Total Productive Maintenance

Tutor’s Introduction

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- Total Productive Maintenance (TPM)
- History of TPM
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DEFINITION

*WHAT IS MEANT BY THE TERM **"MAINTENANCE" ?***

- Maintenance encompasses all those activities that **maintain facilities & equipment in good working order** so that a system can perform as intended.

- Maintenance can also be termed as asset management system which **keeps them in optimum operating condition**.

TYPES OF MAINTENANCE

- BREAKDOWN MAINTENANCE:-
  - Real approach,
  - Dealing with breakdowns or problems when they occur…
- PREVENTIVE MAINTENANCE:-
  - Proactive approach;
  - Reducing breakdowns through a program of lubrication, adjustment, cleaning, inspection, and replacement of worn parts.

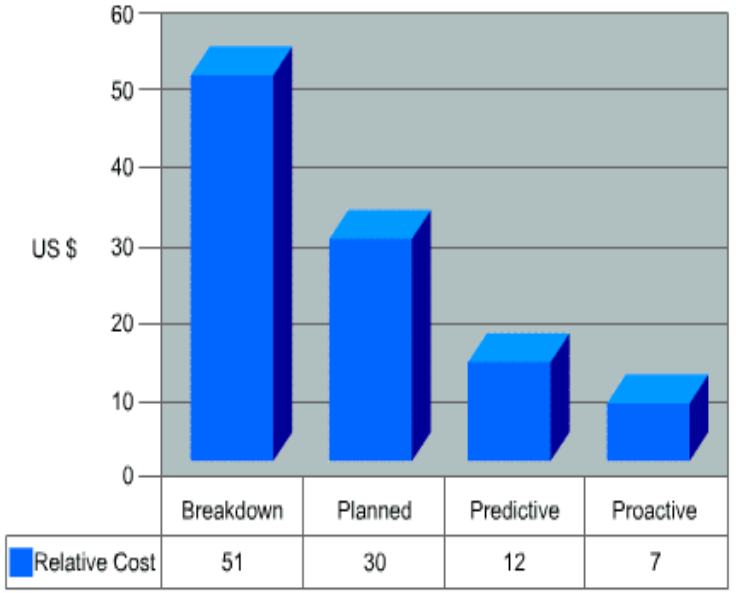
Predictive Maintenance

- This is an attempt to determine when best to perform preventive maintenance.
- The better the predictions of failures are, the more effective preventive maintenance will be.

Predictive Maintenance

Predictive Maintenance is one of the four tactical options available to ensure the reliability of any asset to ensure it fulfils its function and it focuses primarily on maintaining equipment based on its known condition.

Each of these strategies: on-failure, fixed time, predictive and design out, has a place in an optimized maintenance plan, the distribution of the mix being dependent on many factors.



ASME: Hudachek & Dodd

Predictive Maintenance

- Predictive maintenance is often the most attractive concept, since action is only undertaken when knowledge of the asset indicates that failure or underperformance is imminent, making it a cost effective asset management option.
- Equipment may be shut down before severe damage occurs or can be run to failure if required.
- Production can be modified to extend the asset's life i.e. until the next planned shutdown.
- Required maintenance work can be planned
- All of the above lead to increased safety, plant output and availability and lead to improvements in final product quality.

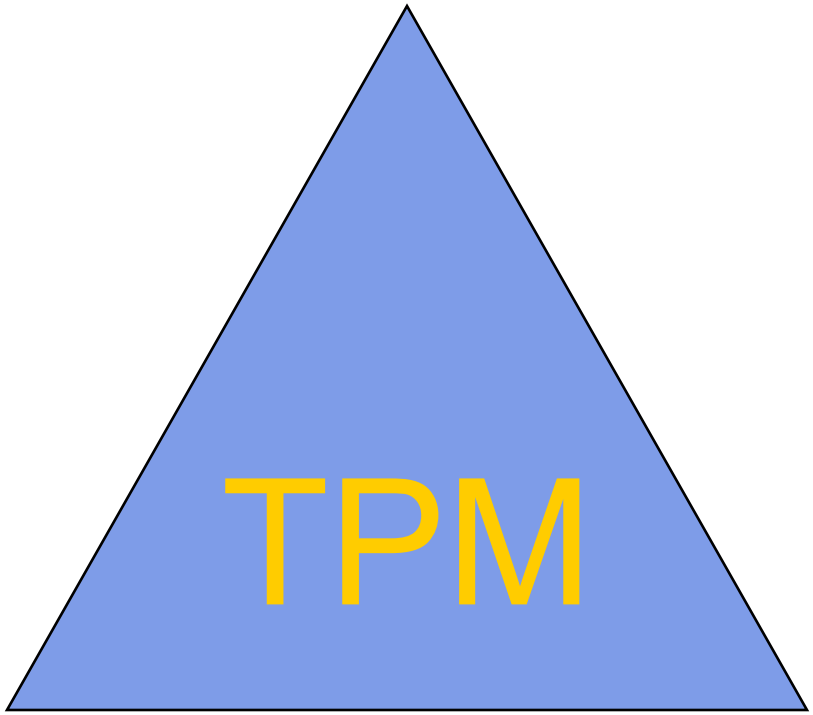
Predictive Maintenance

- Condition monitoring facilitates Predictive Maintenance.

- Condition monitoring is a knowledge-based activity, so for it to be successful and sustainable, it requires comprehensive skills training.
  Any successful predictive maintenance program, not only has a technology element, but requires a measurement system that continuously accounts for the benefits.

Total Productive Maintenance

Company Wide Strategy



System Approach

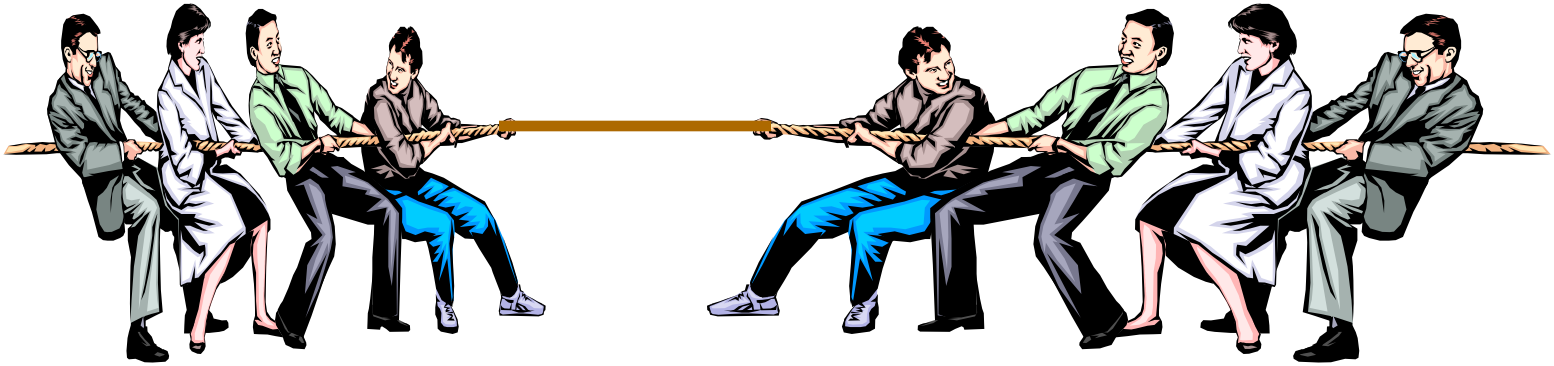
Medical Science of M/c

Total Productive Maintenance

- TPM is a **company wide strategy** to increase the effectiveness of production environments, especially through methods for **increasing the effectiveness of equipment**.

- TPM is **systematic approach** to understand the equipment's function, **Equipment's relationship to Product Quality** and likely causes and frequency of failure of the critical equipment component.

Before TPM Implementation



Maintenance **Operations**

Engineering

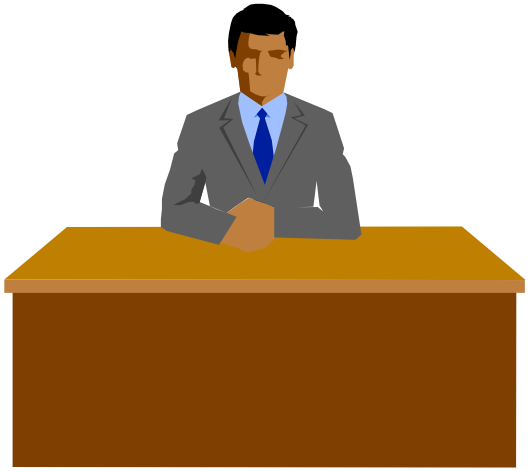
After TPM Implementation

A Team Effort
Operations + Engineering + Maintenance

Waste
Downtime
Defects

The Common Enemies

Before TPM Implementation: Barriers

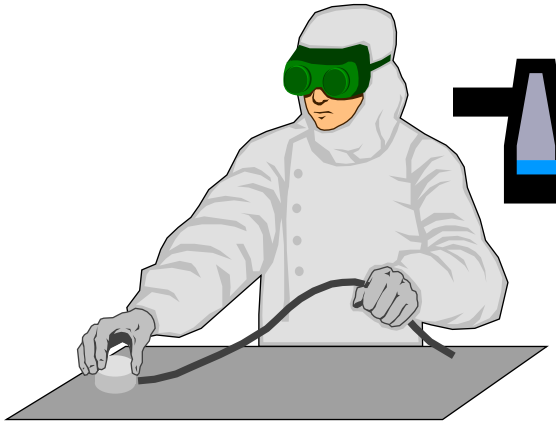


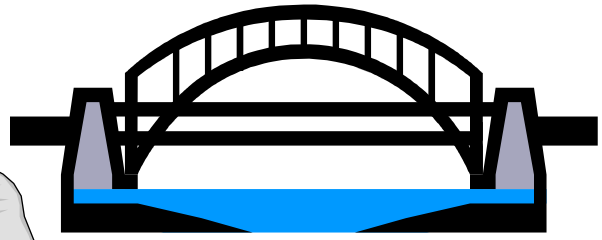
Operations

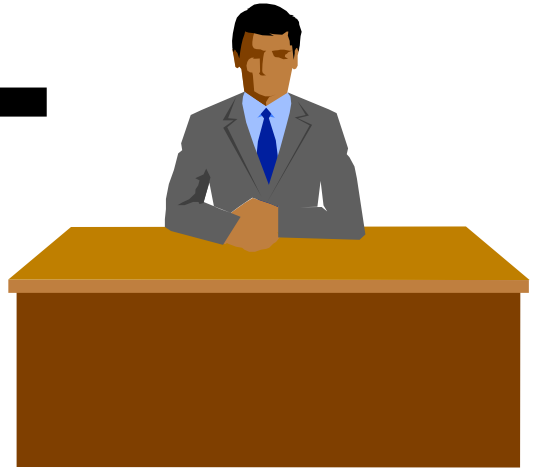
Engineering

Maintenance

TPM Builds Bridges







Operations

Maintenance

Engineering

TPM definition

A company-wide team-based effort to build quality into equipment and to improve overall equipment effectiveness

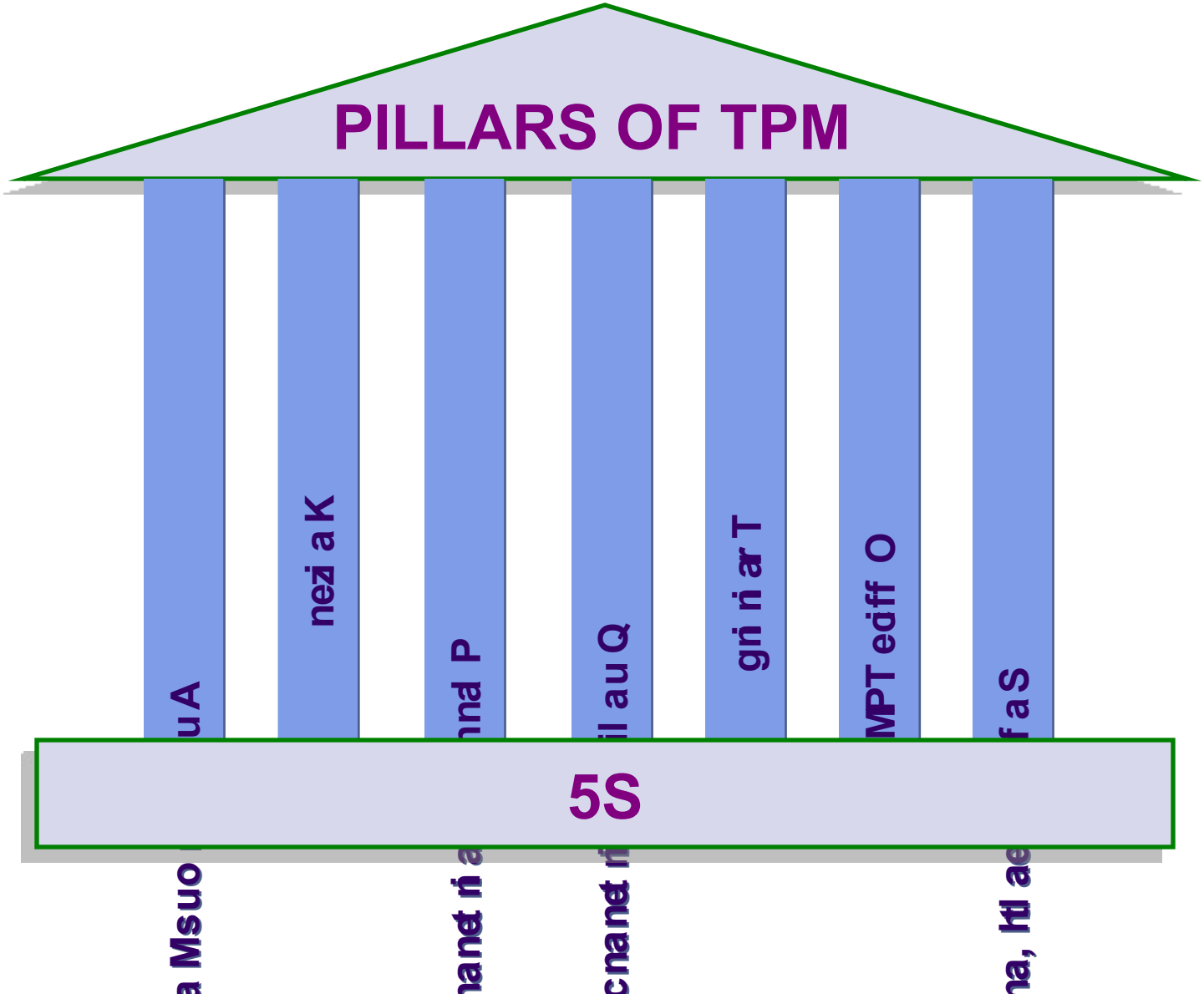
- **Total**
  - all employees are involved
  - it aims to eliminate all accidents, defects and breakdowns
- **Productive**
  - actions are performed while production goes on
  - troubles for production are minimized
- **Maintenance**
  - keep in good condition
  - repair, clean, lubricate

History of TPM

Its origin is a maintenance program used in the late 1960's by **Nippondenso**, a Japanese manufacturer of automotive electrical parts. **Seiichi Nakajima**, an officer with the Institute of Plant Maintenance in Japan is credited with defining the concepts of TPM and seeing it implemented in hundreds of plants in Japan

Total productive maintenance (TPM) was first defined in 1971 by the Japan Institute of Plant Maintenance (JIPM).

Pillars of TPM



Pillar 1

S E I R I ORGANIZATION

Arrange Properly

- Distinguish between those things that are needed and not needed
- Keep only needed materials at the job site
- Throw away all unneeded items immediately

S E I S O NEATNESS

Cleanliness

- Problems are more visible when everything is neat and clean
- Find minor defects while "sweeping clean"

S E I K E T S U

Always Clean

- Clean tools, equipment and job site immediately after use
- Equipment that is kept clean

runs better

5s

S E I T O N

Orderliness

- Put things in right order in designated areas
- Store all materials and information

in an orderly fashion at all times

- Organized according to frequency
- Place for everything and everything in its place

S H I T S U K E

Discipline

- Use and follow standard procedures
- Follow company rules and regulations
- Follow safety procedures at all times

Pillar 2

AUTONOMOUS MAINTENANCE

I PRODUCE I MAINTAIN

The operators are developed to take up small maintenance tasks which frees skilled maintenance people time for more value added activity.

The 7 Steps of Autonomous Maintenance

1.- Initial cleaning	*** Ability to determine machine abnormalities** *** Ability to design and make improvements**	**Development of the skill to spot abnormalities and opportunities and to make the improvements and solve the abnormalities**
2.- Eliminate sources of contamination and inaccessible areas		
3.- Creation of a checklist for cleaning and lubrication standards		**Operators determine by themselves what they have to do**
4.- General inspection	**Understanding operation principles of machine and its**	**More skilled operators and maintenance tech[illegible] teach the least**

OWNERSHIP CONCEPT

CHANGE OF MIND SET

CULTURAL CHANGE

CHANGE FROM

“I OPERATE YOU MAINTAIN”

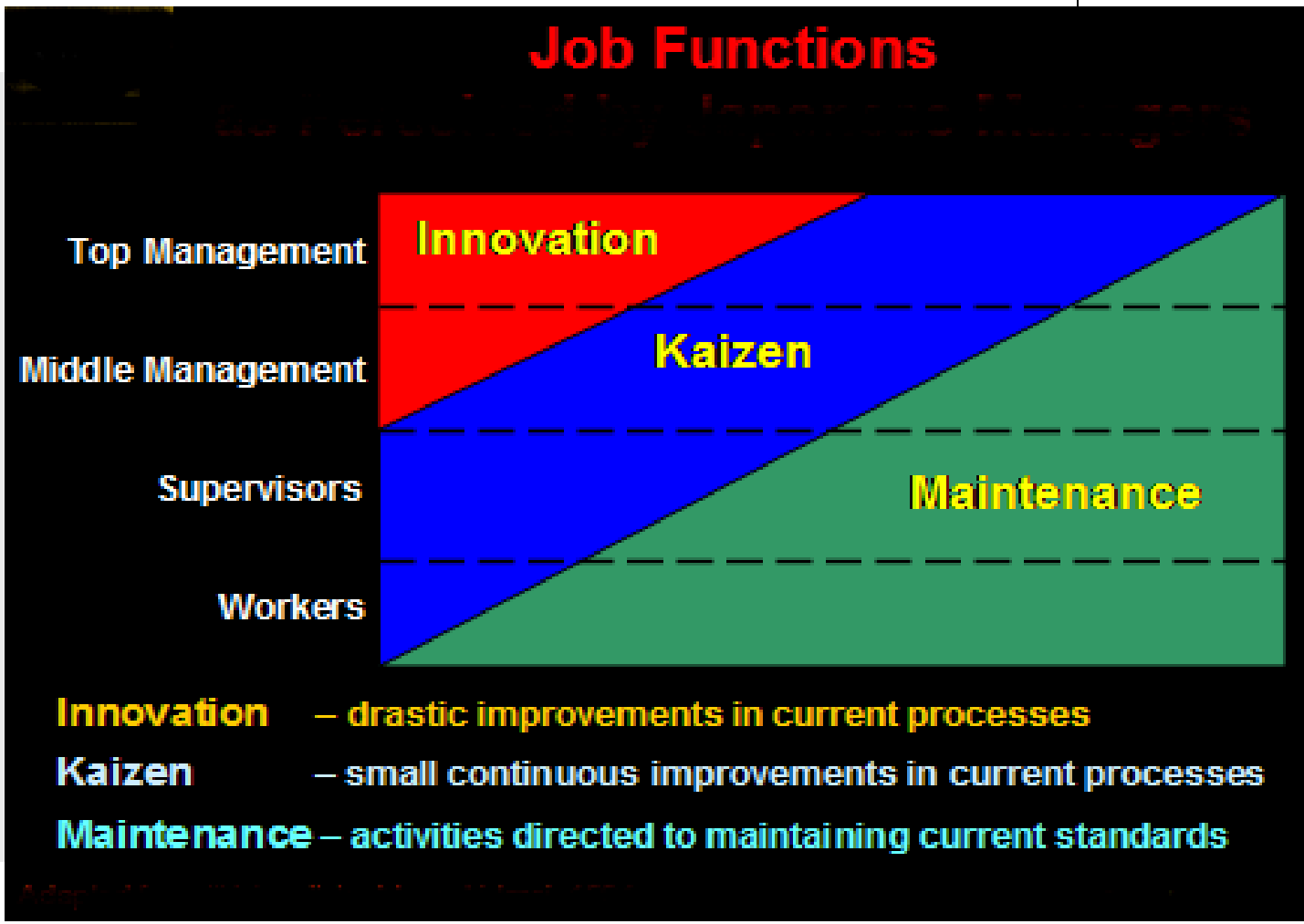
TO

“I OPERATE I MAINTAIN”

Pillar 3

KAIZEN ***Change for the better***

- It is opposite to big innovations.
- It requires no or little investments.
- Principle is " Large number of small improvements are more effective than in organizational environment than few improvements of large value.
- Aimed at eliminating or reducing losses in a systematic way.



Pillar 4

PLANNED MAINTENANCE

It is aimed to have trouble free machines and equipments producing products, without breakdown.

Breakdown Maintenance Equipment is repaired after Failure.

Preventive Maintenance Program is designed to retain healthy condition of equipment, periodic inspection or ECD .

Periodic Maintenance Time based maintenance to inspect, service, clean equipment and replace parts to prevent sudden failure and process failure.

Predictive Maintenance Service life of important part is predicted based on inspection or diagnosis. It is measurement of equipment under operating conditions to detect symptoms that are “out of line” with physical parameters.

Corrective Maintenance It improves equipment and its components so that preventive maintenance can be carried out reliably. Equipment with design weaknesses must be redesigned to to improve maintainability.

Maintenance Prevention It indicates the design of new equipment. Weaknesses of existing machines are studied (On site info leading to failure and defect prevention, safety, and ease of operation) and are incorporated before commissioning a new equipment.

Pillar 5

QUALITY MAINTENANCE

Maintain equipment to maintain perfect quality

It is aimed to have defect free manufacturing. It focuses on eliminating non conformances. We gain understanding of what parts of the equipment affect product quality.

QM INCLUDES

- Defect free condition and control.
- QM activities to support QA.
- Focus on prevention of defect at source.
- Focus on Poka-Yoke. (Mistake proof)
- Online detection and segregation.
- Implementation of operator Quality Control.

DATA FOR QM INCLUDES

- Product wise defects.
- Severity of defect with contribution.
- Magnitude and frequency of defect.
- Online detection and segregation.
- Implementation of operator Quality Control.
- Occurrence trend w.r.t quality replacements.

Pillar 6

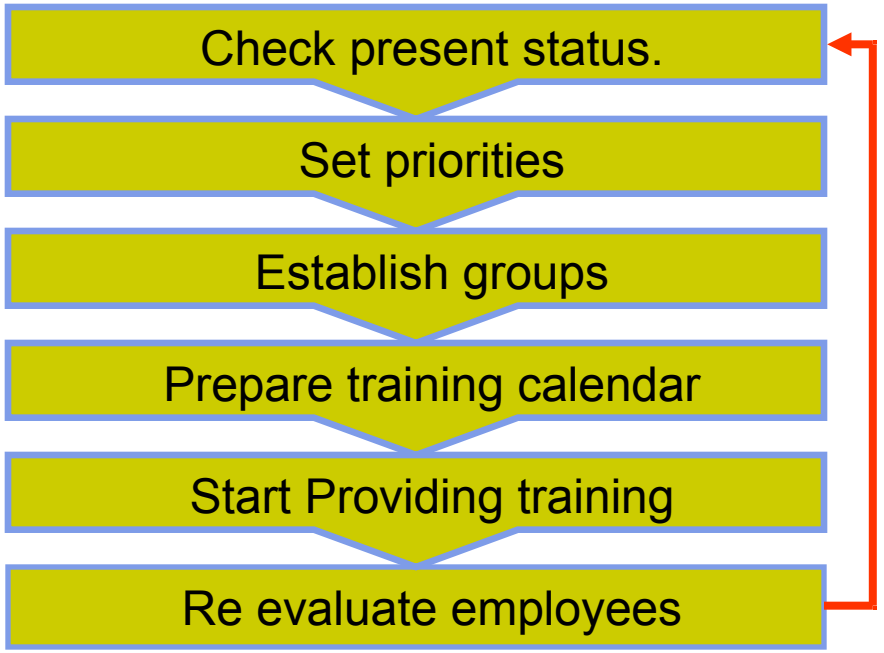
TRAINING

KNOW- HOW AND
KNOW- WHY

It is aimed to have Multi-skilled employees, with high moral, who can perform all required tasks effectively and independently.

PHASES OF SKILLS

1. **Do not know.**
2. **Know but cannot do.**
3. **Can do but cannot teach.**
4. **Can do and also teach.**



Pillar 7

OFFICE TPM

Eliminate losses in administrative areas

- Processing loss
- High inventories
- Communication loss
- Idle loss
- Set-up loss
- Accuracy loss

TPM must be followed to improve productivity, efficiency in the administrative functions and identify and eliminate losses. This includes analyzing processes and procedures towards increased office automation. Office TPM addresses twelve major losses. They are

- **P – Production output lost due to want of material, Manpower productivity, Production output lost due to want of tools.**
- **Q – Mistakes in preparation of cheques, bills, invoices, payroll, Customer returns/warranty attributable to BOPs, Rejection/rework in BOP's/job work, Office area rework.**
- **C – Buying cost/unit produced, Cost of logistics – inbound/outbound, Cost of carrying inventory, Cost of communication, Demurrage costs.**
- **D – Logistics losses (Delay in loading/unloading)**
  - **Delay in delivery due to any of the support functions**
  - **Delay in payments to suppliers**
  - **Delay in information**
- **S – Safety in material handling/stores/logistics, Safety of soft and hard data.**

Pillar 8

Safety, Health and Environment

Create a safe workplace

In this area focus is on to create a safe workplace and a surrounding area that is not damaged by our process or procedures. This pillar will play an active role in each of the other pillars on a regular basis.

- **A team is constituted for this pillar, which comprises representative of officers as well as workers.**
- **Utmost importance to Safety is given in the plant.**
- **Designated person, of appropriate seniority, looks after functions related to safety.**
- **To create awareness among employees various competitions like safety slogans, Quiz, Posters, etc. related to safety can be organized at regular intervals.**

OEE & TPM Vision

Implementing TPM means striving toward a vision of the ideal manufacturing situation, a vision that encompasses:

- zero breakdowns
- zero abnormalities
- zero defects
- zero accidents

The path to this ideal situation is a process of continuous improvement that requires the total commitment of everyone in the company, from operators to top management.

Equipment Effectiveness

- Measures of Equipment Effectiveness
  - Maintainability
  - Reliability
  - Availability
  - Efficiency
  - Quality Rate
  - Overall Equipment Effectiveness

Maintainability

- How quick and easy it is to maintain and repair equipment
- Measure = Mean Time to Repair (MTTR)

$$MTTR = \frac{\sum (Downtime\ for\ repair)}{Number\ of\ repair}$$

Reliability

- Probability equipment will perform properly during normal operation
- Measure = Mean Time Between Failure (MTBF)

$$MTBF = \frac{Total\ running\ time}{Number\ of\ \ failures}$$

Availability

- Proportion of time equipment is actually available out of the time it should be available is the availability (A)

$$A = \frac{MTBF - MTTR}{MTBF}$$

Efficiency

- Rate Efficiency (RE)
  - Actual average cycle time is slower than design cycle time due to unforeseen downtime
- Speed Efficiency (SE)
  - Actual cycle time is slower than design cycle time
- Performance Efficiency (PE)

$$PE = RE \times SE$$

Quality Rate

- Quality Rate (Q) is the percentage of good parts out of the total number produced

Overall Equipment Effectiveness

- Overall Equipment Effectiveness (OEE) is improved with fewer breakdowns, quicker repair, improved machine operation, elimination of defects

$$OEE = A \times PE \times Q$$

Six Big Losses

A - Down Time Loss (Availability)

Equipment Failure

- Un-planned Maintenance
- General Breakdown
- Tooling Failure

Setup & Adjustment

- Setup & Changeovers
- Material Shortages
- Operator Shortages
- Major Adjustments

Six Big Losses

B - Speed Loss (Performance)

Small Stops

- Obstructed Product Flow
- Component Jam
- Misfeed
- Delivery Blocked
- Cleaning / Checking

Reduced Speed

- Rough Running
- Operator Inefficiency
- Equipment Wear

Six Big Losses

C - Defects Loss (Quality)

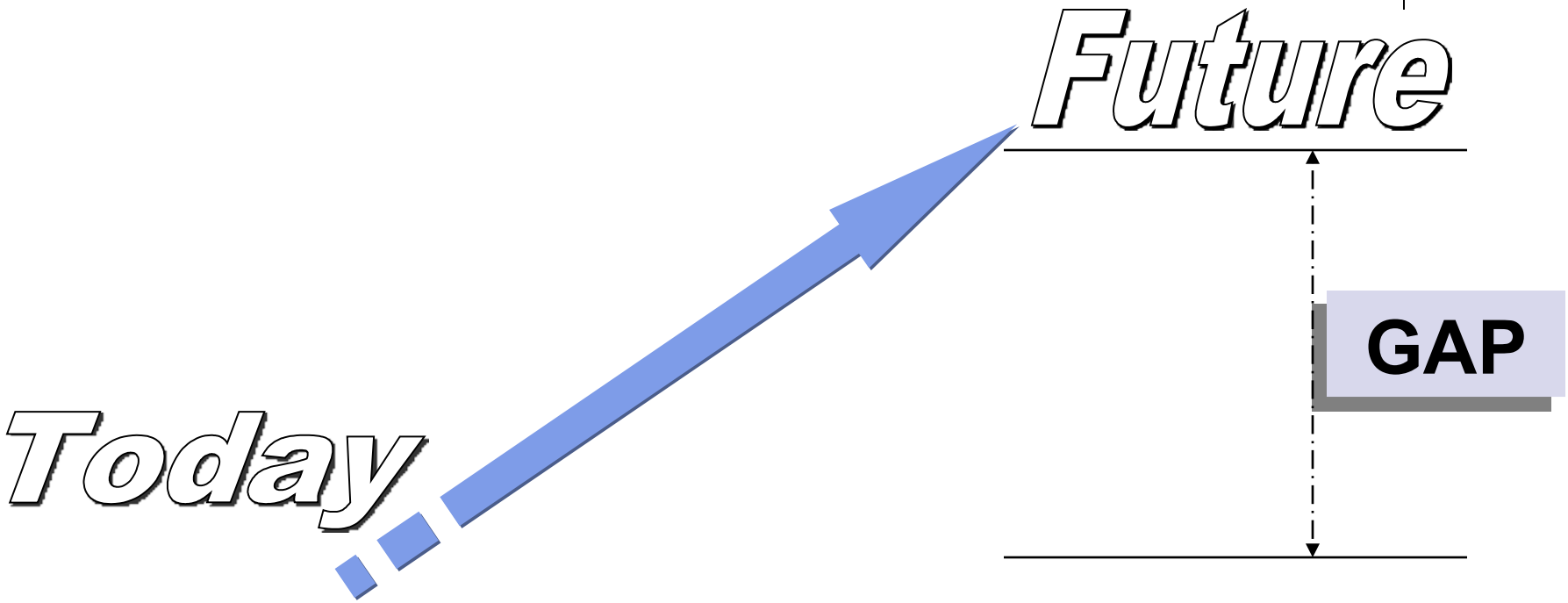
New Setting Reject

- Scrap
- Rework
- In-Process Damage
- Incorrect Assy.

Production Rejects

- Scrap
- Rework
- In-Process Damage
- Incorrect Assy.

Attacking Six Big Losses



GAGE = OEE

Elements of OEE

Overall Equipment Effectiveness =
Availability x Performance x Quality
Yield

Availability = $\frac{\text{Operating Time}}{\text{Total Time Available}}$

Performance = $\frac{\text{Ideal Cycle time x No. of Parts Produced}}{\text{Operating Time}}$

Quality = $\frac{\text{Good Parts}}{\text{Total Parts Produced}}$

Elements of OEE

Diagram of Overall Equipment Effectiveness

		Total operating time		
Availability	A	Net operating time		• *No scheduled production*
	B	Running time	• *Failures* • *Setup*	
Performance	C	Target output		
	D	Actual output	• *Minor stoppages* • *Reduced speed*	
Quality	E	Actual output	**Lost effectiveness**	
	F	Good output	• *Scrap/ rework* • *Startup losses*	

$$OEE = \underbrace{B/A}_{\text{Availability rate}} \times \underbrace{D/C}_{\text{Performance rate}} \times \underbrace{F/E}_{\text{Quality rate}}$$

World Class OEE

OEE Factor	World Class
Availability	**90%**
Performance	**95%**
Quality	**99.9%**
OEE	**85%**

Overall Equipment Effectiveness-- OEE

OEE Is

- A Measure of TPM Progress
- Manufacturing's Contribution to Quality Improvement
- A Method to Identify Opportunities for Improvement

OEE Benefits

- Increased equipment productivity
- Reduced equipment downtime
- Increased plant capacity
- Lower maintenance and production costs
- Approaching zero equipment-caused defects
- Enhanced job satisfaction
- Increased Return On Investment

OEE Example

CNC Machine (GCL 2L) operates in 2 shifts (07 Hrs. per shift) produces BRP – Back Side Final 2000 Pcs. In one month. Downtime averages 120 minutes per day. Daily production averages 200 Pcs. with a 10 % defect rate. The standard time per unit is 225 Sec. (Assume that A, P, and Q are equally weighted.)

Compute OEE ---------->>>

Thank You.