



# World Class Manufacturing

## Total Productive Maintenance (TPM)

# World Class Manufacturing (WCM)

## TPM

- *After completing this chapter you will understand*

Meaning and definition of TPM (JIT).

Overview, philosophy and History of TPM.

Essentials of TPM.

Pillars of TPM

Steps for implementation.

Measuring Effectiveness.

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## TPM

### What is TPM?

**Total  
Productive  
Maintenance**

- **The TPM concept was developed to support (JIT)**
- *You can't be lean if you don't have reliable equipment*
- **Total Participation from top management to shop floor**
- **Relentless Root Cause Analysis and Elimination**
- **Prevention Philosophy**
  - *Autonomous Maintenance*
  - *Visual Controls*
  - *Kaizen Approach*
- **OEE is a metric to evaluate the effectiveness of your TPM improvements**

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## TPM

In order for an organization to function properly, every running process, activity and resource should be properly maintained for their quality, effectiveness and other productivity factors.

TPM is the process which brings the maintenance aspect of the organization under the spotlight. Although maintenance was regarded as a non-profit activity by the traditional management methodologies, TPM puts a brake on it.

With the emphasis on TPM, downtime for maintenance has become an integral part of the manufacturing or production process itself. Now, the maintenance events are properly scheduled and executed with organized plans.

By practicing TPM, the organizations can avoid unexpected interrupts to the production and avoid unscheduled maintenance.

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## TPM

### Definition and Objective of TPM

Total Productive Maintenance (TPM) is a system of maintaining and improving the *integrity* of:

*'Production and quality systems through'*

Machines, equipment's, processes and employees

That add business value to the organization.

### The Japan Institute of Plant Maintenance (JIPM) approach to TPM

The JIPM definition of TPM is:

**T** = Total. Must involve all employees at all levels of the organisation.

**P** = Productive. Effective utilisation of all resources.

**M** =Maintenance. Keeping the Man-Machine-Material system  
in optimum condition.

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**One of the main objectives of TPM is** to increase the productivity of plant and equipment with a modest investment in maintenance. By investing in, for example, equipment maintenance, equipment losses can be prevented.

There are six preventable losses

1. Breakdown losses caused by the equipment
2. Set-up and adjustment losses
3. Minor stoppage losses
4. Speed losses
5. Quality defect and rework losses
6. Yield losses

The first two losses affect the availability of a piece of equipment, the third and fourth losses affect equipment efficiency, and the fifth loss results in reduced quality from output.

***The primary goals of TPM are zero breakdowns and zero defects***

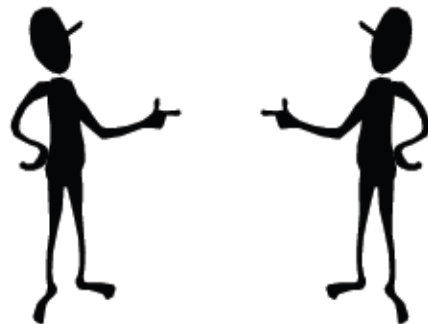
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## TPM

### Philosophy

#### Old Attitude

“I operate, you fix.”  
“I fix, you design.”  
“I design, you operate.”



#### TPM Attitude

“We are all responsible for our equipment.”



Management... Operators... Maintenance...  
Engineers... EVERYONE!

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## TPM

### History

The parent of TPM is TQM. TQM was evolved after the quality concerns the Japan had after the Second World War.

As a part of TQM, the plant maintenance was examined. Although TQM is one of the best quality methodologies for organizations, some of the TQM concepts did not fit or work properly in the area of maintenance.

Therefore, there was a need to develop a separate branch of practices in order to address unique conditions and issues related maintenance.

This is how TPM was introduced as a child of TQM.

In 1971, Nippon Denso Co., Ltd. first introduced and successfully implemented TPM in Japan.

They won the Japan Institute of Plant Maintenance (JIPM) PM Excellent Plant Award for their activities.

Since the JIPM TPM awards were founded, over 3000 organizations have won awards, including Unilever, Wrigley, Tetra Pak, Heineken and Arcelor Mittal.



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## TPM

### Distinctive Features of TPM

**The first principal feature of TPM**, “total effectiveness” or “profitable PM”

**The second feature**, a “total maintenance system,”

. It establishes a maintenance plan for the equipment’s entire lifespan and includes maintenance prevention (MP: maintenance-free design), which is pursued during the equipment design stages.

**The last feature**, “autonomous maintenance by operators” (small group activities), is unique to TPM

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## TPM

### Essentials of TPM

#### Nine Essentials of TPM

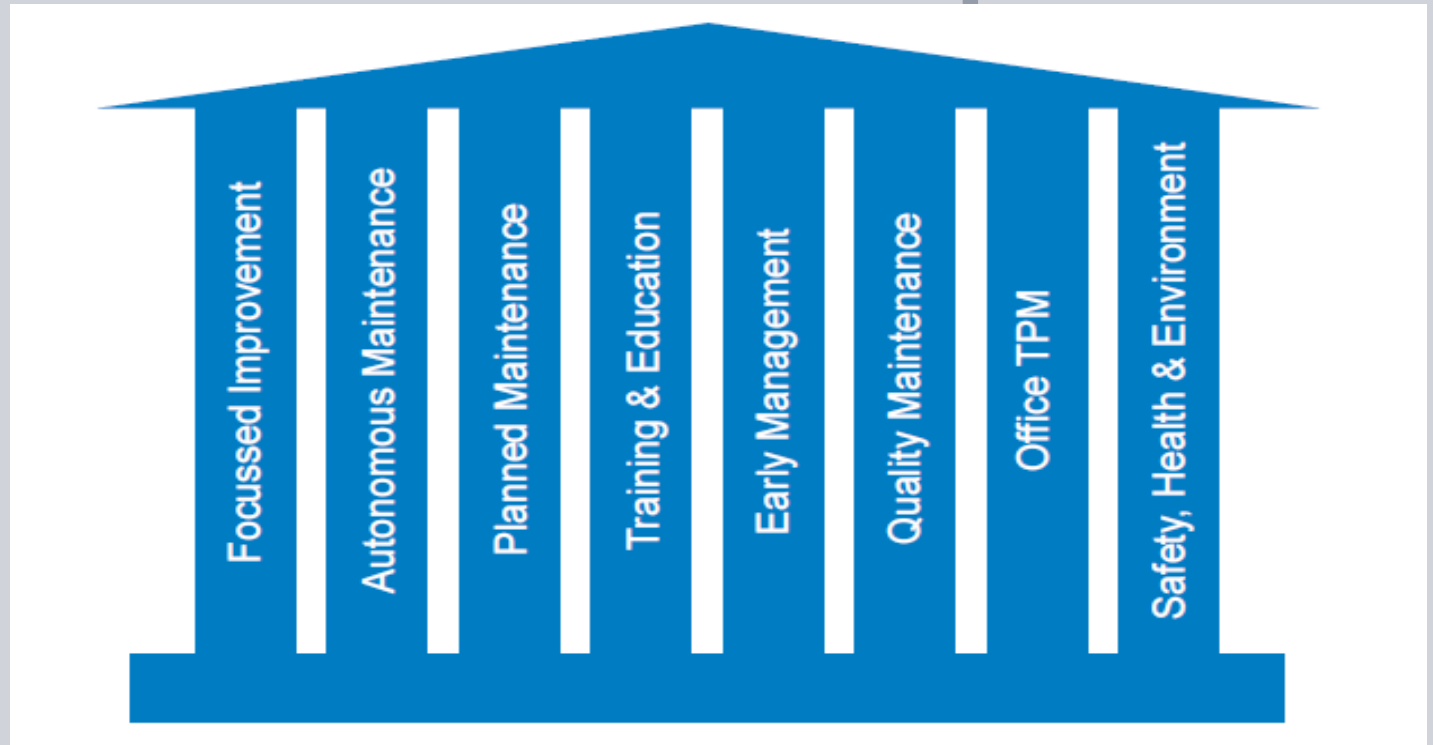
1. Self maintained work place
2. Elimination of the 6 big losses
3. Zero Breakdowns
4. Zero Defect
5. Optimal life and availability of tools
6. Self-improvement
7. Short production-development time and low machine life cost
8. Productivity in indirect departments
9. Zero Accidents

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### Pillars of TPM

The eight pillars of TPM are mostly focused on proactive and preventative techniques for improving equipment reliability.

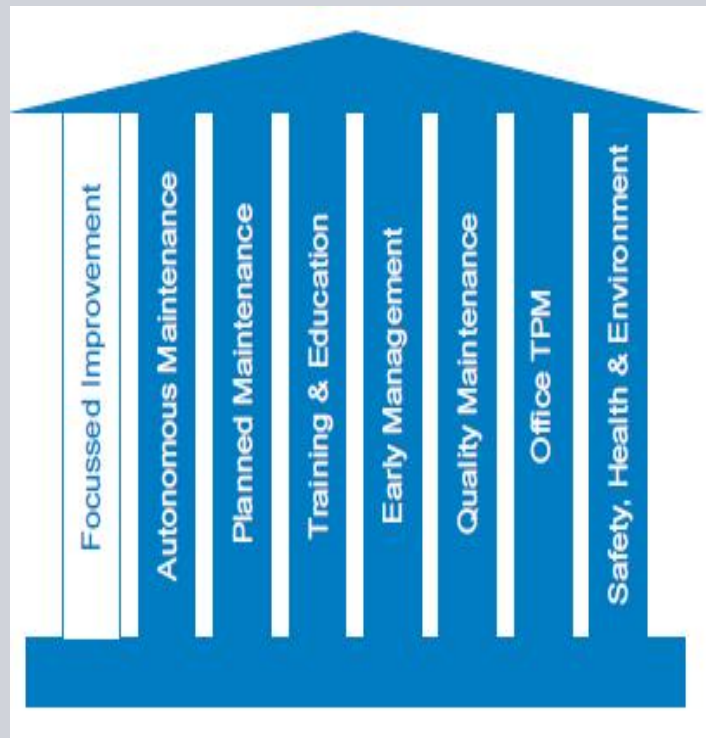


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### What is focussed Improvement: First Pillar of TPM

*It provide structured, team based approach to eliminate identified losses in process*



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## TPM

### How is the Pillar implemented?

- The pillar follows a structured set of steps aligned to the Plan, Do, Check, Act (PDCA) cycle, which can be implemented for improvement activities of any size or complexity in any organization.
- The pillar builds an understanding and analysis of the different loss types
- The pillar develops the capabilities of teams to be self-sufficient

### What are the benefits of the Pillar?

- Improving efficiency, reducing defects and improving safety performance due to eliminating losses.
- Focused Improvement pillar ensures that the approach taken is consistent and repeatable to assure sustainability.

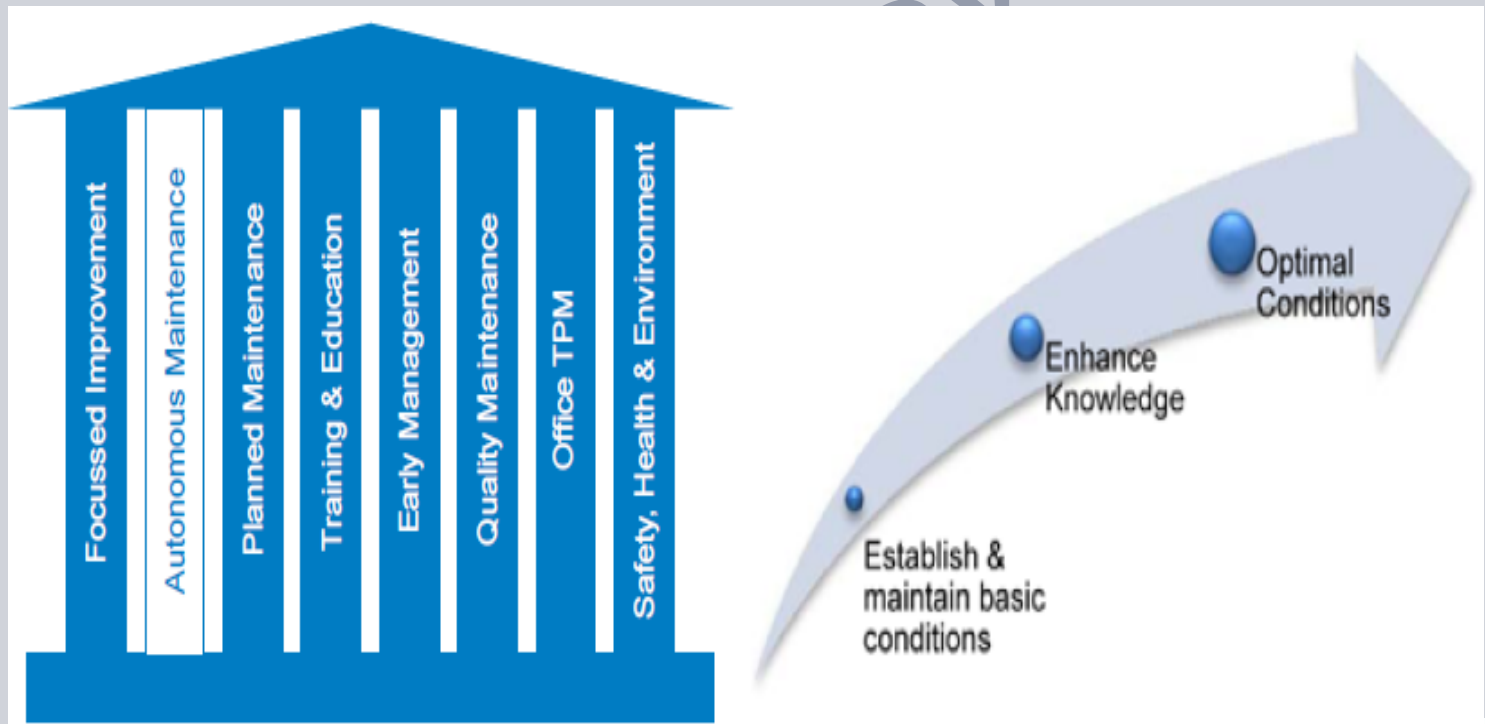
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### What is Autonomous Maintenance?

Autonomous Maintenance is the second of the eight pillars of TPM.

It follows a structured approach to increase the skill levels of personnel so that they can understand, manage to eliminate minor equipment stops



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## TPM

### How is the Pillar implemented?

The Autonomous Maintenance pillar activity is broken down into three phases and is owned by the team who use the equipment on a daily basis.

- The first phase establishes and maintains basic equipment conditions. Standards are introduced for cleaning, inspection, tightening and lubrication to ensure the conditions are sustained.
- The second phase increases the capabilities of the team by training them in the detailed operating principles of the equipment.
- During the third phase, the operators take total ownership of the equipment as self-directed teams, continuously improving equipment condition and performance to further reduce losses.

### What are the benefits of the Pillar?

The deployment of Autonomous Maintenance will improve Overall Equipment Effectiveness (OEE) by reducing:

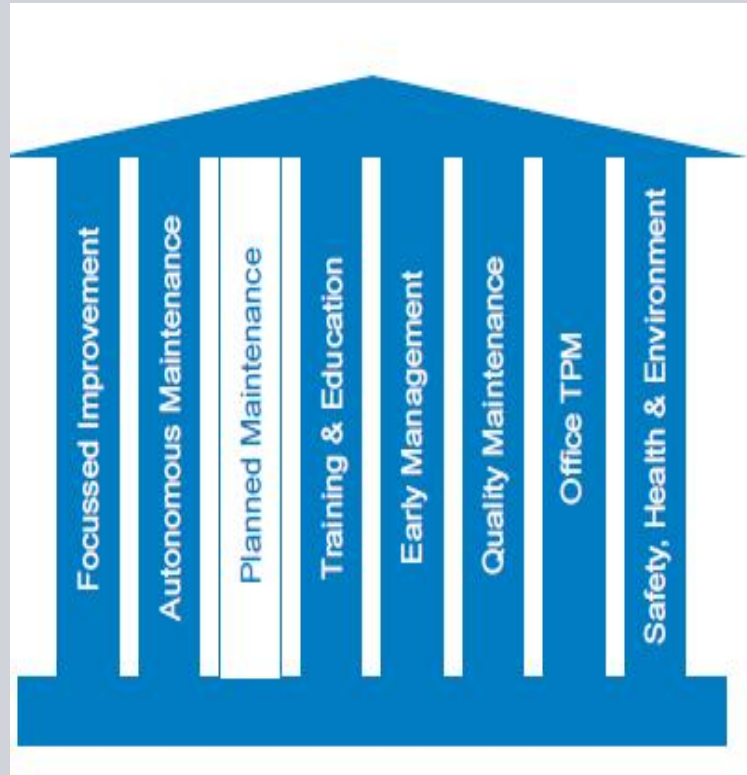
- Performance loss and increasing equipment availability.
- Measurable improvement to employee engagement and capability levels.

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### What is Planned Maintenance?

Planned Maintenance is the third pillar of TPM. It aims to achieve zero breakdowns. It follows a structured approach to establish a management system that extends the equipment reliability at optimum cost.





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## **TPM**

### **How is the Pillar implemented?**

The Planned Maintenance pillar activities are normally led by the maintenance team. The initial phase prioritizes

- Equipment and involves evaluating current maintenance performance and costs to set the focus for the pillar.
- The team identify the optimum approach to maintaining the equipment, starting with a Periodic Maintenance (Time-Based Maintenance) system

### **What are the benefits of the Pillar?**

The primary benefit from implementing Planned Maintenance:

- Reduction in breakdowns, which leads to reduced cost and improved machine efficiency.
- The pillar will also contribute to improved quality and safety performance

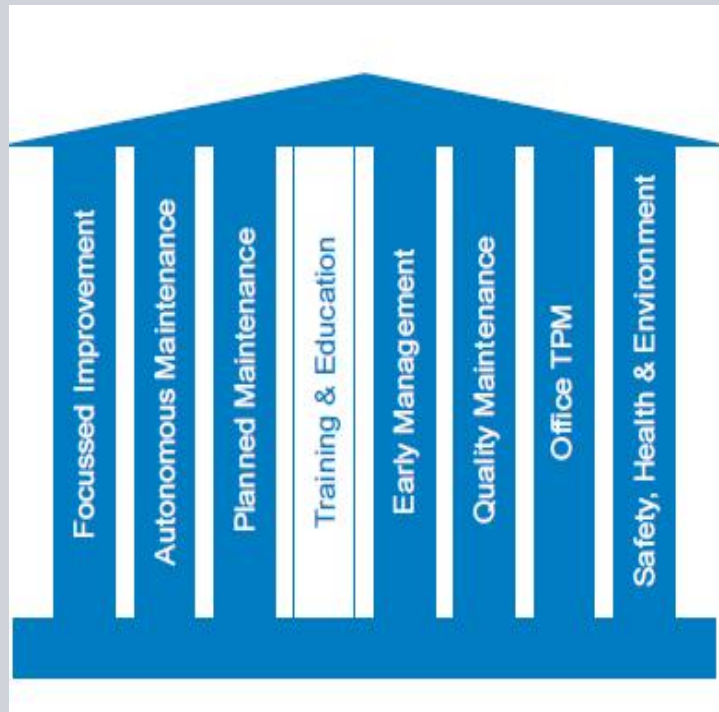
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### What is the Training and Education Pillar?

Training and Education is the fourth pillar of TPM.

It ensures that staff are trained in the skills identified as essential both for their personal development and for the successful deployment of TPM.



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## TPM

### How is the Pillar implemented?

- Initially the knowledge and skills required for carrying out each job are defined, in terms of both complexity of knowledge needed and the number of capable people required.
- A current state analysis assesses the current levels against the established requirements and a training plan is developed to close any gaps.
- This plan is implemented and evaluated to ensure that the activity generates the improved capabilities .

### What are the benefits of the Pillar?

- Increased skills and performance of all personnel throughout the organisation
- Without a strong Training and Education pillar, the impact of the first three pillars will not be sustainable.
- Training and Education creates a corporate environment which is able to maximize the potential of all employees

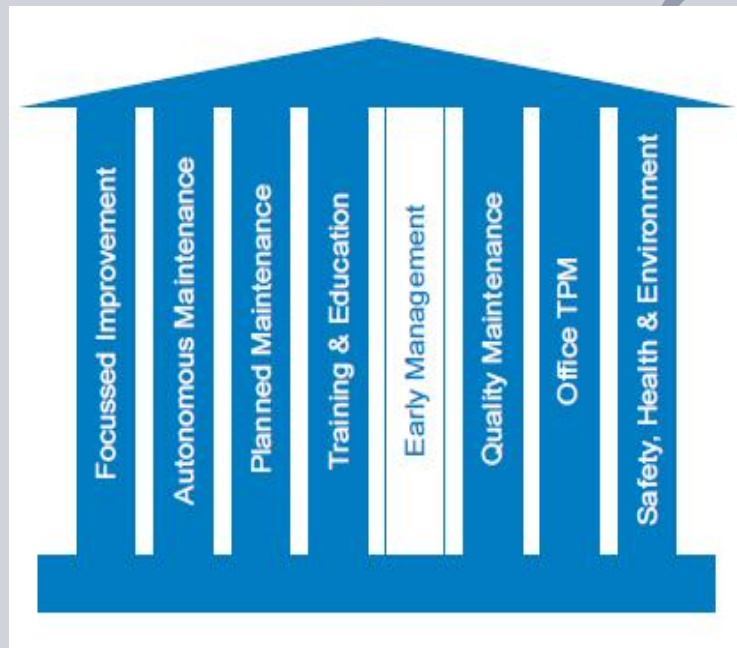
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### What is Early Management?

Early Management is the fifth pillar of TPM and aims to

- Implement new products and processes with vertical ramp up and minimized development lead time.
- It is usually deployed after the first four pillars as it builds on the learning captured from other pillar



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## TPM

### How is the Pillar implemented?

There are two parts to the Early Management pillar:

Early Equipment Management and Early Product Management.

Both approaches focus on using the lessons from previous experiences to eliminate the potential for losses through the planning, development and design stages.

For Early Equipment Management, the goal is to introduce:

A loss and defect free process so that equipment downtime is minimal (zero breakdowns), and maintenance costs are all considered and optimised, from commissioning onwards.

Early Product Management aims to:

Shorten development lead times,

Teams working on simultaneous activities so that vertical start up can be achieved with zero quality loss (zero defects).

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### What are the benefits of the Pillar?

Effective Early Management implementation will deliver :

- Reduced product and process introduction lead times
- Improved Overall Equipment Effectiveness
- Ability to deliver in volume at the right quality from production start-up.
- Cost savings will be delivered both during the introduction phase and throughout the equipment or product life cycle.

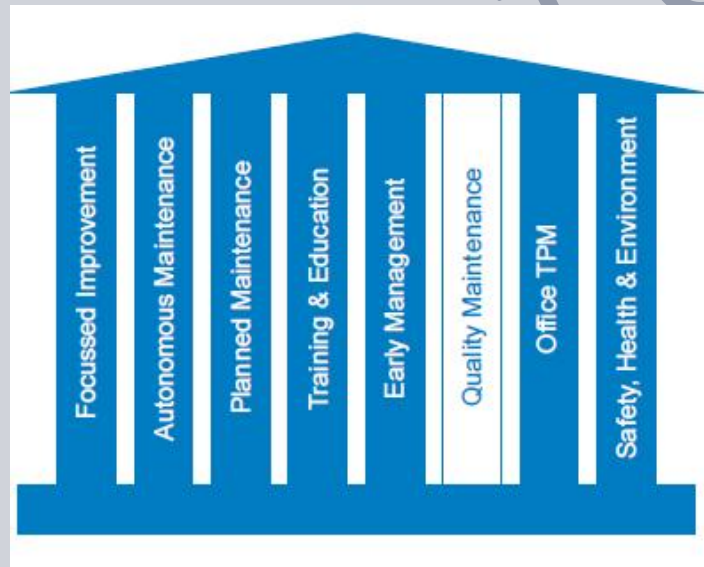
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### What is Quality Maintenance?

Quality Maintenance is the sixth pillar of TPM and aims to assure zero defect conditions.

- It does this by understanding and controlling the process interactions between manpower, material, machines and methods
- The key is to prevent defects from being produced in the first place, rather than installing rigorous inspection systems to detect the defect after it has been produced.





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## TPM

### How is the Pillar implemented?

Quality Maintenance is launched later in the overall TPM deployment process because certain conditions are delivered by full implementation of the first four pillars.

- Process problems must be eliminated
- variation in materials must be under control.
- Operators and maintenance must have the required capability to sustain equipment conditions.

Quality Maintenance is implemented in two phases.

- The first phase aims to eliminate quality issues by analyzing the defects,. Then, the current state is investigated and improvements are implemented.
- The second phase ensures that quality is sustained, by standardizing the parameters and methods to achieve a zero defect system.



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## TPM

### What are the benefits of the Pillar?

Quality Maintenance reduces the:

- Cost of quality, as waste resulting from poor quality, rework, consumer complaints and the need for inspection are reduced.
- Defects become a failure of the organization's systems, not the fault of the operator,
- Poor quality is no longer accepted as a normal occurrence.
- Everyone is responsible for maintaining optimal conditions and striving for zero defects.

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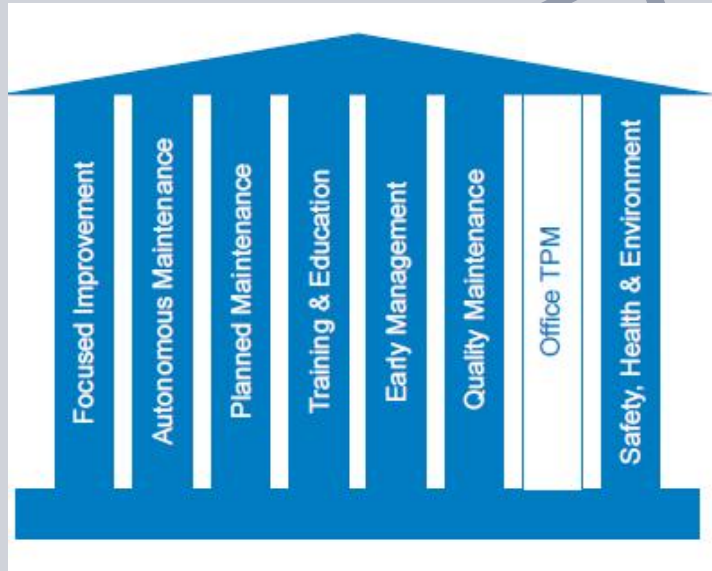
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### What is Office TPM?

Office TPM is the seventh pillar and concentrates on all areas that provide administrative and support functions in the organisation.

The pillar applies the key TPM principles in eliminating waste and losses from these departments.

The pillar ensures that all processes support the optimisation of manufacturing processes



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## TPM

### How is the Pillar implemented?

The initial preparation stage for the pillar ensures that the goals and objectives for each department are aligned to the organization's vision and mission.

There are then five key activities that the Office TPM pillar undertakes

- The Office TPM team implement office versions of Focused Improvement, Autonomous Maintenance
- Training and Education pillars to establish sustainable, performing processes.
- They deploy a flexible staffing policy to allow departments to manage peak workloads, without overstaffing.
- Prioritized improvement program, by loss analysis, against the goals and objectives set in the preparatory activity phase.

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### What are the benefits of the Pillar?

Office TPM benefits organizations by eliminating losses in the administrative systems across the whole organization.

- This delivers cost reductions in the organization's overheads
- Supporting improvement and sustainability of the manufacturing process efficiency.

The application of Office TPM also benefits the organization

- By developing support functions that react flexibility to changes in customer requirement
- Ensure a strong brand image is maintained.

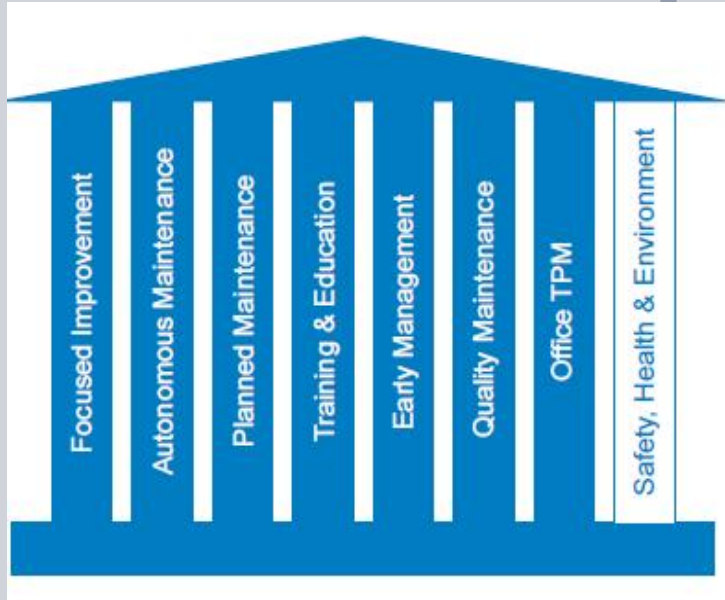
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### What is the Safety, Health and Environment Pillar?

Safety, Health and Environment (SHE) is the final TPM pillar

- Implements a methodology to drive towards the achievement of zero accidents. It is important to note that this is not just safety related but covers zero accidents,
- zero overburden (physical and mental stress and strain on employees) and zero pollution.



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## TPM

### How is the Pillar implemented?

Although the SHE pillar is the eighth pillar of TPM, it should not be thought of as the last to be deployed.

- The implementation of SHE strategies occurs throughout the TPM deployment process and SHE activities are never complete.
- SHE pillar activities aim to reactively eliminate the root causes of incidents that have occurred,
- to prevent reoccurrence, and proactively reduce the risk of future potential incidents by targeting near misses and potential hazards.

The pillar team target three key areas:

- People's behaviors,
- Machine conditions
- Management system.

All SHE pillar activities should be aligned to relevant external quality standards and certifications

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## TPM

### What are the benefits of the Pillar?

The immediate benefits of implementing the SHE pillar are:

- To prevent reoccurrence of lost time accidents
- Reduce the number of minor accidents
- Preventing environmental system failure.

This has a direct financial saving:

- In the cost of containment,
- Investigation and compensation
- Reputational impact.

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### Key Element For Success

### Planning and Scheduling

#### Typical Job Planned On-the-Run (Time)



Planning Activity

#### Same job if Professionally Planned (Time)



Work Activity



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## TPM



Move from this....



...to this!

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## TPM

### Measuring effectiveness

A tool for measuring and evaluating the effectiveness of TPM can be found in "[Overall Equipment Effectiveness](#)" (OEE).

Measuring the effectiveness of TPM is a crucial activity in TPM,

$$\text{OEE} = \text{Availability} \times \text{Performance} \times \text{Quality}$$

$$\text{Availability} = \frac{\text{Actual Operating Time}}{\text{Planned Production Time}}$$

$$\text{Planned Production Time} = \text{Plant Operating Hours} - \text{Planned Shut Down Time}$$

- **Planned Shut Down:** Periods when not scheduled (required) to produce (e.g. weekends, off-shifts, breaks, lunch, etc).
- Note: If your scheduled to run during breaks and lunches, this is not considered Planned Shutdown Time.

$$\text{Quality} = \frac{\text{Good Output}}{\text{Total Output}}$$

- **Total Output** is the total output produced (ie: units, eaches, ft, etc) including good, bad, reworked, QC Samples, and product produced during changeover.
- **Good Output** refers to the total number of good product produced through the process that is available for sale, without any type of rework or re-processing.

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### OEE (Overall Equipment Effectiveness)

It is a metric that identifies the percentage of planned production time that is truly productive.

It was developed to support TPM initiatives by accurately tracking progress towards achieving “perfect production”.

An OEE score of 100% is perfect production.

An OEE score of 85% is world class for discrete manufacturers.

An OEE score of 60% is fairly typical for discrete manufacturers.

An OEE score of 40% is not uncommon for manufacturers without TPM and/or lean programs.

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### Category Definitions

Plants must assess all plant equipment (production, critical systems, critical testing equipment, etc) and assign it an appropriate TPM category based on its criticality to your operation.

Utilize the following guidelines for determining the appropriate category level:

#### **Category 1: *Critical Plant Equipment***

- *Equipment selected by the plant as critical plant equipment that affects either the entire plant or one of the Key Value Streams. Factors to consider may include:*

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Does this equipment shutdown an entire Key Plant Value Stream or the entire Plant?

- Is this critical equipment with no back-up capabilities?
- Is this equipment capacity constrained?
- Is this operation the bottleneck in the value stream?
- Is this equipment critical from a supply / customer risk perspective?
- Does this equipment has a significant impact on other Strategic imperatives (ie: quality issues, high conversion loss, etc)

### **Category 1A: TPM Pilot Equipment**

- Category 1A Equipment is a strategic sub-set of Category 1. These will be the “pilot” equipment strategically selected as most important to the plant, where TPM efforts will initially be focused in the plant.

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### **Category 2: Key Equipment**

- This equipment is considered to have limited or minimal impact to your overall operations.

Factors to consider include:

- Critical equipment with some back-up capabilities
- May shutdown a portion of a key value stream.
- Non-capacity constrained
- May have an limited impact on other strategic imperatives (ie: Quality, conversion loss, financials, etc)

### **Category 3: Non-Critical Equipment**

- This includes all non-critical equipment
- Non-critical equipment
- Auxiliary equipment

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### Summary

Today, with increasing competition and tough markets, TPM may decide the success or the failure of a company. TPM has been a proven program for many years and organizations, especially into manufacturing, can adopt this methodology without any risk.

Employees and the upper management should be educated in TPM by the time it is rolled out. The organization should have long-term objectives for TPM.

Majority of world's first class manufacturing companies follow TPM as an integrated practice in their organizations. Ford, Harley Davidson and Dana Corp. are just a few to mention. Many Indian Companies have started using this technique and have been benefited

All these first class corporate citizens have reported high rates of productivity enhancements after implementing TPM. As baseline, almost all the companies, who have adopted TPM have reported productivity enhancements close to 50% in many areas.

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Thank You

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