
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
- $OEE = Availability \times Performance \times Quality$
- 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:



Total Employee
Involvement



Hands On Approach

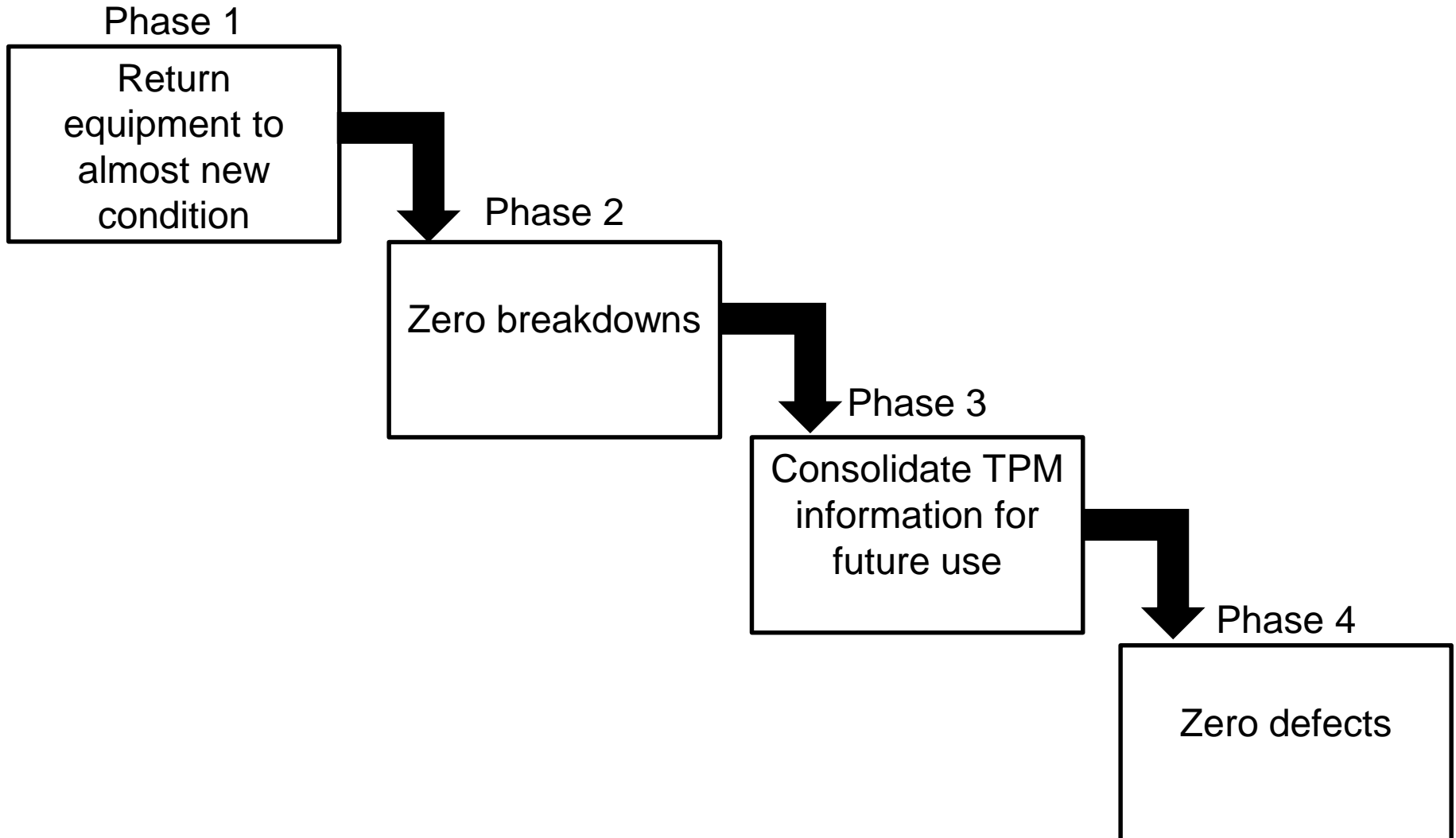


Improve Your
Company's
Competiveness

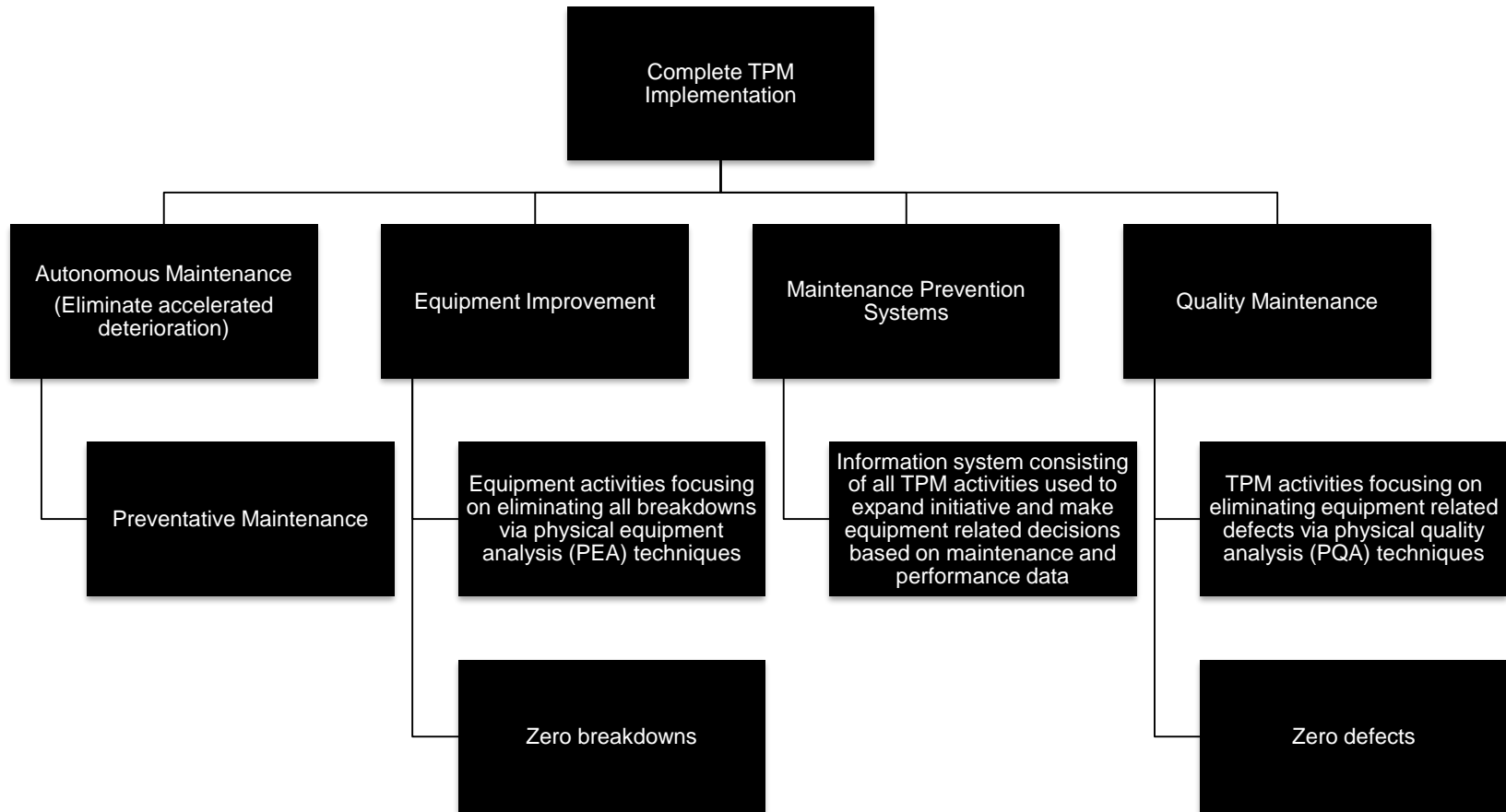
- Objectives:



TPM Methodology



TPM Implementation



Key Definitions

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

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

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

Loading Time (LT)	Total hours available for equipment operation				
Availability Level (AL)	$\frac{LT - (\text{Administrative} + \text{Setup} + \text{Breakdown})}{LT}$			Breakdowns & Admin.	Setup & Adjust
Operating Level (OL)	$\frac{AL \text{ hrs} - (\text{Idling} + \text{Minor stoppages})}{AL \text{ hrs}}$	Idling	Minor Stoppages		
Quality Level (QL)	$\frac{OL \text{ hrs} - (\text{Quality} + \text{Rework})}{OL \text{ hrs}}$	Quality Factors	Rework		
OEE	AL x OL x QL				

Calculating OEE Elements

Loading Time (LT)	Total hours available for equipment operation = 168 hrs			
Availability Level (AL)	$\frac{168 - (12.3 + 12.4 + 12.5)}{168} = 78\%$		Breakdowns & Admin.	Setup & Adjust
Operating Level (OL)	$\frac{131 - (15.4 + 1.1)}{131} = 87\%$		Idling	Minor Stoppages
Quality Level (QL)	$\frac{114 - (3.1 + 0.1)}{114} = 97\%$	Quality Factors	Rework	
OEE	78% x 87% x 97% = 66%			

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

Inspect target equipment

Utilize customized checklists

Tag and document problems

PM Schedule Development: Phase 2

Prioritize
identified
problems

Identify causes
of highest
priority via:

Brainstorming
Data collection
Maintenance/Operator Experience

PM Schedule Development: Phase 3

Develop inspection standards

Written standards are essential for developing accurate PM schedules. They communicate the procedure to carry out effective PM

Build PM schedules

PM Schedule Development: Phase 4

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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