

# Total Quality Management BME613A



**A T M E**  
College of Engineering



## Module 5 Tools and Techniques

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## **Module 5**

### **Total Productive Maintenance (TPM):**

Definition, Types of Maintenance, Steps in introduction of TPM in an organization, Pillars of TPM – 5S, Jishu Hozen, Quality Maintenance, Planned Maintenance.

### **Quality by Design (QbD):**

Definition, Key components of QbD, Role of QbD in Pharmaceutical Industry, Benefits and Challenges of QbD.

### **Environmental Management Systems (EMS):**

Definition, Basic EMS, EMS under ISO 14001, Costs and Benefits of EMS

## Total Productive Maintenance (TPM)

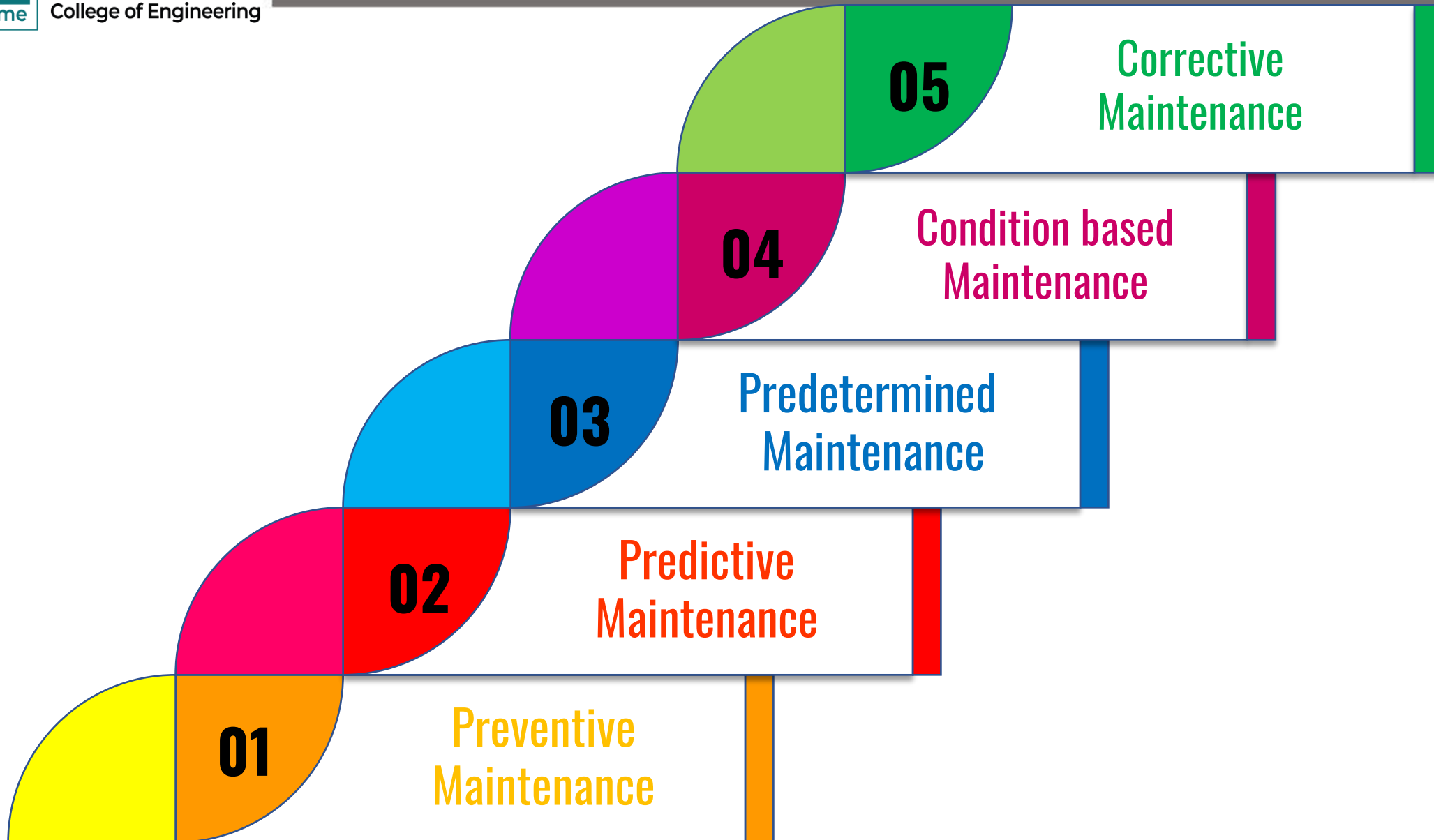
### Definition

TPM (Total Productive Maintenance) is a maintenance philosophy designed to integrate equipment maintenance into the manufacturing process. The goal of any TPM program is to eliminate losses tied to equipment maintenance or, in other words, keep equipment producing only good product, as fast as possible with no unplanned downtime.

- **Total** - All encompassing by maintenance and production individuals working together.
- **Productive** - Production of goods and services that meet or exceed customers expectations
- **Maintenance** - Keeping equipment and plant in as good as or better than the original condition at all times.

## Objectives of TPM

- The overriding objective of TPM is the elimination of LOSSES. Losses, or waste, includes equipment downtime, defects, scrap, accidents, wasted energy, and labor inefficiency.
- TPM was introduced to achieve some of the following important objectives:
  - Safer working environment, Job security
  - Producing goods with improved quality and machine reliability
  - Improved financial performance
  - Produce a low batch quantity at the earliest possible time.
  - Goods send to the customers must be non defective

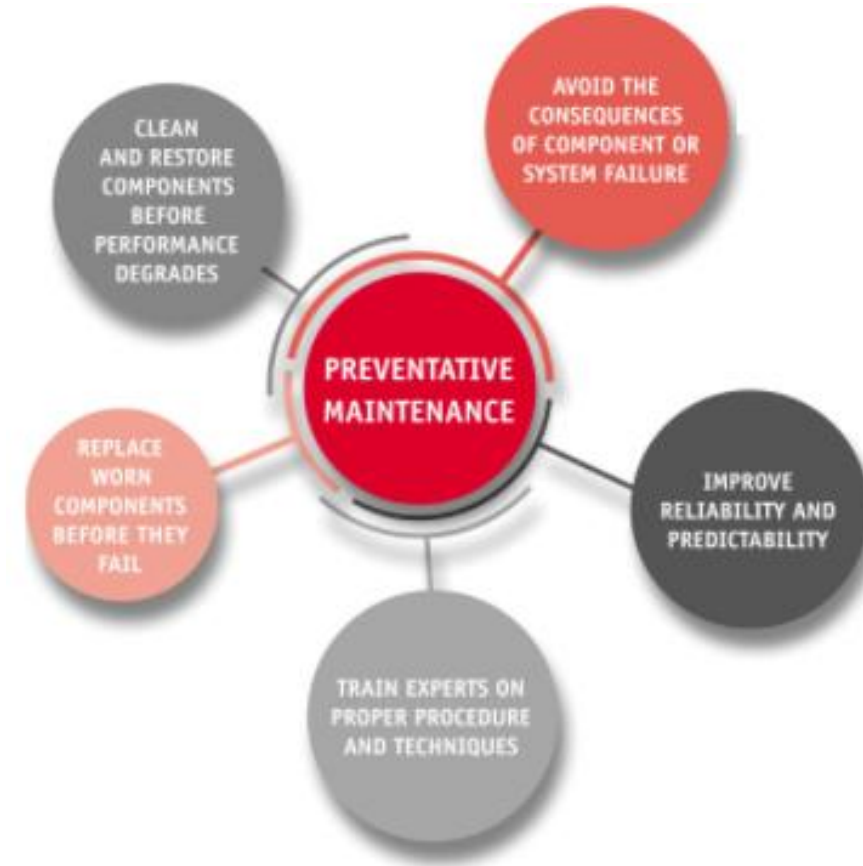


# 1. Preventive Maintenance

Preventive maintenance is defined as taking precautionary steps or actions to prevent equipment failures before they actually occur.

Preventive maintenance typically involves routine inspections, upgrades, proper lubrication (where applicable), adjustments, and replacement of outdated equipment or parts.

Preventive maintenance can be implemented in many areas of your business, and includes any preventive action, such as changing water filters, regularly cleaning essential equipment, inspecting business vehicles (i.e. delivery vans), and checking grout and caulking to protect a property against water damage.



## **Benefits of Preventive Maintenance**

- Minimized downtime and business closures due to unexpected equipment failures – This will help you avoid financial loss, and protect your bottom line.
- Increased life expectancy of essential equipment and assets – Inspecting, updating, and caring for your business's assets will result in less money spent on new equipment in the long run.
- Decreased energy consumption for your business's assets – When equipment runs optimally, less energy is required, which means lower utility bills for your business.



# Preventive Maintenance

## Relevant Industries For Preventive Maintenance

Preventive maintenance is pretty universal, and should be considered in any industry, including but not limited to manufacturing, food production, oil & gas, restaurants, gyms, retail, education, and healthcare.



## Case Study (example) for Preventive Maintenance

An unexpected refrigerator breakdown can leave a restaurant reeling, resulting in considerable food loss, closing for the rest of the day (or the time it takes to schedule and make repairs), and high repair costs. Performing regular inspections and cleaning of the condenser coils will help prevent such a costly incident from occurring, and will mean less risk to your business in the long run. and checking grout and caulking to protect a property against water damage.

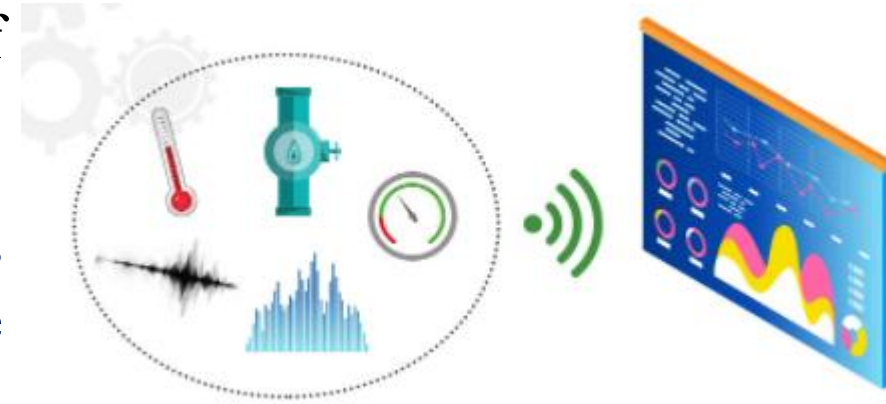


## 2. Predictive Maintenance

Predictive maintenance tracks the normal operation of an appliance or machine to detect possible defects before they pose a problem. This type of maintenance uses condition-monitoring technology to measure the performance of equipment, typically by way of IoT (the Internet of Things).

IoT is more or less a system that connects electronic devices to mechanical and digital machines, and is equipped with the ability to detect and transfer data without requiring human interaction or interference.

Predictive maintenance will alert to possible machine deficiencies without any prompting till end



## Benefits of Predictive Maintenance

- Predictive maintenance is so valuable is because it allows for maintenance to be performed only when absolutely necessary—that is, just before equipment failure is likely to occur.
- Predictive maintenance will enable to save money until the very last minute, when maintenance or repairs are actually required but before any real system damage occurs.
- Fewer production hours lost as a result of equipment failure.
- Predictive maintenance is shown to contribute to a phenomenal tenfold increase in return on investment, as well as a 70-75% decrease in equipment crashes and a 35%-45% reduction in downtime

# Predictive Maintenance

## Relevant Industries For Predictive Maintenance

The industries that rely on predictive maintenance usually have equipment that are critical to their operations and have failure modes that can be predicted with regularly monitoring. Industries that can fit this criteria includes food production, oil and gas, manufacturing, power and energy plants, IT, etc.

## Case Study (example) for Predictive Maintenance

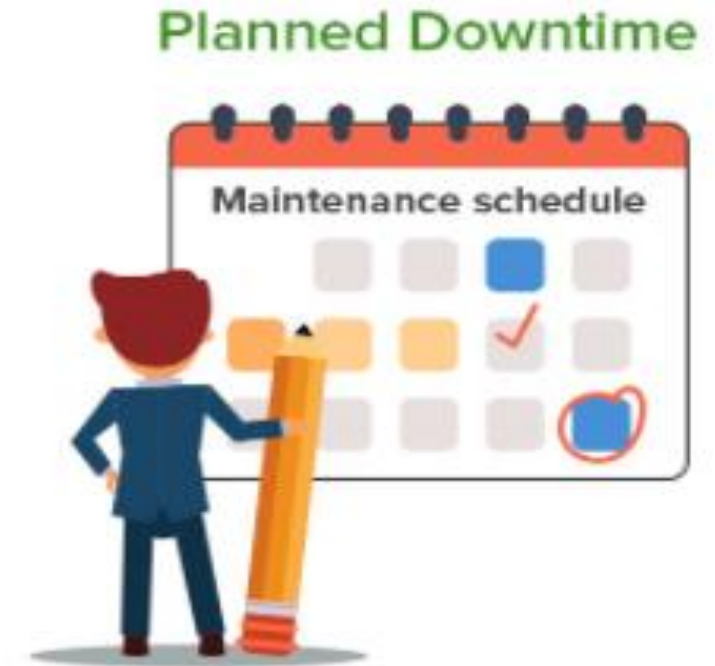
A food production plant may rely on predictive maintenance for their valuable industrial ovens, which may be running 24/7 to stay competitive. A sensor would be installed to the oven that would evaluate and produce data regarding temperature and vibration that would alert staff to make adjustments or tweaks to poor performing machines in real-time, reducing the need to shut down production completely.

### 3. Predetermined/ Planned Maintenance

Planned maintenance covers any maintenance that is planned, scheduled, and documented. It is specifically defined as, preventive maintenance that is carried out according to a set plan.

Preventive maintenance is one type of planned maintenance, and will account for and prevent machine breakdowns before they occur.

There is also planned, unscheduled maintenance, which is the process of correcting or fixing a system that has already broken, and anticipating such business hindrances ahead of time.



## Benefits of Planned Maintenance

- Preparedness in the event of equipment failure, or preventing such failure altogether
- Planned maintenance is often as simple as a regular, planned inspection, seasonal maintenance, etc
- Significant cost savings in the long run – The cost of regular, routine maintenance often costs less in the long run than dealing with a major problem after it has occurred.



# Planned Maintenance

## Relevant Industries For Planned Maintenance

Planned maintenance is universal for all industries, and should be considered in manufacturing, restaurant (food & beverage), hospitality, gym and wellness centers, retail, and schools.

## Case Study (example) for Planned Maintenance

It's generally recommended that a restaurant checks and empties its grease traps every 1-3 months, depending on the size and volume of business. Doing so prevents sewer lines from becoming clogged with waste.



## 4. Condition-Based Maintenance

Condition-based maintenance refers to the process of taking quick action on a machine that is in the early stages of equipment failure.

Many machines produce some sort of alert that the system is beginning to malfunction before total breakdown occurs.

Condition-based maintenance allows for a last-minute response to a system or machine crashing.



## Benefits of Condition-Based Maintenance

- Reduced number of total machine breakdowns – Condition-based maintenance may help to avoid a total machine failure
- Successful condition-based maintenance means that, It is managed to prevent equipment from totally failing, enabling it to function until it can be troubleshooted more thoroughly.
- Advance warning of breakdown – A warning that a machine or system needs attention is preferable to losing its functionality all at once. If such notifications are standard for the machine, Enough time will be there to call a mechanic, rather than attempting to fix equipment by self.

# Condition-Based Maintenance

## Relevant Industries For Condition-Based Maintenance

Industries that typically have high cost equipment and are critical to operations. Most typically common in manufacturing, oil & gas, power and energy plants, and food production with heavy machinery.

## Case Study (example) for Condition-Based Maintenance

A sensor that measures vibrations of a rotating equipment can warn you when the moving piece starts to fall out of alignment and increase in vibration. This will cause the sensor to alert you when the vibration is out of the interval you set.

## 5. Corrective Maintenance

Corrective maintenance is best described as any action that targets and fixes a system malfunction so that the equipment can be restored to proper working order.

Additionally, the defect may be caught or noticed before it causes a significant problem, or total equipment breakdown.

It improves equipment and its components so that preventive maintenance can be carried out reliably. Equipment with design weakness must be redesigned to improve reliability or improving maintainability



## Benefits of Corrective Maintenance

- Reduced duration of planned and unplanned downtime
- Reduced cost and time of running a reactive maintenance strategy
- Reduced cost of maintenance operations/reduced emergency maintenance orders



# Corrective Maintenance

## Relevant Industries For Corrective Maintenance

Any industry may use corrective maintenance, including restaurants, gyms, retail stores, schools, and corporate offices.

## Case Study (example) for Corrective Maintenance

If frost or ice builds up in a walk-in freezer, this can escalate into a costly consequence for a restaurant. Ice accumulation can interfere with optimal refrigeration, causing compressors to use more energy and run less efficiently. If ice has already built up in a commercial freezer, it should be thawed either by turning the system off temporarily, or by using a tool such as a hair dryer to expedite the process.



# Steps in introduction of TPM in a organization

## Step A - PREPARATORY STAGE

STEP 1 - Announcement by Management to all about TPM introduction in the organization :

Proper understanding, commitment and active involvement of the top management is needed for this step. Senior management should have awareness programmes, after which announcement is made to all. Publish it in the house magazine and put it in the notice board. Send a letter to all concerned individuals if required.

STEP 2 - Initial education and propaganda for TPM :

Training is to be done based on the need. Some need intensive training and some just an awareness. Take people who matters to places where TPM already successfully implemented.

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# Steps in introduction of TPM in a organization

## STEP 3 - Setting up TPM and departmental committees :

TPM includes improvement, autonomous maintenance, quality maintenance etc., as part of it. When committees are set up it should take care of all those needs.

## STEP 4 - Establishing the TPM working system and target :

Now each area is benchmarked and fix up a target for achievement.

## STEP 5 - A master plan for institutionalizing :

Next step is implementation leading to institutionalizing wherein TPM becomes an organizational culture. Achieving PM award is the proof of reaching a satisfactory level.

# Steps in introduction of TPM in a organization

## STEP B - INTRODUCTION STAGE

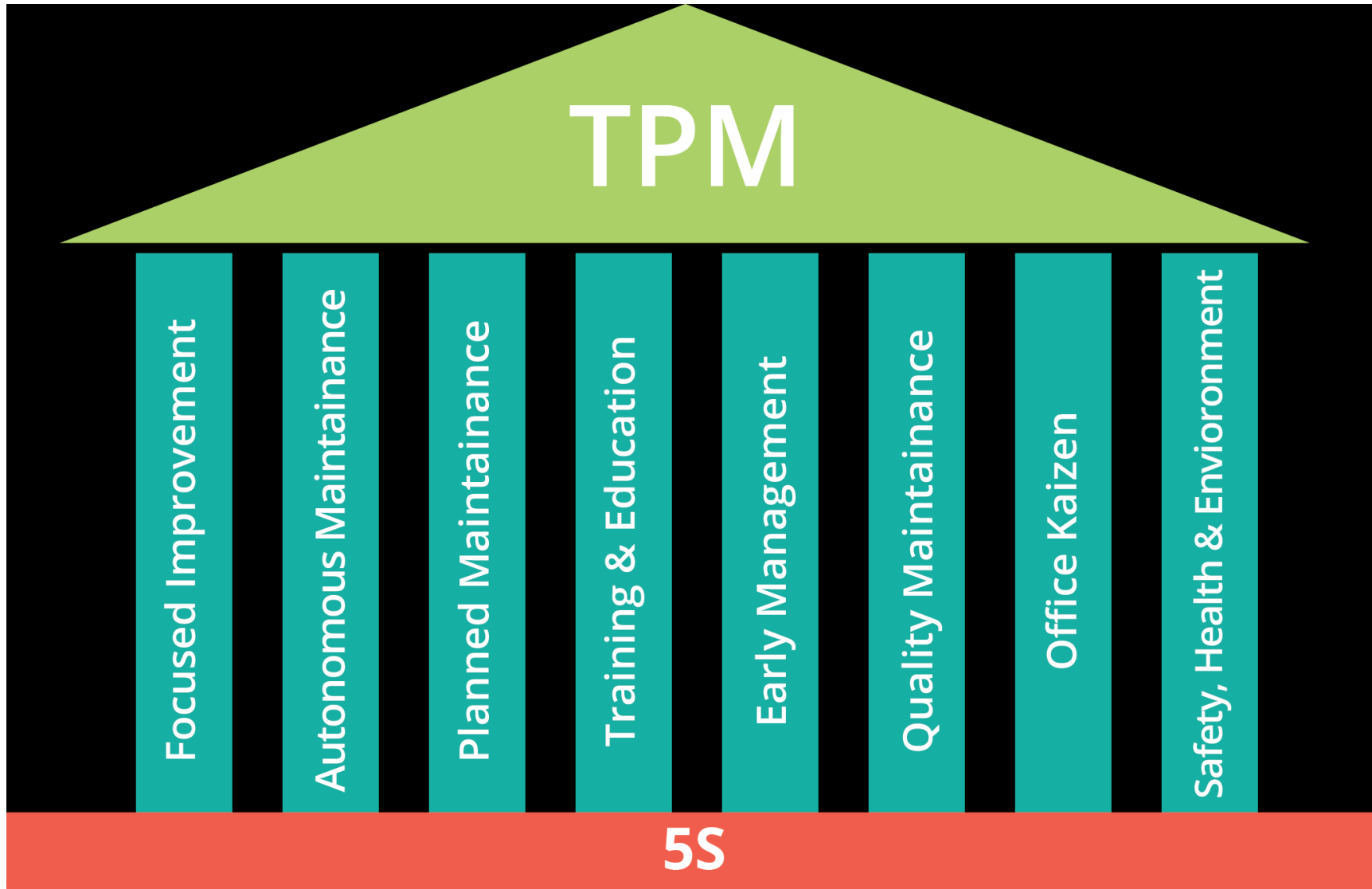
Suppliers as they should know that we want quality supply from them. Related companies and affiliated companies who can be our customers, sisters concerns etc. Some may learn from us and some can help us and customers will get the communication from us that we care for quality output.

## STAGE C – IMPLEMENTATION

In this stage eight activities are carried which are called eight pillars in the development of TPM activity. Of these four activities are for establishing the system for production efficiency, one for initial control system of new products and equipment, one for improving the efficiency of administration and are for control of safety, sanitation as working environment.

## STAGE D - INSTITUTIONALISING STAGE

# Pillars of TPM



# 5 S {The foundation of TPM}

Japanese Term	English Translation	Equivalent 'S' term
<i>Seiri</i>	Organisation	Sort
<i>Seiton</i>	Tidiness	Systematise
<i>Seiso</i>	Cleaning	Sweep
<i>Seiketsu</i>	Standardisation	Standardise
<i>Shitsuke</i>	Discipline	Self - Discipline



# 5 S {The foundation of TPM}



## SEIRI - Sort out

This means sorting and organizing the items as critical, important, frequently used items, useless, or items that are not need as of now. Unwanted items can be salvaged. Critical items should be kept for use nearby and items that are not be used in near future, should be stored in some place. For this step, the worth of the item should be decided based on utility and not cost. As a result of this step, the search time is reduced

## SEITON – Organise

The concept here is that "Each items has a place, and only one place". The items should be placed back after usage at the same place. To identify items easily, name plates and colored tags has to be used. Vertical racks can be used for this purpose, and heavy items occupy the bottom position in the racks.



# 5 S {The foundation of TPM}



## SEISO - Shine the workplace

This involves cleaning the work place free of burrs, grease, oil, waste, scrap etc. No loosely hanging wires or oil leakage from machines.

## SEIKETSU – Standardization

Employees has to discuss together and decide on standards for keeping the work place / Machines / pathways neat and clean. This standards are implemented for whole organization and are tested / Inspected randomly.

## SHITSUKE - Self discipline

Considering 5S as a way of life and bring about self-discipline among the employees of the organization. This includes wearing badges, following work procedures, punctuality, dedication to the organization etc.

## **JISHU HOZEN ( Autonomous maintenance )**

It is geared towards developing operators to be able to take care of small maintenance tasks, thus freeing up the skilled maintenance people to spend time on more value added activity and technical repairs.

### **Policy :**

1. Uninterrupted operation of equipments.
2. Flexible operators to operate and maintain other equipments.
3. Eliminating the defects at source through active employee participation.
4. Stepwise implementation of JH activities.

### **Target :**

1. Reduce oil consumption by 50%
2. Reduce process time by 50%
3. Increase use of JH by 50%

## **Steps in JISHU HOZEN**

- 1.Preparation of employees.
- 2.Initial cleanup of machines.
- 3.Take counter measures
- 4.Fix tentative JH standards
- 5.General inspection
- 6.Autonomous inspection
- 7.Standardization and
- 8.Autonomous management.

## PLANNED MAINTENANCE

It is aimed to have trouble free machines and equipments producing defect free products for total customer satisfaction. This breaks maintenance down into groups

### Policy :

1. Achieve and sustain availability of machines
2. Optimum maintenance cost.
3. Reduces spares inventory.
4. Improve reliability and maintainability of machines

### Target :

1. Zero equipment failure and break down.
2. Improve reliability and maintainability by 50 %
3. Reduce maintenance cost by 20 %
4. Ensure availability of spares all the time.

# PLANNED MAINTENANCE

## Six steps in Planned maintenance :

1. Equipment evaluation and recoding present status.
2. Restore deterioration and improve weakness.
3. Building up information management system.
4. Prepare time based information system, select equipment, parts and members and map out plan.
5. Prepare predictive maintenance system by introducing equipment diagnostic techniques and
6. Evaluation of planned maintenance.

# QUALITY MAINTENANCE

- It is aimed towards customer delight through highest quality through defect free manufacturing.
- Focus is on eliminating non-conformances in a systematic manner, much like Focused Improvement.
- QM activities is to set equipment conditions that preclude quality defects, based on the basic concept of maintaining perfect equipment to maintain perfect quality of products.
- The condition are checked and measured in time series to verify that measure values are within standard values to prevent defects.
- The transition of measured values is watched to predict possibilities of defects occurring and to take counter measures before hand.



# QUALITY MAINTENANCE

## Policy :

1. Defect free conditions and control of equipments.
2. QM activities to support quality assurance.
3. Focus of prevention of defects at source
4. Focus on poka-yoke. ( fool proof system )
5. In-line detection and segregation of defects.
6. Effective implementation of operator quality assurance.

## Target :

1. Achieve and sustain customer complaints at zero
2. Reduce in-process defects by 50 %
3. Reduce cost of quality by 50 %.

# Quality by Design

Definition of:

**Quality by Design is the practice of using a multidisciplinary team to conduct conceptual thinking, product design, and production planning all at one time.**



## The Easy Definition!!!

With a team to simultaneously design  
and develop products that have



**Ease of  
Producibility**



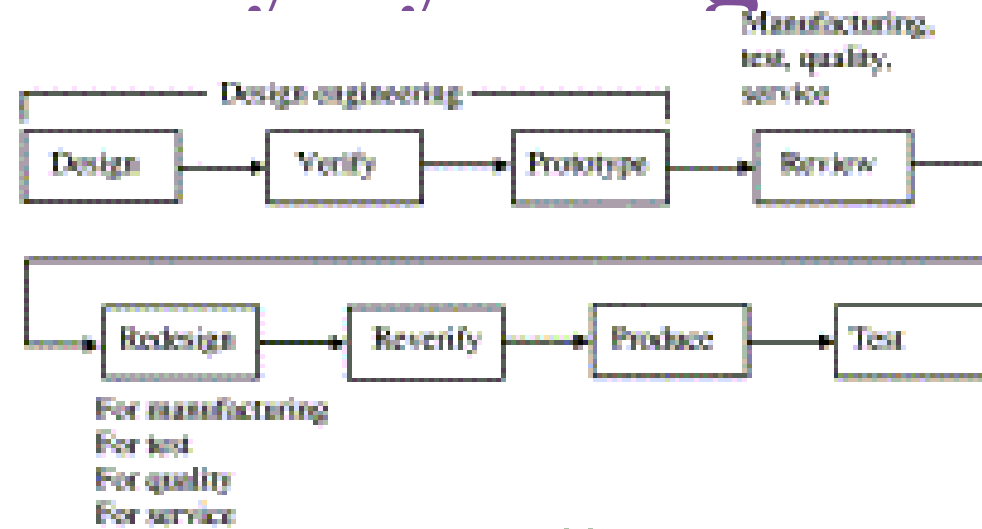
**Customer  
Satisfaction**

## Other Terms for Quality by Design

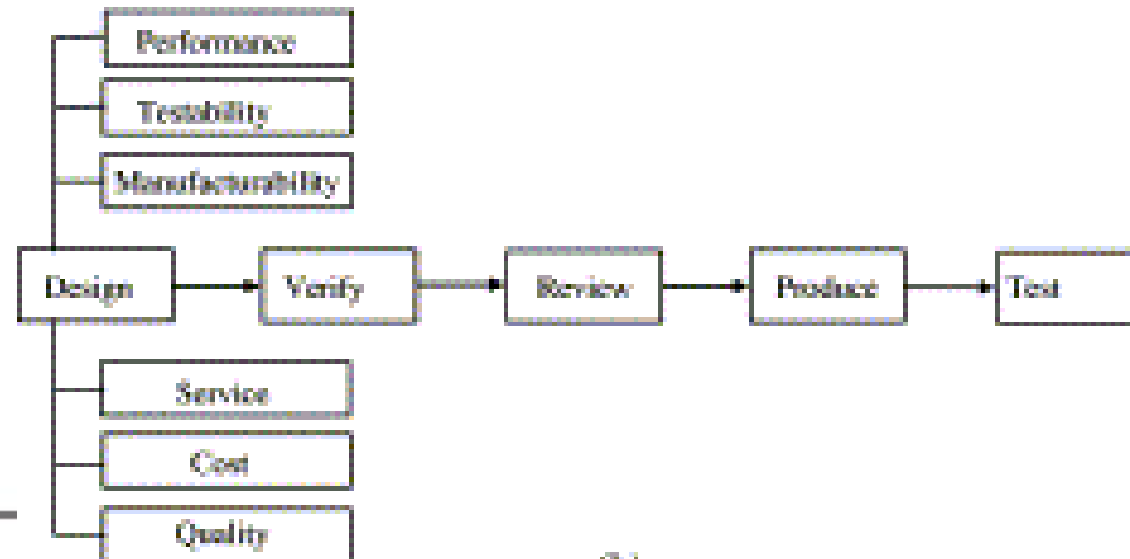
- Concurrent Engineering
- Simultaneous Engineering
- Parallel Engineering



# Quality by Design

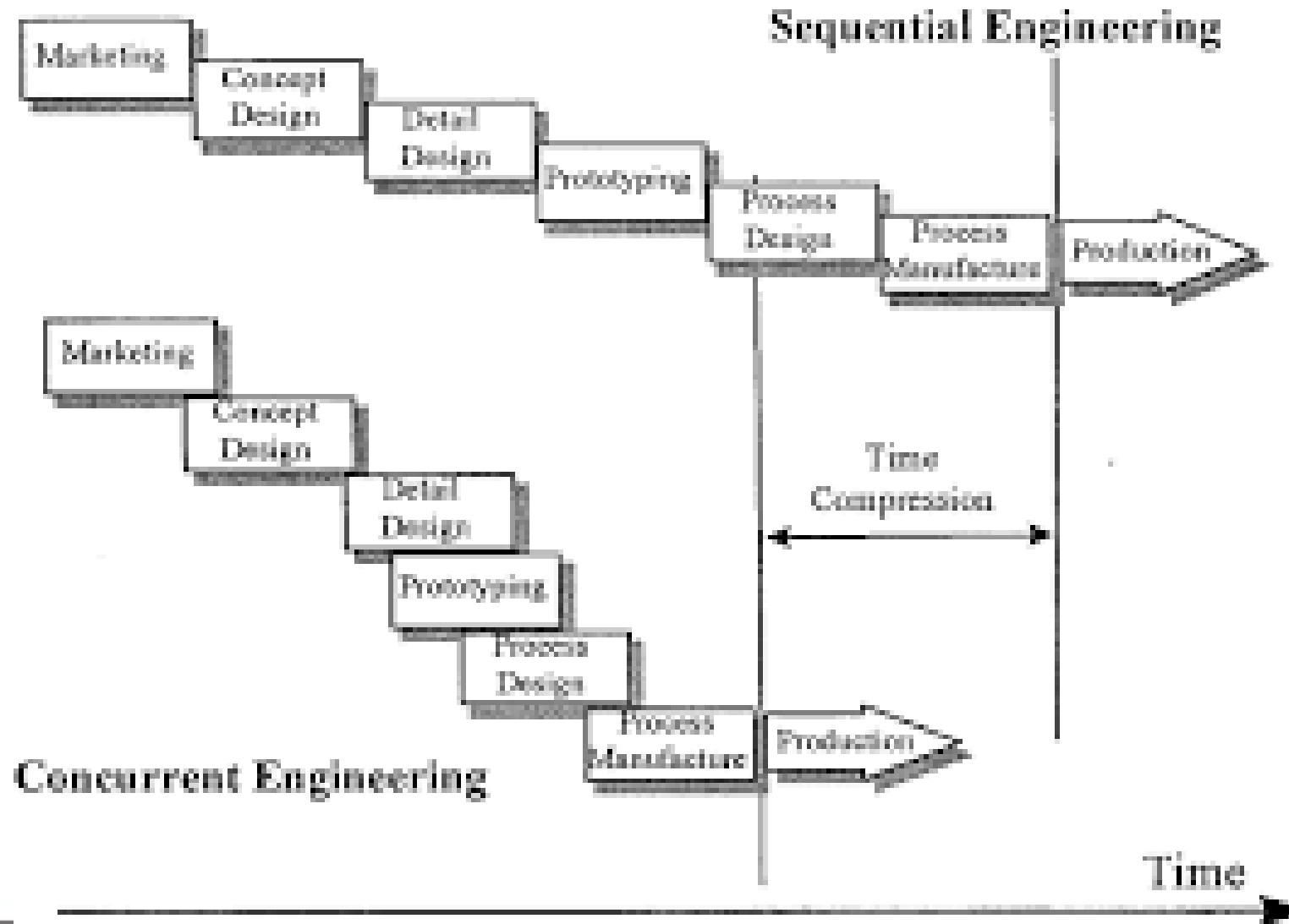


(a)



(b)

# Quality by Design





# Benefits of Quality by Design

- Significant decrease in time to market
- Faster product development
- Better quality
- Less work in progress
- Fewer engineering change orders
- Increased productivity
- Reduced labor costs
- Increased profits for the company

