OPERATING TIME**
2. **PLANNED PRODUCTION TIME**
3. **OPERATING TIME**
4. **NET OPERATING TIME**
5. **FULLY PRODUCTIVE TIME**

Each plot is divided into sections for **PLANNED SHUT DOWN**, **DOWN TIME LOSS**, **SPEED LOSS**, and **QUALITY LOSS**.
OEE Factors:

**Plant Operating Time** = amount of time facility is open and available for equipment operation.

**Planned Production Time** = Plant Operating Time less Planned Shut Down – breaks, scheduled maintenance, no demand
**OEE Factors – Availability:**

Operating Time = Planned Production Time less Down Time Loss

- All events that stop planned production
  - Equipment failures
  - Material shortages
  - Changeover time (normally)

- Availability = ratio of Operating Time to Planned Production Time
## OEE Factors – Performance:

Net Operating Time = Operating Time less Speed Loss

### Examples include:

- Machine wear
- Substandard materials
- Mis-feeds, Operator inefficiency

### Performance = ratio of Net Operating Time to Operating Time
# OEE Factors – Quality:

**Fully Productive Time** = Net Operating Time less Quality Loss

<table>
<thead>
<tr>
<th>FULLY PRODUCTIVE TIME</th>
<th>QUALITY LOSS</th>
<th>SPEED LOSS</th>
<th>DOWN TIME LOSS</th>
<th>PLANNED SHUT DOWN</th>
</tr>
</thead>
</table>

- **Examples include:**
  - Rejected/Non-conformances
  - Product that does not meet specifications

- **Quality** = ratio of Good parts to Total parts – can be expressed as pieces or time
The Six Big Losses:

- Breakdowns
- Setup and Adjustments
- Small Stops
- Reduced Speed
- Startup Rejects
- Production Rejects

and the 7th... Planned Shut Down
Improvement Approach:

- Identify Critical Equipment (Constraint?)
- Measure OEE
- Set Aggressive Goals
- Make Measured OEE Visible
- Root Cause Analysis for Improvements
- Make Improvements
- Constantly Re-Measure and Make Visible
## World Class Manufacturing

### Overall Equipment Effectiveness (OEE)

<table>
<thead>
<tr>
<th>Time Element per week</th>
<th>Minutes</th>
<th>Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calendar Time per Week 7 x 24</td>
<td></td>
<td>10,080</td>
</tr>
<tr>
<td>Unmanned Weekends 2 x 24</td>
<td>2,880</td>
<td>7,200</td>
</tr>
<tr>
<td>16 hour Week days – loss of 5 x 8hrs/day</td>
<td>2,400</td>
<td>4,800</td>
</tr>
<tr>
<td>Planned Production Time – 5 day x 16 hours</td>
<td></td>
<td>4,800</td>
</tr>
<tr>
<td>Unplanned Maintenance/Stoppages</td>
<td>823</td>
<td>3,997</td>
</tr>
<tr>
<td>Changeover</td>
<td>1,020</td>
<td>2,977</td>
</tr>
<tr>
<td>Operating Time</td>
<td></td>
<td>2,977</td>
</tr>
<tr>
<td>Minor Stops – lunch, etc.</td>
<td>90</td>
<td>2,887</td>
</tr>
<tr>
<td>Running Time</td>
<td></td>
<td>2,887</td>
</tr>
<tr>
<td>Quality Yield Loss - 1.5% Defect Rate</td>
<td>43</td>
<td>2,844</td>
</tr>
<tr>
<td>Effective Time</td>
<td></td>
<td>2,844</td>
</tr>
</tbody>
</table>
World Class Manufacturing

Overall Equipment Effectiveness

Available Time for Flexing/Large Capacity Increase

Clear Immediate Potential to Reduce Downtime Losses

Current Demonstrated Ability
= 150,000+ per day
= 36M units/year
World Class Manufacturing

Visual Performance Measurements

• Daily Production Thru-put and Downtime Established and Posted
• Need to Include On-Time Delivery and Daily Yield Data
• Need to factor in number of people/hrs to reflect true productivity measurements

• Next Steps:
  • On-going owner?
  • Daily review process at Standup Meeting
  • Output from Machine?
World Class Manufacturing

DOWNTIME TOP TEN
July 2016 Total Downtime - Line 2 (Minutes)

Analysis of Downtime Focused on Line 2 and Sorted by Time
# Top Ten Downtime Reasons – July 2016 Line 2

<table>
<thead>
<tr>
<th>Downtime Reason</th>
<th>Total Downtime (Minutes)</th>
<th>Occurrences</th>
<th>Downtime Range (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change Over</td>
<td>1677</td>
<td>43</td>
<td>3 to 250</td>
</tr>
<tr>
<td>Robot Adjustment</td>
<td>817</td>
<td>48</td>
<td>3 to 43</td>
</tr>
<tr>
<td>Maintenance - Nuspark</td>
<td>449</td>
<td>5</td>
<td>80 to 99</td>
</tr>
<tr>
<td>Filter too High</td>
<td>304</td>
<td>5</td>
<td>9 to 185</td>
</tr>
<tr>
<td>Glue Warm Up</td>
<td>248</td>
<td>7</td>
<td>25 to 52</td>
</tr>
<tr>
<td>Auger Adjustment</td>
<td>237</td>
<td>5</td>
<td>17 to 67</td>
</tr>
<tr>
<td>MDT</td>
<td>178</td>
<td>12</td>
<td>5 to 30</td>
</tr>
<tr>
<td>Filter Change</td>
<td>81</td>
<td>18</td>
<td>2 to 11</td>
</tr>
<tr>
<td>Robot Adjustment for Boxes</td>
<td>64</td>
<td>5</td>
<td>3 to 27</td>
</tr>
<tr>
<td>Tray Pusher</td>
<td>35</td>
<td>4</td>
<td>6 to 12</td>
</tr>
</tbody>
</table>
Changeovers:

- Deploy principles of SMED* to all changeovers
- Focused on preparation and internal versus external changeover activities
- All direct employees to be trained
- Champion: Riber

*Single Minute Exchange of Die

**Internal Activities:**
- those that can only be performed when the process is stopped.

**External Activities:**
- those that can be done while the last batch is being produced, or once the next batch has started.
Overall Equipment Effectiveness

5 Steps to Quick Changeover:

1. Observe the current process
2. Differentiate Internal and External
3. Convert Internal to External
4. Streamline Internal operations
5. Streamline External operations
Methodology: 32 Hours to Rapid Set-Up/SMED

Discovery & Measure
- Train
- Video Tape
- Analyze
- Set Goal

Day 1

Analysis
- Differentiate Internal & External
- 5-S

Day 2

Improvement
- Convert Internal to External
- Streamline

Day 3

Standardize And Control
- Final Practice
- Standardize & Modify Doc’n
- Ongoing Tracking
- Celebrate

Day 4
Set-Up Reduction

SMED Success Story:
Vacuum Molding, Spa Body

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
<th>% Imp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set-Up Time</td>
<td>15 Mins</td>
<td>5 Mins</td>
<td>67%</td>
</tr>
<tr>
<td>Defect Rate</td>
<td>6.2%</td>
<td>0.9%</td>
<td>85%</td>
</tr>
</tbody>
</table>

- Centering devices on platen
- Stop bars on platen
- Quick clamps

- Channels for forklift
- Centering device on all molds

- Rollers on Platen
- Plates on platen

- Elimination of going under platten
- Vacuum line access from front
- Clamps access from top

- Quick disconnect Vacuum hoses

- Easy access molds
- Standardized labels in large font
- Close to machines
- Forklift available/Designated driver

- Green-red mold ready
- Vacuum lines in front and color coded
- Standardized frames

- Easy access tool boards at each station
- No hunting for tools

- Sheet at each station
- Multiple racks
- Top load
World Class Manufacturing

Total Productive Maintenance

- Proactive Preventative Improvement
- Focused on Major OEE Deficiencies
- Visual Schedule of Planned Activities
- OEM Requirements (validated?) at a Minimum
- Critical Spare Parts Management

- Champion: tbd
What is TPM?

TPM stands for Total Productive Maintenance and is a holistic and systematic approach for optimization and increasing throughput.

Target: achieve Zero-Losses

Involves/informs all employees

Uses a systematic procedure

Transparency of performance through KPIs

Is based on team activities at shopfloor level
World Class Manufacturing

TPM Model

House of TPM

- Continuous Improvement
- Autonomous Maintenance
- Talent Management
- Planned Maintenance
- Equipment Management
- Quality Maintenance
- EHS
- Office

5 S
The 5-S System

- Sort
- Set in Order
- Standardize
- Shine
- Sustain
World Class OEE

- Availability 90.0%
- Performance 95.0%
- Quality 99.9%
- Overall Equipment Effectiveness 85.0%

Consider Discrete versus Continuous Mfg Process?
### Overall Equipment Effectiveness - Maturity Model Assessment

**Site: San Diego**

<table>
<thead>
<tr>
<th>Define</th>
<th>Measure</th>
<th>Analyze</th>
<th>Improve</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>OEE process owner has been identified</td>
<td>Measure Systems Analysis (MSA) has been completed</td>
<td>OEE is calculated weekly</td>
<td>Near-term action items are developed to address losses</td>
<td>Input variables and process parameters that affect output are in statistical control</td>
</tr>
<tr>
<td>Desired goals are established</td>
<td>Loss Codes have been developed</td>
<td>OEE performance metric is visually displayed</td>
<td>Daily review of action item completion</td>
<td>Out of control conditions for OEE components are reacted to immediately</td>
</tr>
<tr>
<td>Critical units/WCs have been identified</td>
<td>OEE Components that support the ALPS OEE definition are available</td>
<td>Lost Codes are analyzed and Pareto chart is produced</td>
<td>Action Items are completed on time</td>
<td>OEE performance metric shows positive trends and improvements</td>
</tr>
<tr>
<td>Data recording procedure &amp; record location/storage has been established</td>
<td>Data for performance and losses is collected daily</td>
<td>Lost Code Paretos are reviewed weekly (meeting)</td>
<td>Processes Sops that affect process parameters are routinely reviewed for improvement</td>
<td></td>
</tr>
<tr>
<td>Operator OEE training has been completed</td>
<td>Baseline OEE performance has been established</td>
<td>SOPs that affect process parameters have been reviewed for accuracy</td>
<td>OEE Best Practices are shared with other sites</td>
<td></td>
</tr>
</tbody>
</table>

**Define Status:**

- [ ]

**Measure Status:**

- [ ]

**Analyze Status:**

- [ ]

**Improve Status:**

- [ ]

**Control Status:**

- [ ]

**Overall Site Status:**

- [ ]

**Reviewer:** Bruce

**Date:** August 5, 2016
OEE Critical Success Factors:

- Consistent OEE Calculation – Flexible in development, consistent during use.
- Measured and Visually Posted OEE performance (daily)
- Analysis of downtown (min. shift)
- Actionable Improvements
  - Prevention, Mistake Proofing
  - Controllable Process Inputs
OEE Cautions:

• Do not allow the desire to improvement OEE to cause you to over-produce

• Do not attempt to improve OEE without the assistance and input of machine operators and maintenance personnel

• Do not stop measuring and making visible once you have achieved your on-going goals
The House of Lean

EXPANDED VALUE STREAM
ENTERPRISE WIDE DEPLOYMENT
BEST QUALITY – LOWEST COST – SHORTEST LEADTIME

FLOW & PULL
- Takt Time
- Pull System
- Kanban
- Quick-Changeover
- Smaller Lots
- Layout

EMPLOYEE INVOLVEMENT
- Kaizen
- Lean Teams
- Multi-Skilled
- 5-S Visual Workplace

VALUE & PERFECTION
- TPM
- Stable Processes
- Mistake Proofing
- 5-S Visual Workplace

VALUE STREAM ANALYSIS

= OEE Touchpoints with Lean Tools
Overall Equipment Effectiveness

Summary

- Background and Intro
- Understanding OEE
- Addressing The Six Big Losses
- World Class Levels of OEE
- Critical Success Factors
Overall Equipment Effectiveness

Further Resources:
Overall Equipment Effectiveness

Questions?

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