Autonomous Maintenance
TPM & Autonomous Maintenance

I run it, you fix it!

I fix it, you run it!
What is Maintenance?

Why is “Possible Utilization Rate” Necessary?

One way to look at Lean (JIT) production is to compare it to the body’s circulatory system, in which blood flows to the various organs “just-in-time” to be used. Just as the factory (hospital) handles large and small parts for its products, so too does the body have its large arteries and small veins and capillaries.

In Lean (JIT) production, however, any delay in the flow of small parts (in the “veins” of processing sub-line) soon stops the flow of the large parts (in the “arteries” or main production line).

To prevent such problems, Lean (JIT) production vitally depends on maintaining a condition of zero breakdowns. This makes proper maintenance an essential part of (JIT) production. That is why it is more important to maximize the equipments “possible utilization rate” (the availability of functioning equipment) than to raise its capacity utilization rate. People need to know the equipment will be in working order whenever they need it.

The key to achieving zero breakdowns is not maintenance in terms of repairing broken down equipment, but rather “preventative maintenance” that treats the causes of breakdowns before the breakdowns actually happen.

Hiroyuki Hirano
4 Types of Maintenance

• Preventative Maintenance: routine maintenance to maintain the basic equipment conditions, replace deteriorating parts, and maintain equipment in on-spec condition. It is carried out at predetermined periods, to ensure equipment reliability.

• Predictive Maintenance (condition-based): corrects equipment deterioration by condition monitoring and machine diagnosis and helps detect impending problems before they occur.
4 Types of Maintenance

• **Breakdown Maintenance** (reactive): corrects equipment deterioration after the occurrence of a breakdown.

• **Autonomous Maintenance**: Process by which equipment operators accept and share responsibility (with Maintenance) for the performance and health of equipment.
The Six Big Losses of Machine and Equipment Availability

- Planned Availability
  - Reduced Yield
  - Unusable Output
  - Speed Reductions
  - Usable Condition
  - Minor Stoppages
  - Setup & Adjustment
  - Equipment Failure

- Actual
  - Quality Losses
  - Speed Losses
  - Usage Losses
  - Downtime Losses

- Lost Productivity
  - Heap of Lost Productivity

Downtime Losses:

- Setup & Adjustment
- Equipment Failure
The Real Losses of Machine & Equipment Non-Availability

We must make up these losses.
That means:

- **Overtime**
  - (lost weekends)
- **Running Bigger/Larger Batches**
- **Accidents and Injuries**
- **Delays**
  - (work faster)
- **Somewhere to store the extra inventory**
- **Putting it into racks.**
- **Taking it out of racks.**
- **Overproduction**
  - It means buying bigger, faster, more expensive equipment so we can run faster after we fix it!
- **Increased wait time**
- **Frustrated Staff and patients**
- **(lost weekends)**
Detecting And Responding To Abnormal Conditions

Reacting
Detecting Equipment Failures
Production Stoppages
Quality Problems

Continuous Improvement
Detecting Conditions that lead to equipment failures
Deformation
Misalignment
Over-Heating
Vibration
Excessive wear

Responding
Detecting Conditions that lead to equipment failures
Corrosion
Leaks
Dust, Dirt, Grime

Prevention
Preventing Conditions that lead to equipment failures
Lack of lubrication

MACHINE BROKEN.
FIX IT.
MACHINE NOT 100%.
FIX IT.
KEEP MACHINE AT 100%.
MAINTAIN IT.
Stages on the Path to Equipment Breakdown

• **Stage 1: Latent minor defects**
  Though difficult to see or hear, the machine’s rotating and moving parts are operating under increasing friction and its fastened parts are getting a little looser. These and other subtle defects characterize the first stage of equipment deterioration.

• **Stage 2: Apparent minor defects**
  The same defects described in the first stage have now become somewhat noticeable to the eye or ear. In addition, the machine may be vibrating more, making more noise, and leaking small amounts of oil, water, or air. But none of these defects are major enough to impair the machine’s functioning.

• **Stage 3: Performs below expectations**
  At this stage, it has become difficult to get the machine to perform with the desired precision and within the specified tolerances. The machine is turning out products with varying quality or not performing as specified, and suddenly it needs more adjusting than it use to require. It can no longer keep up with quality standards and is producing lower yields or performance expectations.
Stages on the Path to Equipment Breakdown

• **Stage 4: Stops Intermittently**
  At this stage, the machine has to be shut off fairly often to make adjustments to bring the functioning and product quality back into line. The machine frequently turns out sub par results, but can be usually started up again after making simple adjustments and repairs.

• **Stage 5: Stops or Breaks Down**
  At this final stage, the machine functions so poorly that it stops itself, which is to say it breaks down.

  We should keep in mind that machines usually break down due to deterioration, and these kinds of breakdowns never happen all the sudden; they happen in stages. One or more machine’s deteriorating parts are left to deteriorate and eventually this deterioration accumulates or combines in a simple or complicated way to cause a breakdown.

  If we respond to deterioration only when it reaches the fifth stage, we will have to deal with various machines that are currently at the other four stages in the path. In other words, we cannot hope for a true reduction in breakdowns until we work our way up the path and treat deterioration before it results in breakdowns.
## Maintenance and Safety Stages

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Machines breakdown frequently. Accidents are common</td>
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<tr>
<td>2</td>
<td>Fixing machine breakdowns is always left to maintenance staff. Accidents occur occasionally</td>
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<tr>
<td>3</td>
<td>Thorough maintenance and repairs are done after breakdowns occur. Major accidents rarely occur.</td>
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<tr>
<td>4</td>
<td>Thorough preventative maintenance is practiced. Major or minor accidents rarely occur.</td>
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<td>5</td>
<td>Hospital-wide maintenance activities are practiced. No machine breakdowns or accidents occur.</td>
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What is TPM
Five Main Points

1. An innovative approach to maintenance that optimizes equipment effectiveness through continuous improvement of product and service processes

2. Establishes a world class reliability based maintenance system utilizing proactive, predictive, and preventative maintenance practices focusing on the entire equipment life cycle.

3. Requires buy in at every level of the organization. Executive to middle management to frontline teams working together

4. Coordinates all departments and requires the participation of vendors, (engineers) operators, and maintenance personnel

5. Promotes and implements team-based activities aimed at the organization-wide goal of zero defects and zero breakdowns.
3 TPM Principles

1. Operators perform maintenance functions for which they have been trained, that do not require skilled maintenance persons.

2. Skilled maintenance persons train equipment operators in equipment maintenance functions.

3. Maintenance personnel move from the “fire-fighting” mode to the prevention mode.
TPM Benefits

• Sharpens the employees equipment related knowledge and skills.

• Improves internal communications.

• Provides a basis for training and team unity

• Establishes an equipment base line.

• Allows easy audit and diagnosis.

• Controls process and equipment variability.
Why do you need a TPM Program?

• To make effective use of your human resources
• To eliminate unscheduled downtime
• To meet quality and regulatory certification requirements
• To increase equipment efficiency
• To avoid reactive crisis management
The Role of Maintenance in TPM

• Provide technical support and training for autonomous maintenance done by operators

• Restore equipment to like new condition

• Identify design weaknesses and improve equipment to error-free function

• Improve the technical skills of all maintenance team members through training, teamwork, and work assignments
The Role of Maintenance in TPM (continued)

• Implement a reliability based maintenance system established upon data from equipment manufacturers and equipment operators

• Through the use of data analysis, predictive maintenance, and diagnostic non-intrusive tests, perform appropriate maintenance to avoid equipment failure
The Role of Maintenance in TPM (continued)

• Maintain a work order system and equipment data base to monitor and support continuous equipment improvement

• Ensure that maintenance is treating root cause and not the symptom

• Understand the product and service process and be able to operate the equipment to successfully achieve the above goals
What is Autonomous Operator Maintenance?

- Autonomous maintenance is a phrase coined to clarify the shift to operators participating in maintaining their own equipment

AM is....
- Work area based
- Operator Conducted
- Operator Enhancing
- Team Activity
- TPM Foundation
- Part of the Job

- There are seven fundamental steps to Autonomous maintenance
The Seven Steps of Autonomous Maintenance

- Step 1: Clean and inspect
- Step 2: Eliminate cause of machine stoppage and inaccessible areas
- Step 3: Establish cleaning and lubrication standards
- Step 4: Conduct general inspections, verify standard operating conditions
- Step 5: Conduct autonomous inspections after operators are trained on equipment function and parameters for good operation
The Seven Steps of Autonomous Maintenance

• Step 6: Standardize and visually manage all work processes, i.e. lubrication, inspection, and cleaning standards, data records, spare parts and tool management.

• Step 7: Implement autonomous equipment management, develop company policies and objectives, keep reliable data and improve equipment

• Measure Results:  
  Zero Breakdowns  
  Zero Defects  
  Zero Lost Time Accidents
Autonomous Maintenance Workshops

8 Steps of Implementation

• Step 1: Establish workshop baseline
• Step 2: Energy Awareness
• Step 3: Cleaning is Inspecting
• Step 4: Eliminating Contamination
• Step 5: Visual Management
• Step 6: Equipment / Tool Maintenance
• Step 7: Equipment Lubrication
• Step 8: Consumables
The Spirit of Autonomous Maintenance

• Discard old attitudes
• Think of ways to make new ideas work don’t say “we can’t”, before you even try, don’t accept excuses
• Don’t substitute money for brains
• Correct problems immediately
• Ask “why” five times to get to the root cause
• Improvement is made at the workplace, not in the office
• Ideas from many people are better especially if the people are closer to the problem
• There are no limits to improvement
## Autonomous Maintenance Progress Report

**Workshop Leader:**

**Equipment Description:**

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<tr>
<th>Date:</th>
<th>Work Area:</th>
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<tr>
<th></th>
<th>Start</th>
<th>Target</th>
<th>Day1</th>
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**Visual Controls Identified**

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**Tags Written**

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**Tags Completed**

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**Critical Cleaning Points Identified / Documented**

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**Inspection Points Identified / Documented**

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**Lube Points Identified / Documented**

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**Number of Contamination Sources Identified (ex: oil leak, etc.)**

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**Routes and Processes Documented**

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- Start Up/Shut Down
- Lockout /Tag/Tryout
- Consumable Restocking Plan
- CCI&L

**5S Level**

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**SinglePoint Lessons**

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**Number of Revisions to the PM**

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**CCI&L = Critical Cleaning is Inspecting & Lubricating**
# The Seven Steps of Autonomous Maintenance

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<thead>
<tr>
<th>Step</th>
<th>Process Name</th>
<th>Activities</th>
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<tbody>
<tr>
<td>1</td>
<td>Clean and Inspect</td>
<td>Eliminate all dirt and grime on the machine, lubricate, tighten bolts, and find and correct problems</td>
</tr>
<tr>
<td>2</td>
<td>Eliminate problem sources and inaccessible areas</td>
<td>Correct sources of dirt and grime; prevent spattering and improve accessibility for cleaning and lubrication. Shorten the time it takes to clean and lubricate.</td>
</tr>
<tr>
<td>3</td>
<td>Draw up cleaning and lubrication standards</td>
<td>Write standards that will ensure that cleaning, lubricating, and tightening can be done efficiently. (Make a schedule for periodic tasks)</td>
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<tr>
<td>4</td>
<td>Conduct General Inspections</td>
<td>Conduct skills training with inspection manuals and use general inspections to find and correct slight abnormalities in the equipment.</td>
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<tr>
<td>5</td>
<td>Conduct autonomous inspections</td>
<td>Prepare standard checksheets for autonomous inspections. Carry out the inspections.</td>
</tr>
<tr>
<td>6</td>
<td>Standardize through visual workplace management</td>
<td>Standardize and visually manage all work processes. Examples of standards needed:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• cleaning, lubrication, and inspection standards</td>
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<tr>
<td></td>
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<td>• work area material flow standards</td>
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<td></td>
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<td>• data recording method standards</td>
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<td></td>
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<td>• tools &amp; supplies management standards</td>
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<tr>
<td>7</td>
<td>Implement autonomous equipment management</td>
<td>Develop company policies and objectives; make improvement activities part of everyday practice; keep reliable MTFB (mean time between failures) data, analyze it, and use it to improve equipment.</td>
</tr>
</tbody>
</table>
The Vision:

Zero accidents.

Zero breakdowns.

Zero abnormalities.

Perfect quality.

Just-in-time.
Autonomous Maintenance Online Resources

http://www.plantservices.com

http://www.tpmonline.com

http://www.implement-lean-manufacturing.com

http://www.amazon.com/Autonomous-Maintenance-Seven-Steps-Implementing