

Total Productive Maintenance (TPM)



Operational
Excellence Consulting
Empowering Sustainable Change

Program Outline

- Overview of TPM
- TPM Foundation: 5S & Visual Management
- TPM Tools
- Equipment Loss & OEE
- 8 Pillars of TPM
- TPM Implementation

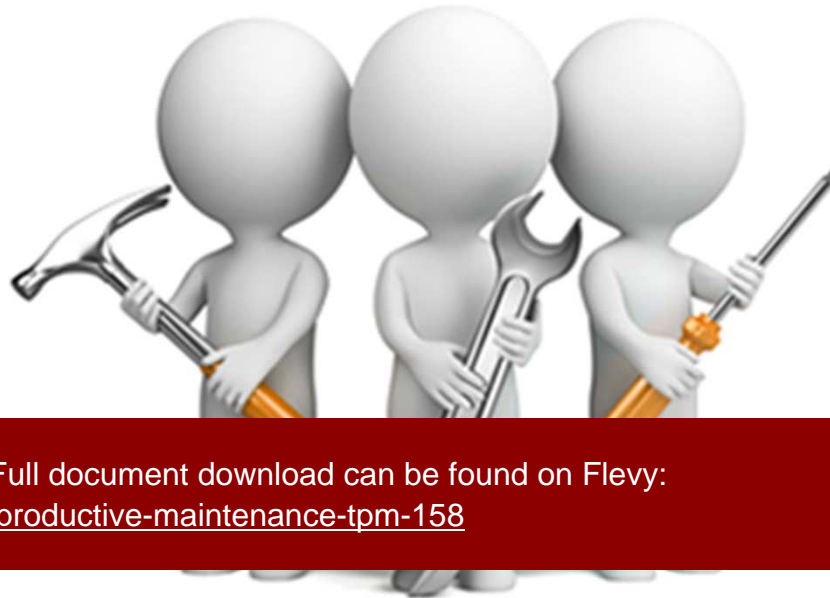
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Critical Success Factors

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What is TPM?

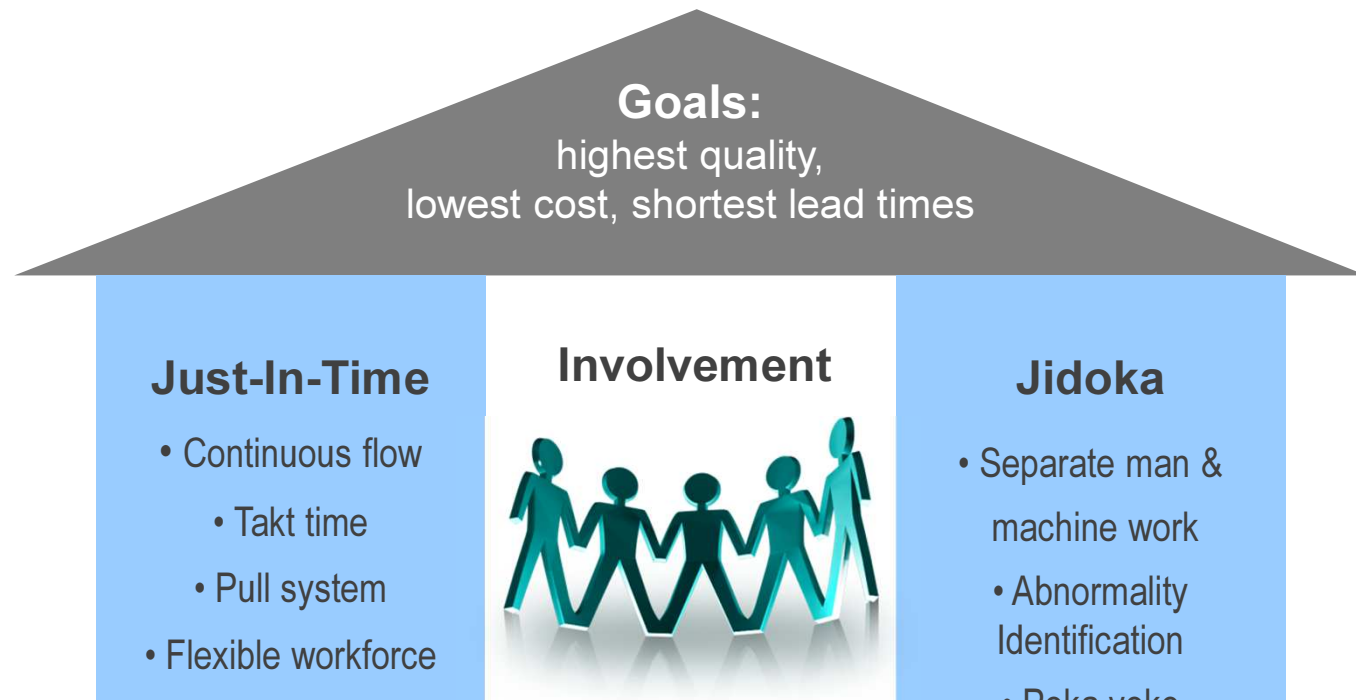
Total Productive Maintenance (TPM) is a method to achieve maximum equipment effectiveness through employee involvement



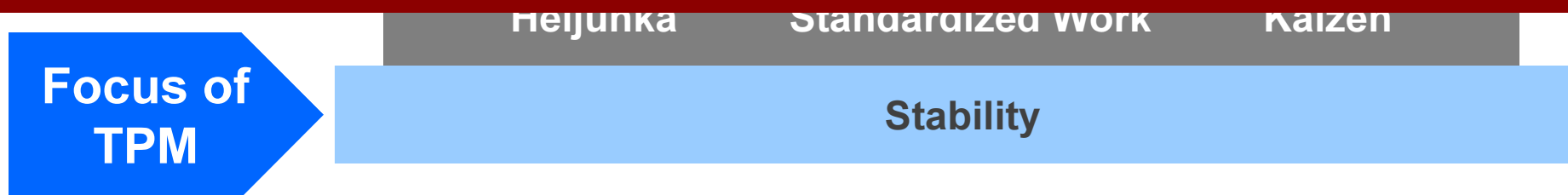
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Management + Operators + Maintenance

TPM provides basic stability for Lean transformation



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TPM Goals



- Maximize equipment effectiveness
- Zero breakdowns
- Zero defects
- Zero accidents

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Zero waste!

TPM Pillars & Activities ²

Pillar	Activities
Quality maintenance	Activities to manage product quality by maintaining optimal operating conditions
Early equipment maintenance	Methods to shorten the lead time for getting new equipment online and making defect-free products
Safety and environmental management	Safety and environmental training; integration of safety checks, visual controls, and mistake-proofing devices in daily work
TPM in the office	TPM implementation in the supporting functions such as HR, Finance, Purchasing, etc.

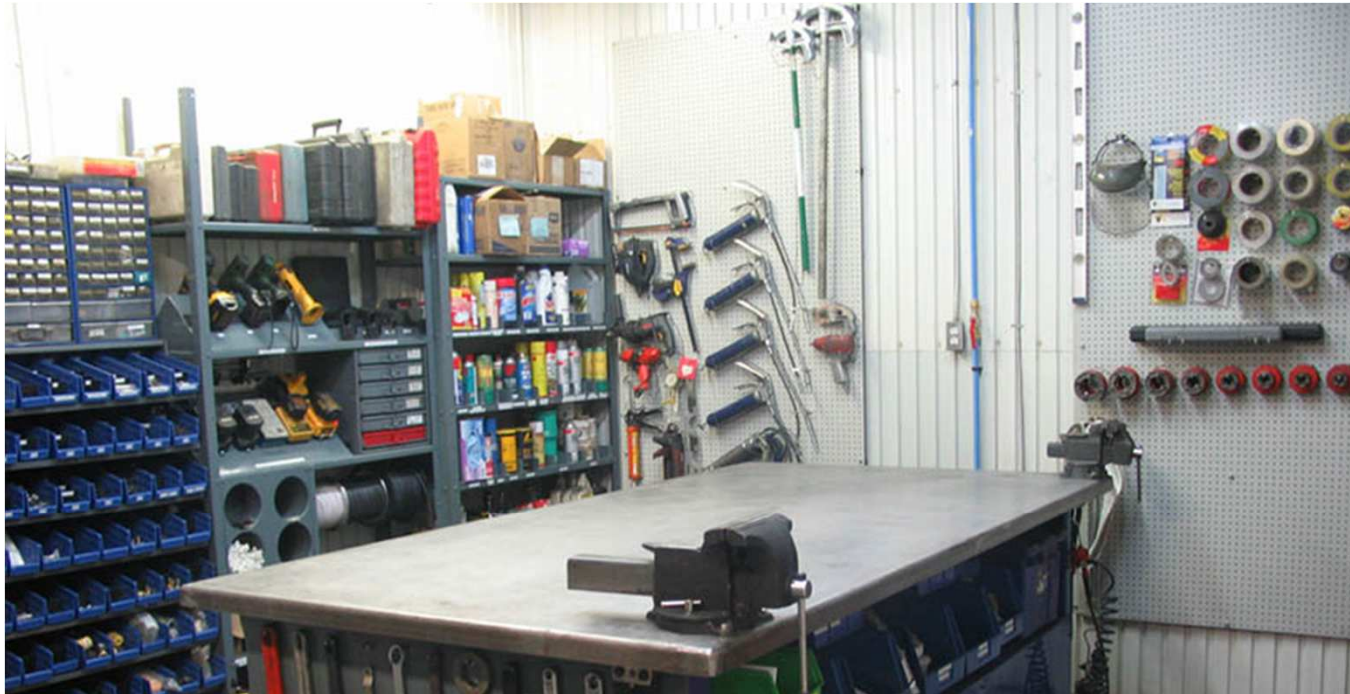
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5S Principles

Principles		General Description
1S	Sort	Remove what is not needed and keep what is needed
2S	Set in Order	Arrange essential items in order for easy access
3S	Shine	Keep things clean and tidy; no trash or dirt in the workplace
4S	Standardize	Maintain a clean workplace
5S	Sustain	Make 5S a habit and teach others to adhere to established standards

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Set in Order: Making things easy to find



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Shine - Check Sheet

- Ceilings
- Aisles
- Workstations
- Corners, under equipment
- Loading docks
- Floors
- Machines
- Conveyance equipment
- Plumbing, sinks
- Cabinets, shelves, racks
- Carts, racks

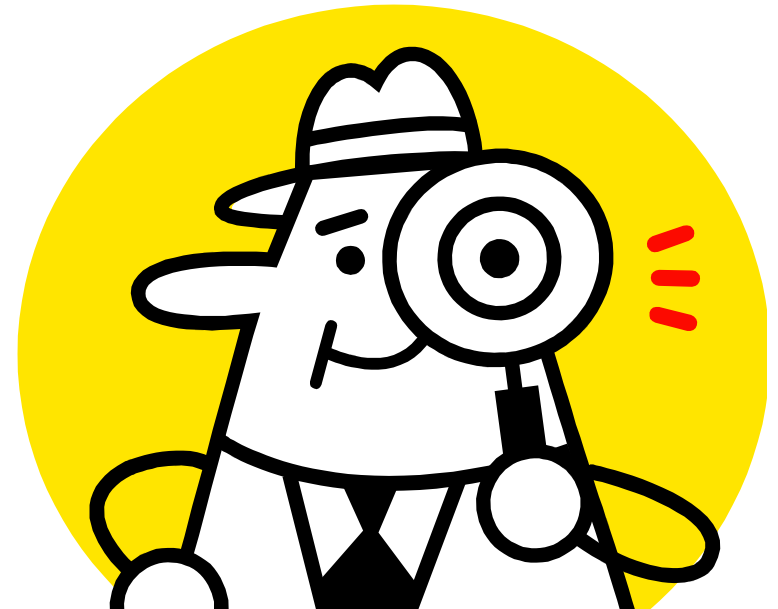
Walls

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- Pillars, posts
- Fixtures, power boxes

5S & Equipment Maintenance ³

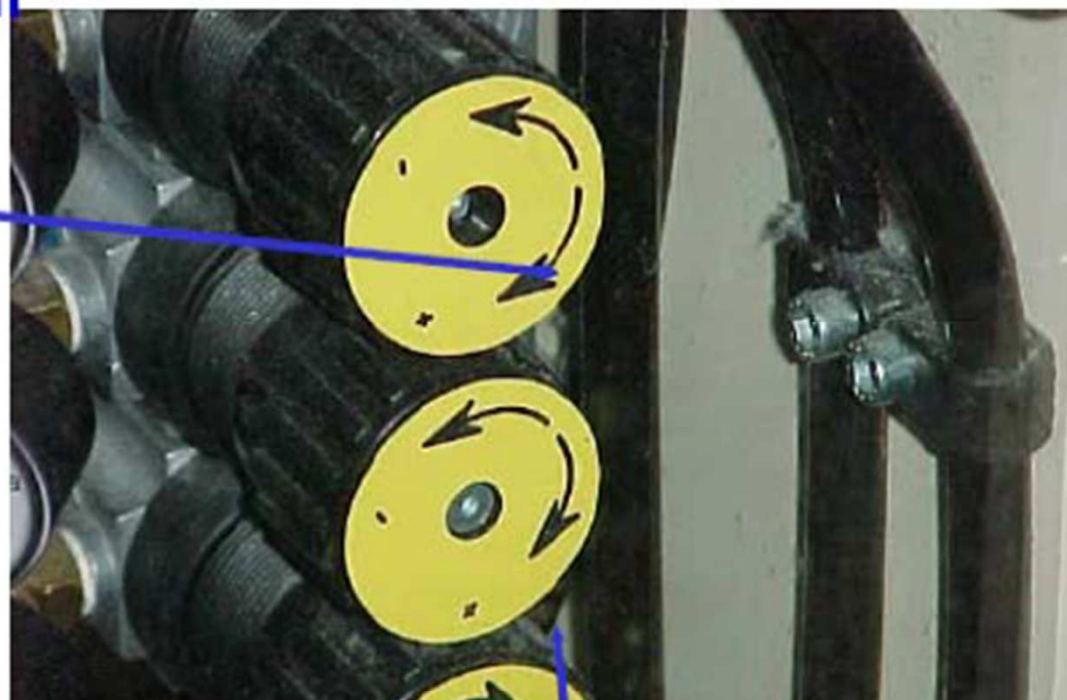
- Train operators to perform simple autonomous maintenance (AM) daily
 - Equipment inspection
 - Cleaning
 - Lubrication



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Example – Visual Controls

Indicates direction
of adjustment



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Visual controls to improve ease of operations

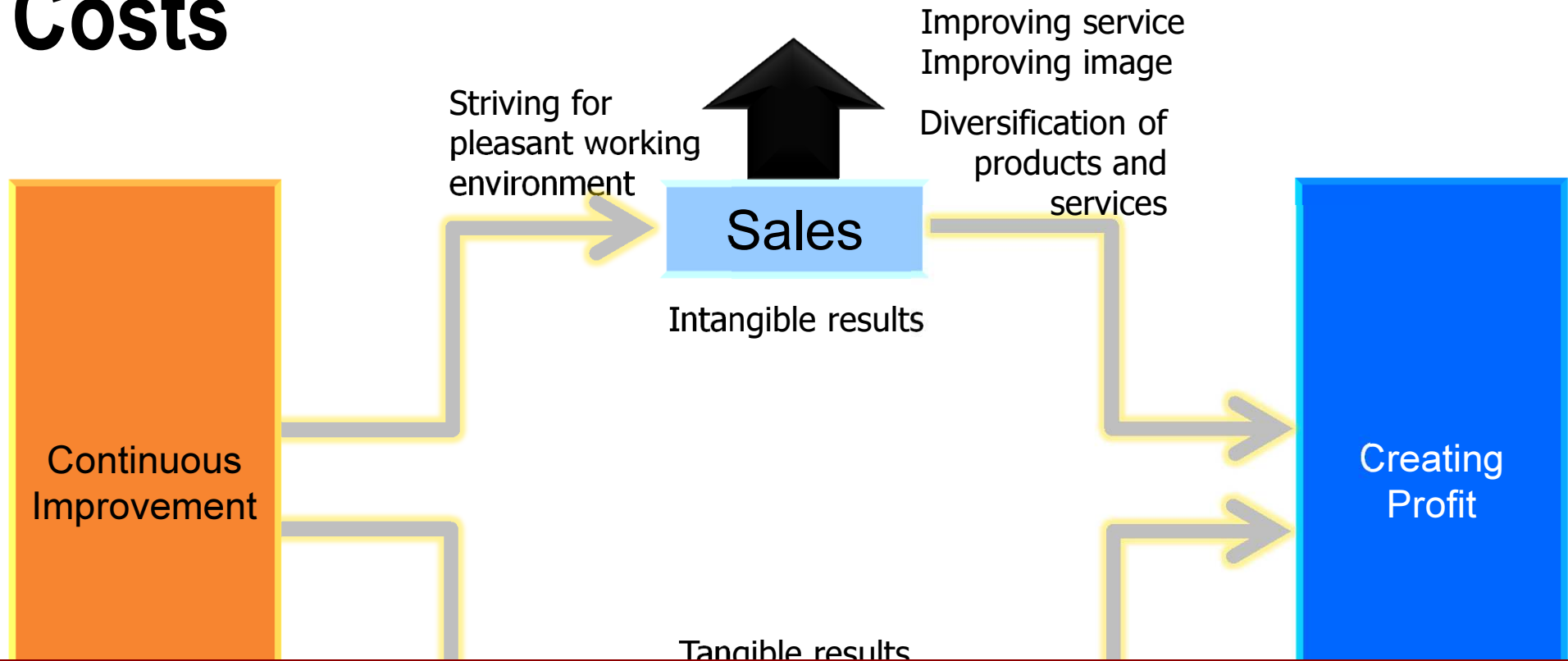
Source: Society for Maintenance & Reliability Professionals

Small Group Activities (SGAs)

- Informal, voluntary small groups to carry out specific tasks, e.g. QC circles, etc.
- For employees at all levels to make incremental improvements
- Use of tools and techniques – PDCA, 5W1H, problem-solving process, Pareto chart, root

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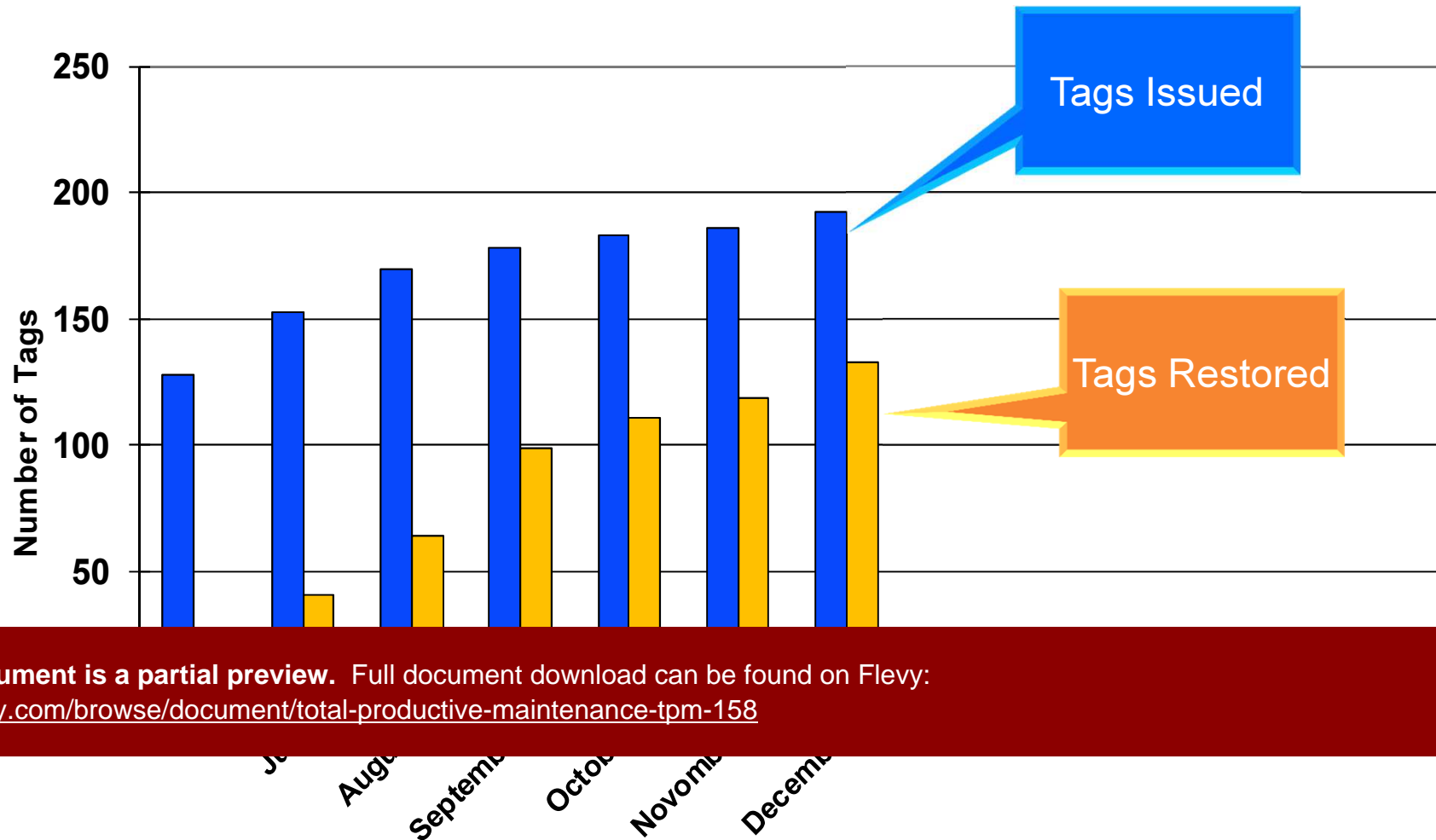
Suggestions to Improve Sales & Reduce Costs



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Source: Kaizen Teian 1 - Developing Systems for Continuous Improvement Through Employee Suggestions

Monitoring Tags



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3 Purposes of One-Point Lesson

1. To help sharpen equipment-related knowledge and skills and communicate information about specific problems and improvement
2. To share important information easily when it is needed
3. To improve the performance of the entire team

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Example: One-Point Lesson


One-Point Lesson is a tool with the following characteristics:

- One sheet...
- To share the results of *autonomous study*...
- For 5-10 minutes

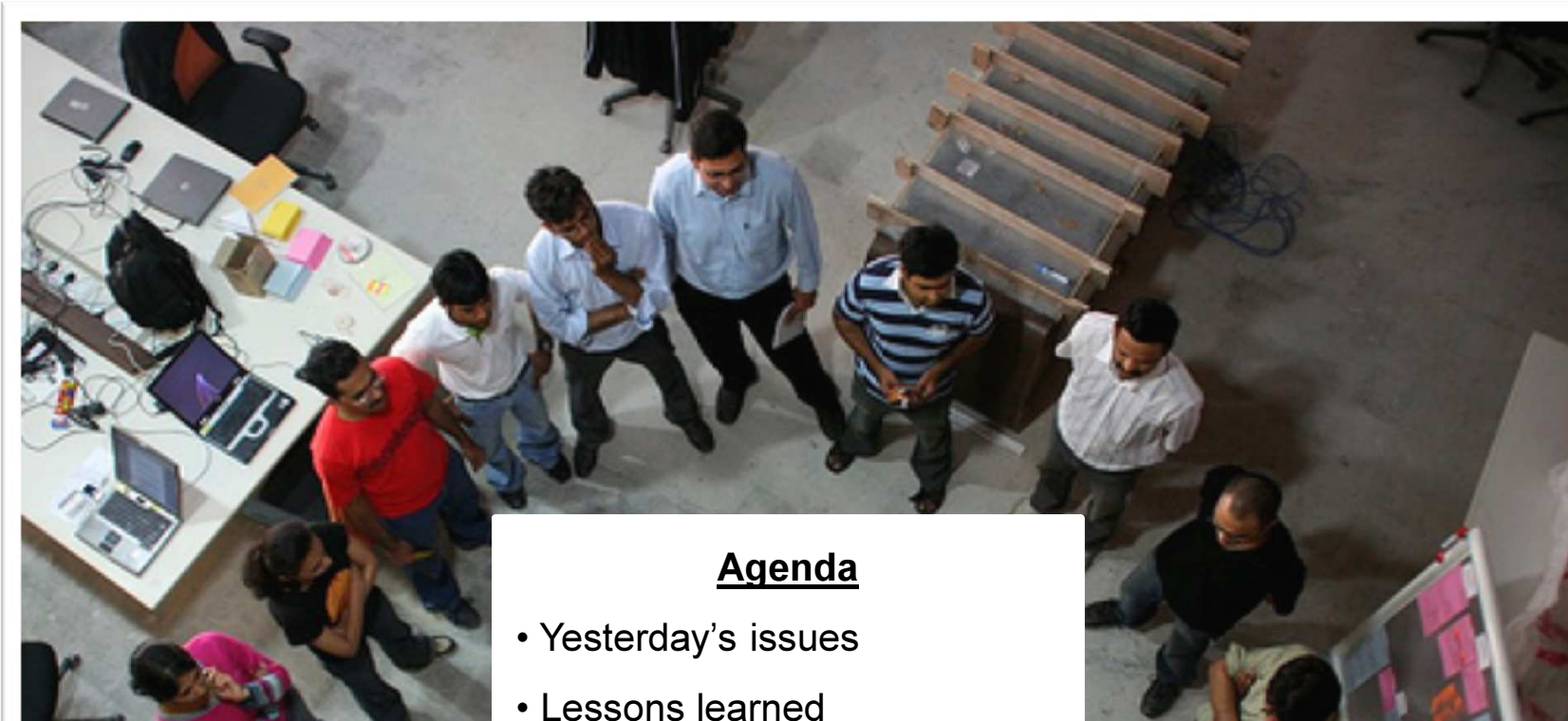
Contents can be knowledge and

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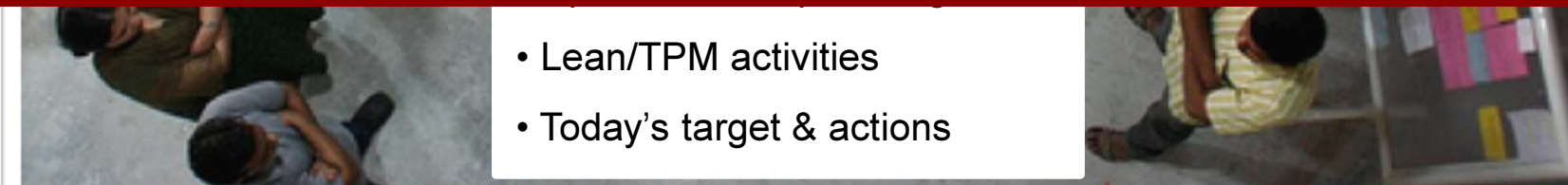
- Safety
- Operation process
- Task

TPM One-Point Lesson							
Subject	Compressed Air Usage For Line #1 & 2			No.		DL4301	
				Date of Creation		November, 2010	
Classification	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Dept. Manager	Super-visor	Team Leader	Created by
	Basic Knowledge	Improvement Example	Trouble Cases	Tom	Mark	Paul	David
				<p>1. Compressed Air may only be used on the Dribbler Scale ONLY</p> <p>2. Scale Area is currently Hard-To-Reach and may</p>			
<i>Don't make a bigger mess!</i>							
Action History	Date Executed						
	Instructor						
	Trainee						

Activity Board & Daily Standup Meetings



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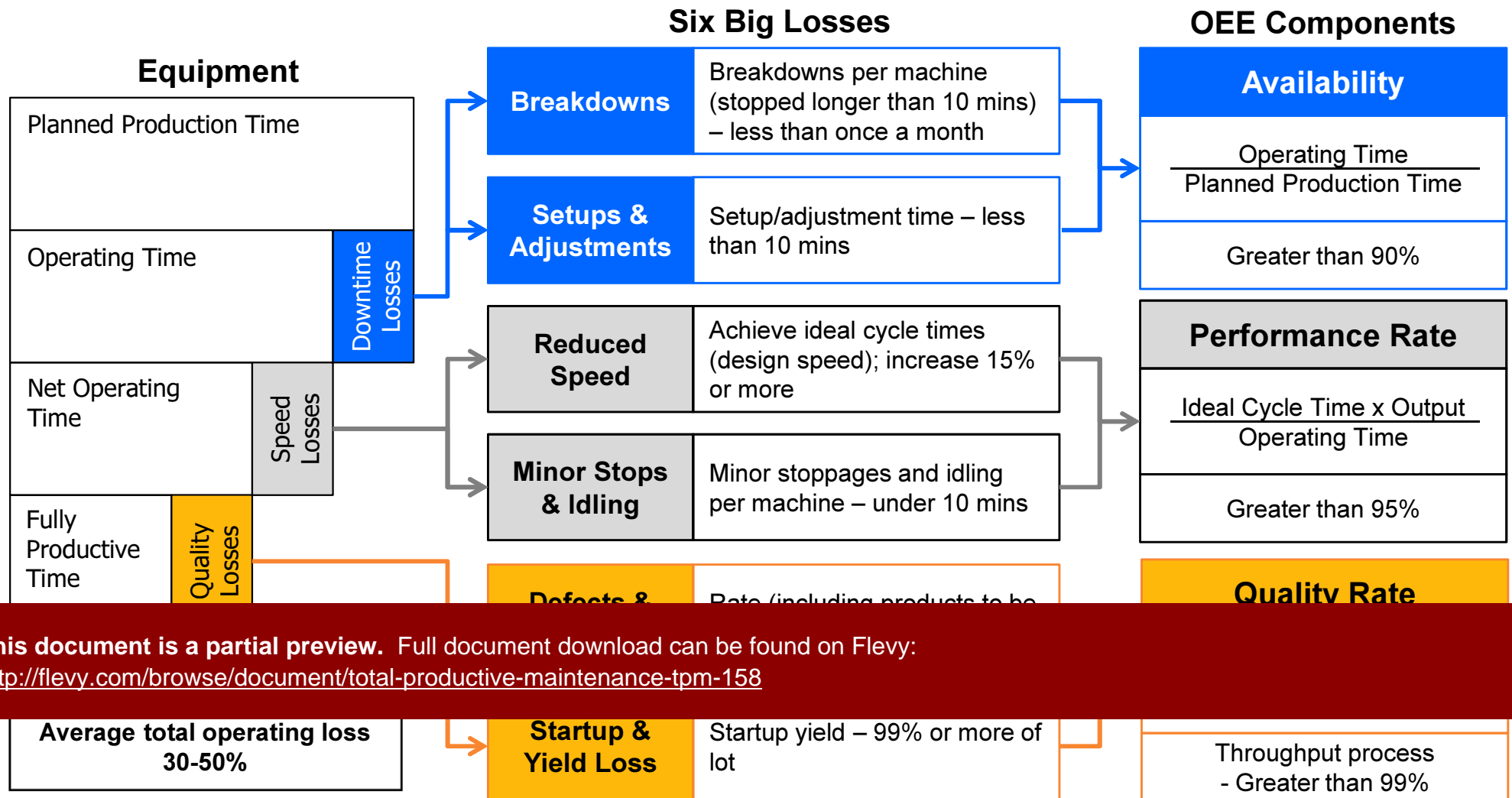


3 Key Components of OEE

Component	TPM Goal	Type of Productivity Loss
Availability	No Breakdowns	Availability takes into account Downtime Loss , which includes all events that stop planned production for an appreciable length of time (typically several minutes or longer)
Performance	No Small Stops or Slow Running	Performance takes into account Speed Loss , which includes all factors that cause production to operate at less than the maximum possible speed when running
Quality	No Defects	Quality takes into account Quality Loss , which factors out manufactured pieces that do not meet
OEE	Perfect Production	OEE takes into account all losses (Downtime Loss, Speed Loss, and Quality Loss), resulting in a measure of truly productive manufacturing time

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Equipment Losses & OEE



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Overall Equipment Effectiveness = Availability x Performance x Quality

Setup & Adjustment Losses

- Caused by changes in operating conditions, e.g. beginning of production runs or start-up at each shift, changes in products and conditions of operation
- These losses consist of setup (equipment changeovers, exchanges of dies, jig and tools), start up, and adjustment

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- Magnitude is measured in **downtime**

Quality Defect & Rework Losses

- Caused by off-specification or defective products
 - Rework
 - Scrap
- Losses consist of labor required to rework the products and the cost of the material to be scrapped
- Measured by the **ratio of quality products to total production**

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order to distinguish from defective products during start-up and adjustment operations

Session 5:

Autonomous Maintenance

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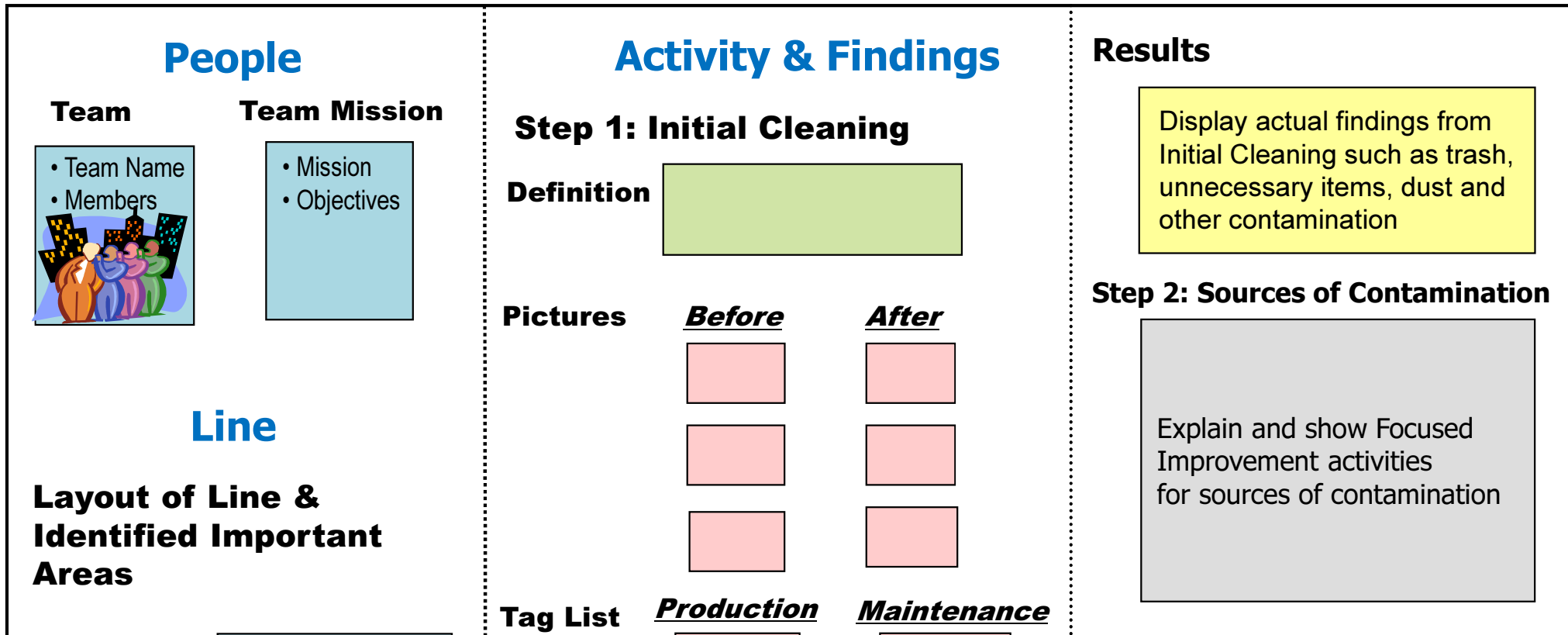


Autonomous Maintenance

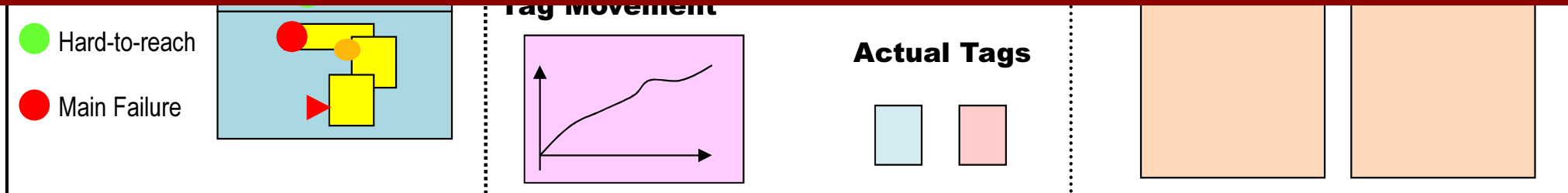
- Policy
 - Uninterrupted operation of equipment
 - Flexible operators to operate and maintain other equipments
 - Eliminating the defects at source through active employee participation
 - Step by step implementation of AM activities

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Example: AM Activity Board



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Step 1 – Clean and inspect

Eliminate all sources of dirt and grime on the machine, lubricate, tighten bolts, and find and correct problems

- Eliminate all dirt and grime on the machine, lubricate and tighten bolts
- Find and correct problems
- Implement the Activity Board and the 4Ms

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Develop countermeasures to this operations as early as possible

When You Find a Problem, Tag It!

- Attach a tag to each problem you expose so that it won't be forgotten
- Fix problems as soon as possible and remove the tag
- Draw up plans for resolving problems that can't

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Step 2 – Key Points to Note

- Make the equipment easier to clean
- Minimize the spread of dirt, dust and grime
- Stop contamination at its source
- Minimize the scattering of cutting oil and debris
- Make the equipment easier to inspect
- Install inspection windows
- Tighten loose areas
- Eliminate the need for oil pans
- Install more oil gauges
- Change the locations of the lubrication inlets

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debris

- Minimize the area through which cutting oil flows
- Simplify wiring and piping layouts
- Make it easier to replace parts

Step 3 – Draw up cleaning and lubricating standards

- Establish a Lubrication Control System
 - What is lubrication control?
 - Preparation by the maintenance department
 - Identify lubricating points and surfaces
 - Allocate routine lubrication tasks
 - Draw lubrication system flowcharts
 - Set tentative lubrication standards

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- Set cleaning and lubrication standards
- Thoroughly implement a color lubrication control system

Step 4 – Conduct general inspections

Conduct skills training with inspection manuals and use general inspections to find and correct slight abnormalities in the equipment.

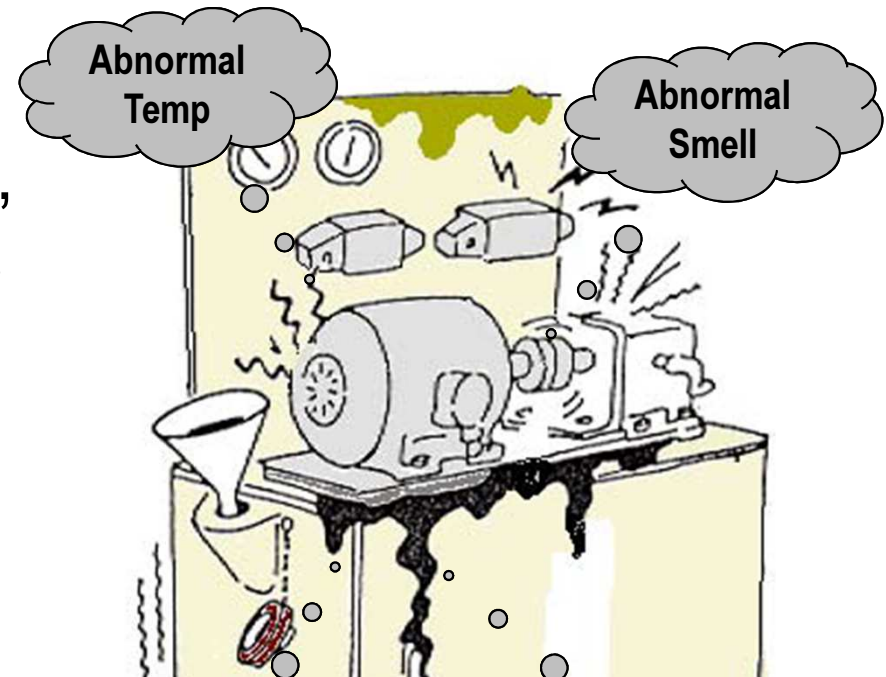
- Train operators in **skills** like pneumatics, electrical, hydraulics, lubricant and coolant, drives, bolts, nuts and safety
- This is necessary to improve the technical skills of operators and to use **inspection manuals** correctly

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- By acquiring the new technical knowledge, operators are now well aware of machine parts

How to Perform Inspection?

- Inspect the conditions of each part of equipment using the human senses of sight, hearing, smell, and touch to detect signs of equipment failure.
- Symptoms of potential problems can include unusual vibrations, noises, abnormal



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heating, or unusual sights, such as smoke, metal chips, or fluid leakage.

Step 5 – Conduct autonomous inspections

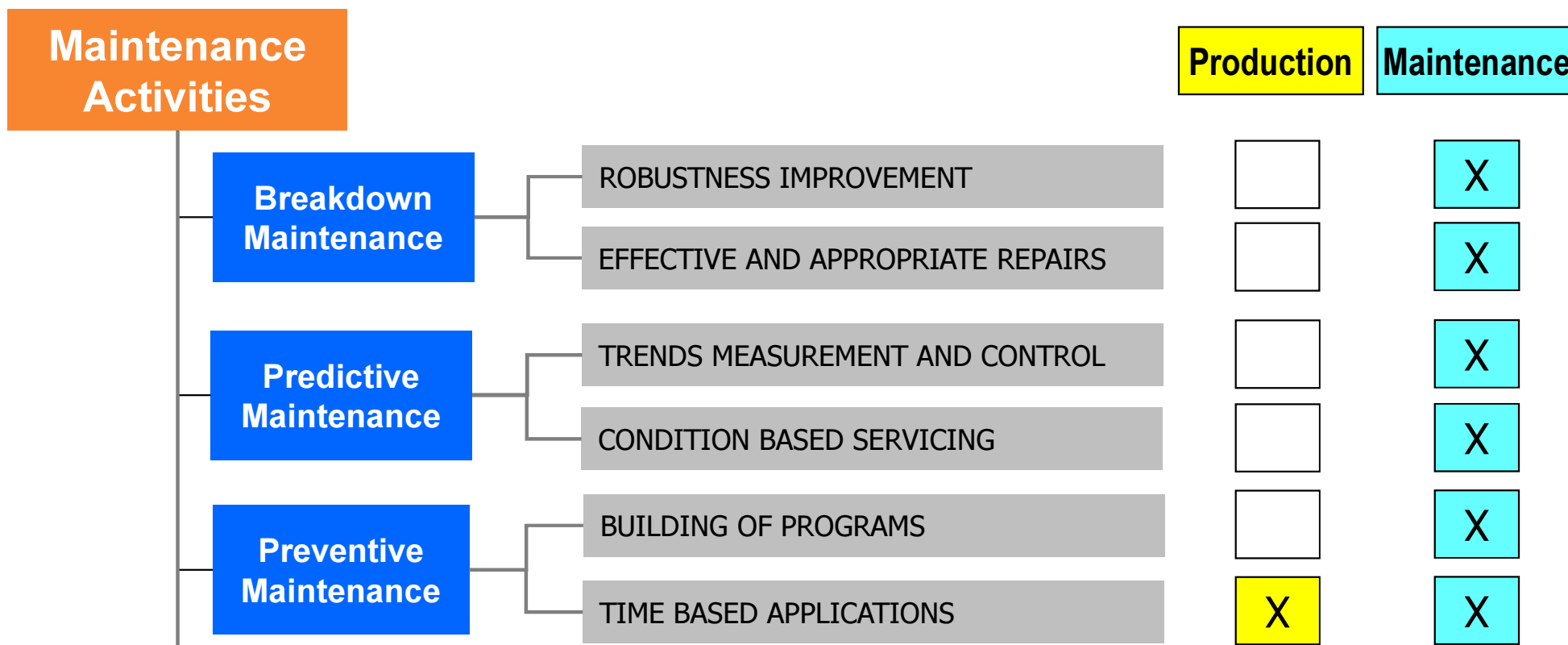
Prepare standard worksheets for autonomous inspections. Carry out the inspections.

- Prepare standard **check sheets** for autonomous inspections
- Define autonomous **chart / schedule** for each operator

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- Use **new methods** of cleaning and lubricating

Example: AM – Who does what?



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Step 6 – Standardize through visual workplace management

- Standardize and visually manage all work processes. Examples of standards needed:
 - Cleaning, lubricating and inspection standards
 - Shopfloor materials flow standards
 - Data recording method standards

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- Tool and die management standards

Step 7 - Implement autonomous equipment management

- Develop company policies and objectives
- Keep reliable MTBF data, analyze it and use it to improve equipment
- Make improvement activities part of everyday practice

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for Kaizen activities

Key Implementation Points of AM

1. Proper education and training
 - a. Are the operators certified?
 - b. Who certifies them?
2. Development of four equipment-related skills
3. Establishment of AM schedule for each operator
4. Autonomous management using activity board and meeting

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6. Participation in problem solving and OEE improvement

Difference between Reliability & Availability

- **Availability**

- An operations parameter
- For example, if the equipment is available 85% of the time, we are producing at 85% of the equipment's technical limit
- Usually equates to the financial performance of the

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- Availability is measured as: $\text{Uptime} / \text{Total time (Uptime + Downtime)}$

Planned Maintenance

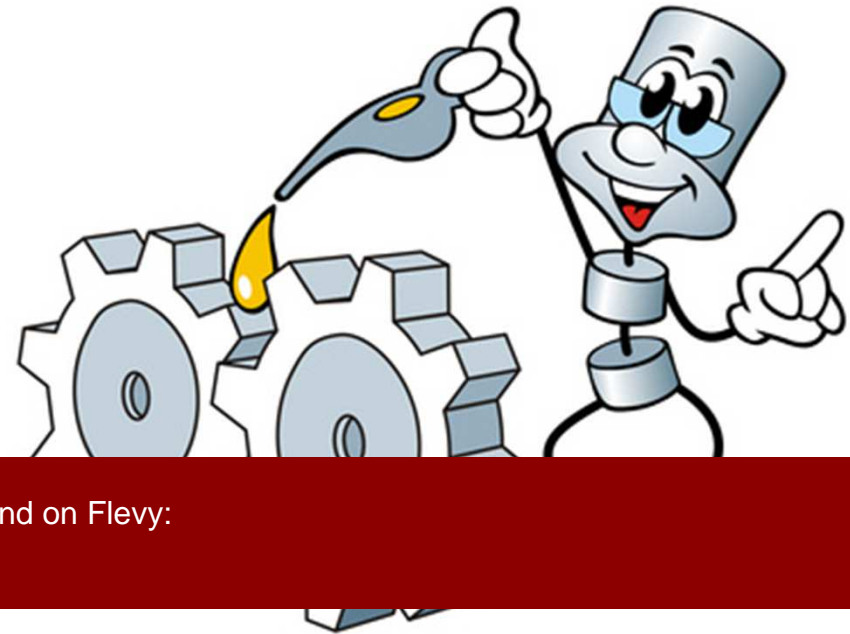
- Policy
 - Achieve and sustain **availability** of machines
 - Optimum maintenance cost
 - Reduces spares inventory
 - Improve reliability and maintainability of machines

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Planned Maintenance

- How to achieve the natural life cycle of individual machine elements
 - Correct operation
 - Correct set-up
 - Cleaning
 - Lubrication
 - Retightening



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minor defects

- Quality spare parts

How to develop a preventive maintenance system

1. What are the possible failures?
2. Which of these failures are significant? (FMEA)
3. How can we avoid these failures?
4. When we can't avoid failure, how can we get an early warning?

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6. Collect the results of the tests for analysis and decision making

6 Steps of Planned Maintenance

1. Evaluate and record present equipment status
2. Restore deterioration and improve weaknesses
3. Build information management system
4. Prepare time-based data system, select equipment, parts, and team, and make plan

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Introducing equipment diagnostic techniques

6. Evaluate planned maintenance

Focused Improvement

- Aims at **reducing losses** in the workplace that affect efficiencies
- Make **continuous improvements** in small steps
- Uses a special **event approach** that focuses on improvements associated with machines and is linked to the application of TPM

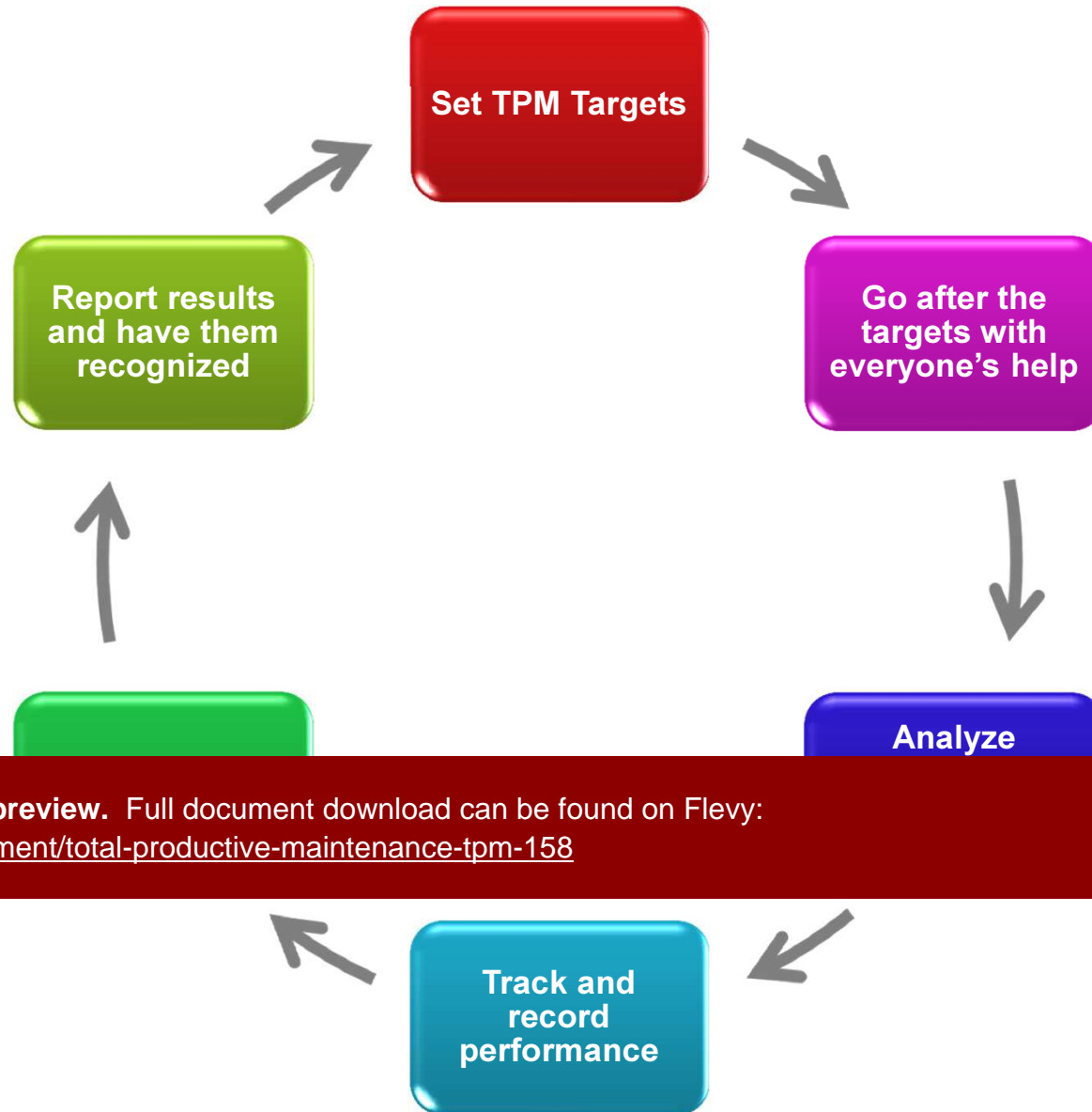
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Focused Improvement - Target

- Achieve and sustain zero losses - OEE
 - Unplanned downtimes
 - Minor stops
 - Measurement and adjustments
 - Defects
- It also aims to achieve 30% manufacturing cost

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Improving OEE Through Kaizen Event



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Session 8:

Other TPM Pillars

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Education & Training

- Training schedule for multi-skilling
- 2 major components
 - **Soft skills training:** how to work as teams, diversity training and communication skills
 - **Technical training:** e.g. upgrading problem-solving and analytical skills (Focused Improvement) and equipment-related skills (Planned Maintenance)
- Training on use of visual controls and one point lessons

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- Train operators in “know-how” and “know-why”

Early Equipment Management

Objective: To minimize the Life Cycle Cost of equipment by improving the design of new equipment

- Benefits
 - New equipment reaches planned performance levels much faster due to fewer startup issues

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installation

Problems of Poor Equipment Design

- Problems in newly installed equipment:
 - Poor selection of materials at the design state
 - Errors occurring during fabrication of the equipment
 - Installation errors
- Poor communication between Engineering, Production and Maintenance departments

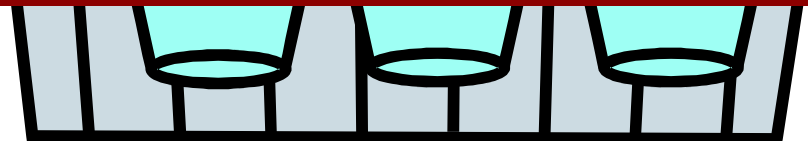
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Quality Maintenance

- Quality rate has a direct correlation with:
 - Material conditions
 - Equipment precision
 - Production methods
 - Process parameters



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Prerequisite for Quality Assurance

- Operator's roles
- Materials to be handled by operators
- What is proper operation?
- Learn quality control methods

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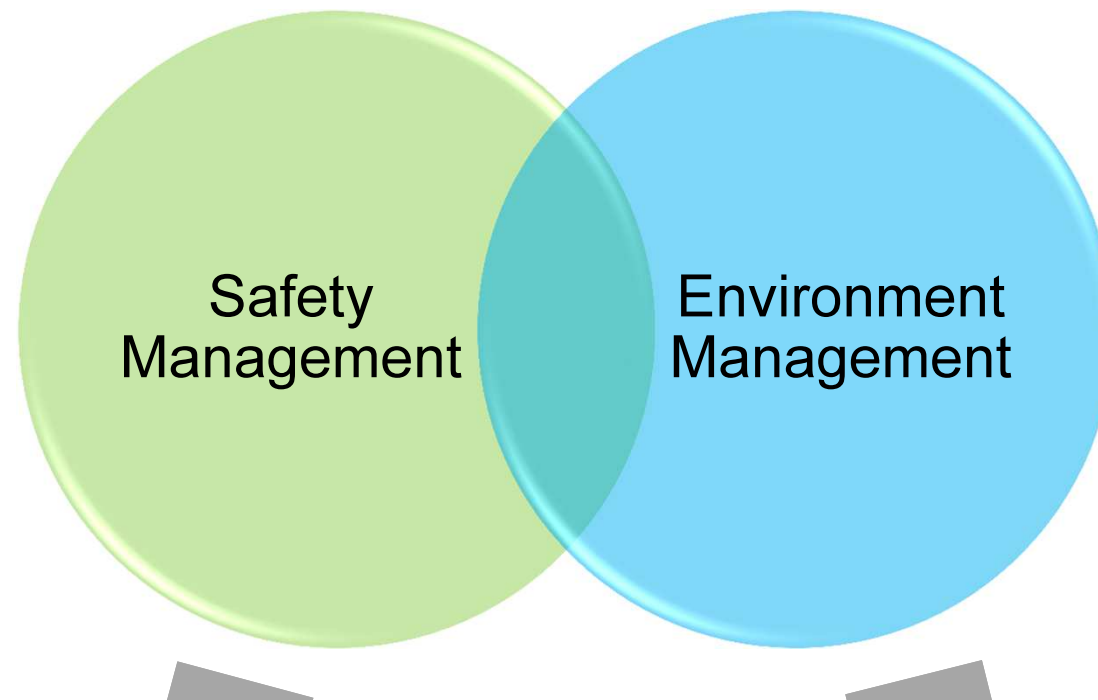
How to Start Office TPM ?

- Lead by a senior person from one of the supporting departments
 - Providing awareness about office TPM to all support departments
 - Helping them to identify P, Q, C, D, S, M in each function in relation to plant performance
 - Identify the scope for improvement in each function
 - Collect relevant data

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- Make up an activity board where progress is monitored on both sides - results and actions along with Kaizens
- Fan out to cover all employees and circles in all functions

Safety & Environment Management



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Zero Accident
Zero Injury

Zero Pollution
Zero Waste

Steps for Safety & Environment Management

- **Step 1: Collaboration with Other Pillars**

- **Pillar 1 “Focused Improvement”:**

- Identify and solve any ergonomic problems to the operators
- Alignment to ISO14001 and ISO18001

- **Pillar 2 “Autonomous Maintenance”:** Zero dangerous objects and clean work place

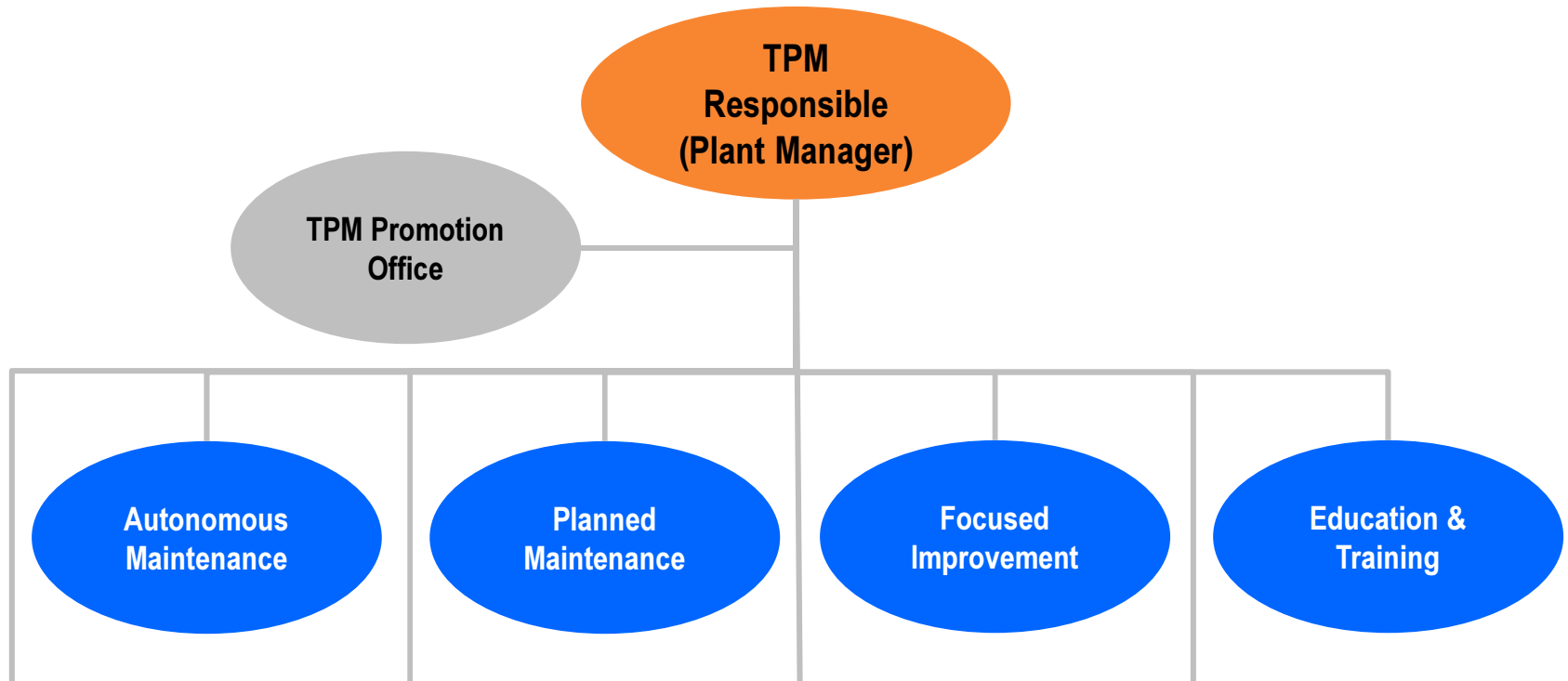
- **Step 2: Accident/Danger Zone Map**

countermeasures

- **Step 3: Routine Safety Patrol by Plant Manager**

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Example of TPM implementation structure



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Management

Maintenance

Management

TPM

How to Sustain TPM

- Engaging employees
- Aim for early success
- Providing active leadership
- Share success stories
- Rewards and recognition

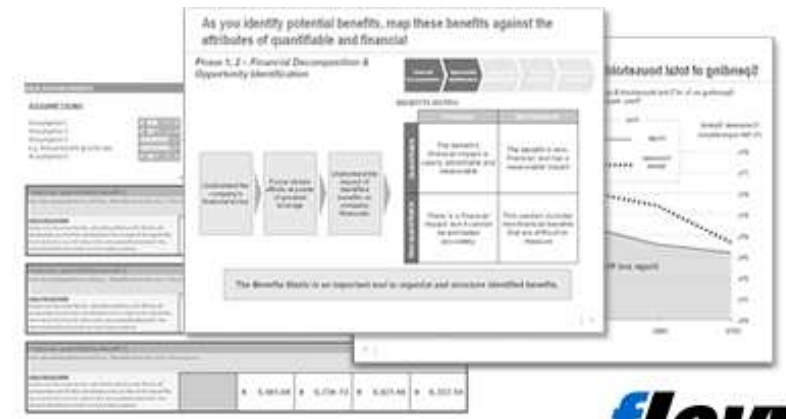


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- Evolving the TPM initiative over time and integration with Lean

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