Total Productive Maintenance: Implementation and Application

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Traditional Approach to Maintenance

Maintenance Department – “WE FIX”
- Perform all maintenance activities
- Perform “fire fighting” maintenance when a machine breakdown occurs
- Perform preventative maintenance

Manufacturing – “WE OPERATE”
- Generally does not perform any maintenance activities
- Contact maintenance when a machine breakdown occurs
- Inactive during maintenance activities
- “Run it ‘til it breaks”
Definition of TPM

• Total Productive Maintenance is an innovative approach to equipment maintenance involving maintenance personnel and operators working in teams focusing on eliminating equipment breakdowns and equipment related defects.

• TPM means equipment is well maintained, eliminating any chance of failures. Equipment works all the time producing quality product at design speed.
TPM

• Is About Maximizing **Overall Equipment Effectiveness**

• OEE = Availability x Performance x Quality

• Availability: % time equipment is operating

• Performance: % running at relative to design rate

• Quality: % good quality output

• 85% OEE is considered world class
TPM Objectives

• Create well designed **Equipment** and build in **Quality** and **Safety**

• Develop equipment knowledgeable **People** who will exercise their full **Potential**

• Create an **Enthusiastic** work environment at all levels
Components of TPM

• **Equipment Management**
  – Requires purchase of equipment on a team basis. Team to include operators, maintenance, engineers and supervisors.

• **Preventive and Predictive Maintenance**
  – Requires using all technologies to assess and predict performance and on planned basis replacing worn out components. Upgrading equipment to eliminate quality and safety issues.

• **Autonomous Maintenance**
  – Emphasizes that people who operate equipment have the responsibility for its upkeep. They should be trained to maintain equipment and bring in specialized staff only for skills they do not possess.
TPM Goals and Objectives

• Goals:
  - UNPLANNED EQUIPMENT DOWNTIME
  - BARRIERS BETWEEN DEPARTMENTS
  - EQUIPMENT RELATED DEFECTS

  Total Employee Involvement
  Hands On Approach
  Improve Your Company’s Competitiveness

• Objectives:
TPM Methodology

Phase 1
Return equipment to almost new condition

Phase 2
Zero breakdowns

Phase 3
Consolidate TPM information for future use

Phase 4
Zero defects
Complete TPM Implementation

Autonomous Maintenance
(Eliminate accelerated deterioration)
  Preventative Maintenance
    Zero breakdowns

Equipment Improvement
  Equipment activities focusing on eliminating all breakdowns via physical equipment analysis (PEA) techniques

Maintenance Prevention Systems
  Information system consisting of all TPM activities used to expand initiative and make equipment related decisions based on maintenance and performance data

Quality Maintenance
  TPM activities focusing on eliminating equipment related defects via physical quality analysis (PQA) techniques
    Zero defects

Zero breakdowns

Zero defects
## Key Definitions

### Preventive Maintenance

Preventive maintenance is a time or usage based method of maintaining equipment. Maintenance activities are performed on equipment based on **defined time and/or usage intervals** to prevent equipment breakdowns from occurring.

- PM Schedules
- Team Activities

### Predictive Maintenance

Predictive maintenance is a situation based method of maintaining equipment. Maintenance activities are performed on equipment based on **visible signals or diagnostic techniques** to prevent equipment breakdowns from occurring.

- Vibration Analysis
- Ultrasound
- Thermography
- Laser Measuring
- Generator Testing
- Oil Analysis
Overall Equipment Effectiveness (OEE)

- A metric that shows us how well the equipment is performing.

- Measure of the percent of time a piece of equipment is producing quality product. OEE measures the effect of the six big losses.
## OEE Definitions

6 major equipment losses fall into 3 categories

### Availability Level

**Breakdowns**
Malfunctions causing equipment to stop processing product more than a set time (i.e. 10 min)

**Setup**
Any activity related to equipment changeover, setup, and adjustments

### Operating Level

**Idling**
Load/unload time for product on a piece of equipment and/or operators waiting for activities out of their control

**Minor Stoppages**
Malfunctions causing equipment to stop processing product less than a set time (i.e. 10 min)

### Quality Level

**Quality Factors**
Activities related to ensuring the quality of the product produced on the equipment

**Rework**
The time taken to process product of rework
Relationship of OEE and Utilization

- Utilization: actual machine run time divided by available machine run time (availability level)
- OEE further defines the effectiveness of equipment by monitoring the effect of load/unload time and minor stoppages (operating level) and quality factors and rework (quality level)
- OEE indicates the actual time the equipment is producing quality product
- OEE takes utilization to a more detailed level
Why Measure OEE?

• To help prioritize improvement projects and reflect results
• To combine utilization, operation, and quality aspects of equipment
• Measure changes to capacity, productivity, and quality
# OEE

<table>
<thead>
<tr>
<th>Loading Time (LT)</th>
<th>Total hours available for equipment operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability Level (AL)</td>
<td>LT – (Administrative + Setup + Breakdown)</td>
</tr>
<tr>
<td>Operating Level (OL)</td>
<td>AL hrs – (Idling + Minor stoppages)</td>
</tr>
<tr>
<td>Quality Level (QL)</td>
<td>OL hrs – (Quality + Rework)</td>
</tr>
<tr>
<td>OEE</td>
<td>AL x OL x QL</td>
</tr>
</tbody>
</table>

- Breakdowns & Admin.
- Setup & Adjust
- Idling
- Minor Stoppages
- Quality Factors
- Rework
## Calculating OEE Elements

<table>
<thead>
<tr>
<th>Loading Time (LT)</th>
<th>Total hours available for equipment operation = 168 hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability Level (AL)</td>
<td>$\frac{168 - (12.3 + 12.4 + 12.5)}{168} = 78%$</td>
</tr>
<tr>
<td>Operating Level (OL)</td>
<td>$\frac{131 - (15.4 + 1.1)}{131} = 87%$</td>
</tr>
<tr>
<td>Quality Level (QL)</td>
<td>$\frac{114 - (3.1 + 0.1)}{114} = 97%$</td>
</tr>
<tr>
<td>OEE</td>
<td>$78% \times 87% \times 97% = 66%$</td>
</tr>
</tbody>
</table>

- Breakdowns & Admin.
- Setup & Adjust
- Idling
- Minor Stoppages
- Quality Factors
- Rework
Initial TPM Focus: Preventive Maintenance

- The initial OEE calculations for equipment identifies the current baseline.
- OEE will reflect improvements as the TPM initiative involves.
- The initial focus of TPM is to return the equipment to like new condition and prevent any further deterioration.
- Implementing Preventive Maintenance (PM) schedules is the first step toward eliminating deterioration.
Four Phased Approach to PM Schedules

**PHASE 1**
1. Inspect equipment for problem areas via the electrical, hydraulic, mechanical, pipefitter checklists
2. Tag all abnormalities
3. Document abnormalities using “Tag Log”

**PHASE 2**
1. Prioritize abnormalities via “Tag Log”
2. Identify causes of abnormalities

**PHASE 3**
1. Develop PM standards for abnormalities via “Inspection Standards” worksheet
2. Identify PM frequency based on priority ranking
3. Build PM schedules based on inspection standards

**PHASE 4**
1. Training maintenance and operators on PM standards and PM schedules
2. Implement PM schedules
3. Monitor PM schedule usage and effectiveness (OEE)
4. Update standards to reflect changes in requirements
PM Schedule Development: Phase 1

1. Inspect target equipment
2. Utilize customized checklists
3. Tag and document problems
PM Schedule Development: Phase 2

Prioritize identified problems

Identify causes of highest priority via:
- Brainstorming
- Data collection
- Maintenance/Operator Experience
Develop inspection standards

Written standards are essential for developing accurate PM schedules. They communicate the procedure to carry out effective PM.
Deliver training
Effective training to targeted operators and maintenance personnel is required for effective PM implementation

Implement PM schedules

Monitor and adjust
Implementing monitoring measurements provides the vehicle to adjust and change. OEE is an effective monitoring tool.
Summary

• TPM is a key tool for Lean Operations
• Lean Goal is to have zero defects, zero safety incidents and giving customer products what they want and when they want it.
• To achieve this our equipment and systems have to work when needed and TPM mind set helps to achieve all that.
Questions?

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