

# *Reliability Engineering*

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## *Reliability Engineering*

- What is Reliability Engineering?
- Role of Reliability Engineering (Technical Support)
- Reliability Engineering Activities
  - Maintenance Prevention
  - LCC Analysis
  - Proactive Maintenance (FPA, RCFA, Specification for New/Rebuilt Equipment, etc.)
  - Capital Equipment Replacement
  - Economic Evaluation/Justification Analysis in R&M Investments
- Other Analytical Techniques for Improvement
- Elements of a Reliability Improvement System

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## *What is Reliability?*

- “The RELIABILITY of an item/system is the probability that the item/system performs a specified function under specified operational and environmental conditions at and throughout a specified time.” Quantitatively, reliability is the probability of success. Usually expressed as Mean Time Between Failures (MTBF)
- “A collection of planned activities (established through formal and informal management systems) that are effectively working together to prevent loss of system function.”

This second definition is a managed approach to maintain the reliability of system functions. Both definitions refer to the system and maintaining the functionality of the system

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## *Definitions*

- Maintainability: The ability of an item, under stated conditions of use, to be retained in, or restored to, a state in which it can perform its required function(s), when maintenance is performed under stated conditions and using prescribed procedures and resources. Expressed as Mean Time To Repair (MTTR).
- Availability: Is the probability that a system is available for use at a given time- a function of reliability and maintainability. It is operating time divided by load time, which is the available time per day minus the planned downtime
- Failure: The termination of the ability of an item to perform its required function.

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## *Inherent Availability*

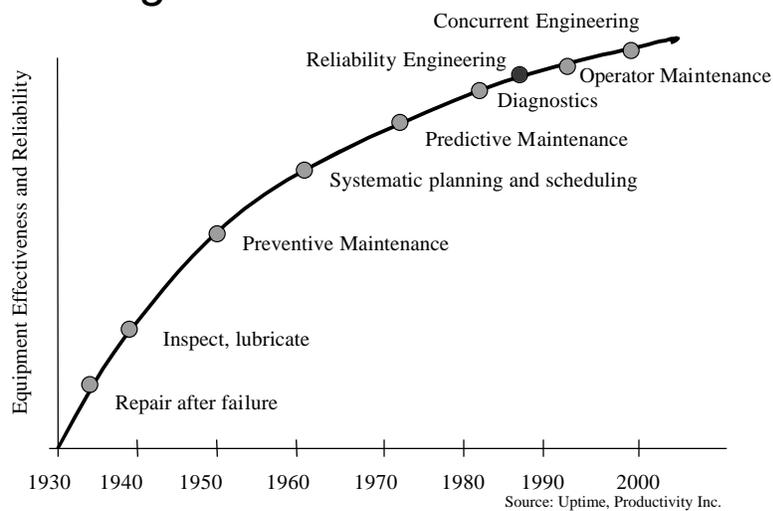
$$A_i = \frac{MTBF}{MTBF + MTTR}$$

Inherent availability considers only corrective maintenance in an ideal support environment (with neither administrative nor logistic delays).

When equipment is in a failed state it is no longer available for work, and its reliability decreases. As the length of time in a failed state (downtime ) increases, the maintainability of the equipment decreases.

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## *Emerging Strategies for Maintenance Management*



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## *What is Reliability Engineering?*

- Focuses on eliminating maintenance requirements.
- Utilizes technology analysis to achieve reliability and maintenance task improvements.
- Improves the uptime and productive capacity of critical equipment using formalized problem-solving techniques

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## *Important Aspects of Reliability Engineering*

1. Current knowledge of predictive, analytical, and compliance technologies, and the ability to apply these techniques to add value to the firm.
2. The adaptation and application of concepts such as TPM and RCM.
3. The development and implementation of a proactive M&R plan(s) to eliminate maintenance requirements, minimize the use and costs of reactive maintenance, maximize the benefits of PM and PdM, and achieve increasing levels of integrated asset management.
4. The ability to lead or technically support multidisciplinary teams.
5. During design, advises other engineers on reliability (prediction) for their systems and tactics to improve reliability such as redundancy, parts derating, Failure Mode and Effects Analysis, etc.

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## *Important Aspects of Reliability Engineering (Cont.)*

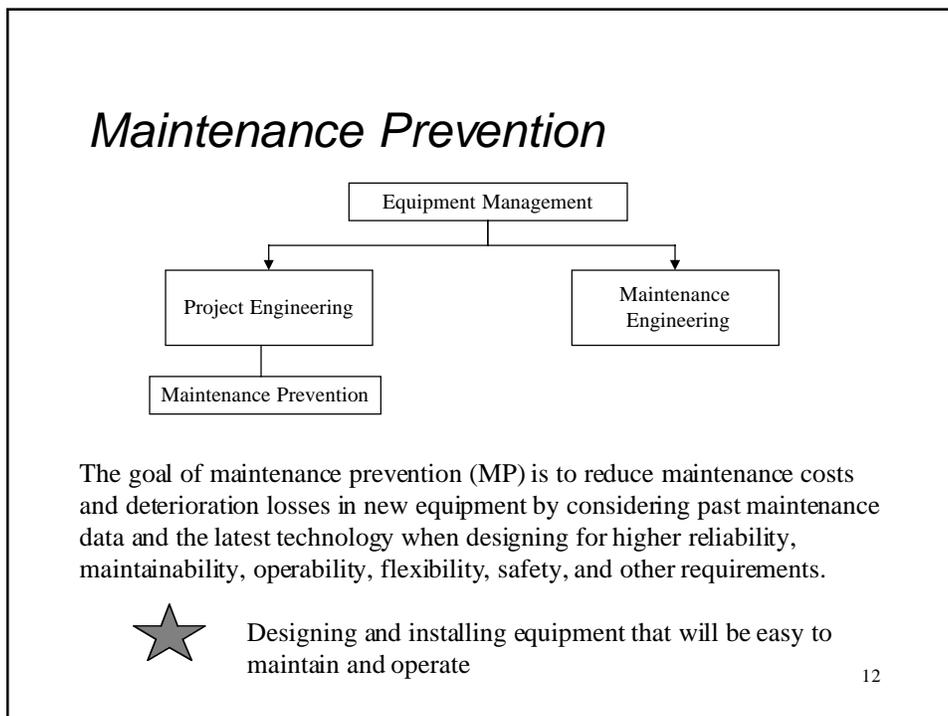
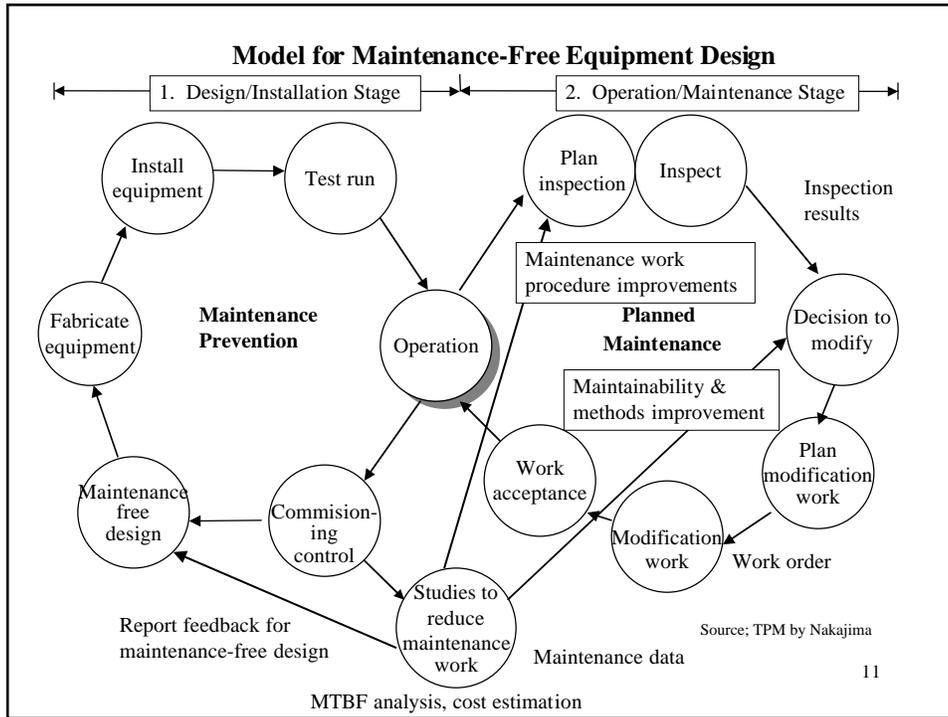
6. During design, participates in trade-off studies among performance, cost, and reliability. Reliability estimates are a key input to Life Cycle Costing (LCC)
7. During development, continues to update reliability predictions and prepares reliability test plans.
8. During pre-production, verifies reliability of subsystems and entire system through various types of testing

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## *What do Reliability Engineers Do?*

- Maintenance Prevention
- Optimizes equipment life-cycle costs by using life-cycle costing (LCC) analysis
- Employs proactive techniques to extend machinery life: Failed-part analysis (FPA) ; Root-Cause Failure Analysis (RCFA)
- Adapts Total Productive Maintenance (TPM), Reliability Centered Maintenance (RCM) and other concepts to the operating environment
- Provides specifications of new/rebuilt equipment
- Develops plans and analysis of capital equipment (and other assets) replacement
- Involvement in the economic evaluation/justification of investments in M&R

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## *MP Objectives*

- Reduce the time taken from the design to stable operation
- Accomplish the transition efficiently with minimum labor and a balanced workload
- Ensure that equipment is designed to be highly reliable, maintainable, economical, operable, and safe
- Minimize future maintenance costs and deterioration losses of new equipment
- MP design process improves equipment reliability by investigating weaknesses in existing equipment and feeding the information back to the designers.

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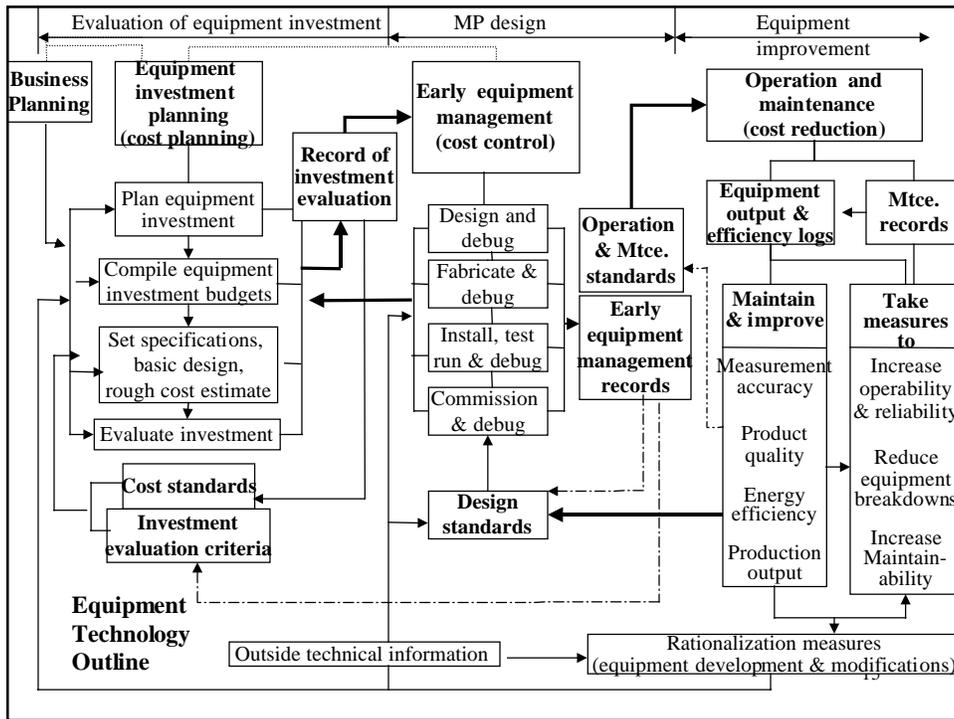
## *Maintenance Prevention (MP)*

Ideally, MP-designed equipment should not break down or produce out-of-spec products. It should be easy and safe to maintain.

MP design activities are subject to the following constraints:

- Technology (production and equipment technology)
- Quantitative and qualitative equipment capacity
- Basic equipment specifications
- Capital budget
- Operating costs (operator labor, raw materials yields, maintenance costs, energy costs, etc.)

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## Maintenance Prevention (MP)

- Maintenance prevention activities are conducted during the stages of:
  - Equipment design
  - Fabrication
  - Installation and test run
  - Commissioning ( establishing normal operation with commercial production)
  - Include debugging at each stage ( detecting and correcting errors and malfunctions)
- Production and maintenance departments must join forces with the design department to form a project centered engineering department.
- What if a supplier is developing your new equipment? How can<sub>16</sub> MP be established under that scenario.

## Maintenance Prevention (MP)

- The team will examine possible problems at each stage of MP design with respect to the following issues:
  - Quality
  - Productivity
  - Operability
  - Energy-saving
  - Cost
  - Maintainability
  - Safety and environment
- Aim is to “front end” load maintenance improvements so that troubles (repairs, inspections, adjustments, lubrication, cleaning, tightening) during start-up and commissioning are minimized.
- Use of standard checklists at each stage

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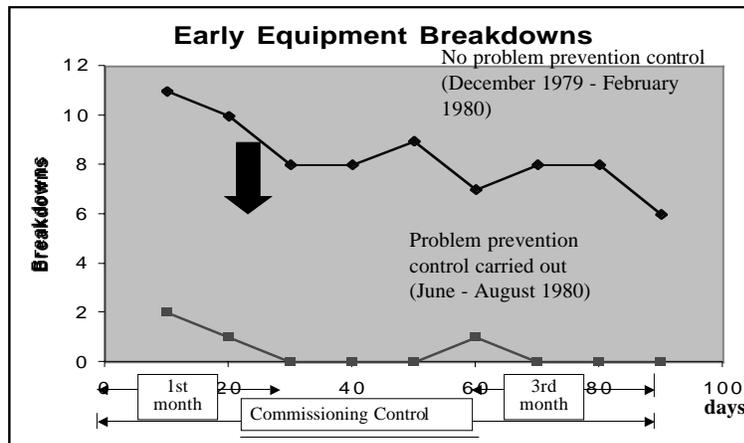
### Example of a Design Checklist (Fuji Photo Film)

Design standard Y-0302
Design Checklist (Preconditions)
1. Tackle the task positively. Use sound technical knowledge and a scientific approach to achieve the best results. 2. Work in active collaboration and cooperation with other departments concerned.
Check Details
<b>I. Planning and design:</b>
1. Do you know the object of the design? (reason, conditions set by originator of design request relevant conditions)
2. Are the design procedures appropriate? (method of execution, completion date, priority schedule planning)
3. Is there satisfactory contact with the originator of the design request?
4. Has the site been thoroughly investigated?
5. Are reference materials adequate? (technical data, introduction of new technology, use of existing technology)
6. Are the most suitable and optimal methods and systems being applied? Has complacency been avoided?
7. Are design calculations error-free? (strength, functions, capacity) Have all problems been fully considered?
8. Are the maintenance prevention considerations adequate? (Was the maintenance department consulted and did they confirm in advance; will they check the design afterward?)
9. Will the design be cost-efficient? (within budget, operating costs) Is operability good; has safety been considered?
10. Has the optical sensitivity of materials been checked? (Has a request for the photographic characteristics test been issued?)
11. Have related departments been contacted? (maintenance engineering, electrical and instrumental, packing engineering, fabrication departments, safety department)
<b>II. Drawings</b>
1. Have the drawings been reviewed? Are they error-free? (dimensions, number of parts, accuracy, materials, procurement of spare parts, use of checklists to prevent design errors)
2. Has microfilming been considered?
3. Have cost reduction checklists been used?
4. Have the drawings been checked and approved?
<b>III. Purchasing</b>
1. Are specifications of equipment to be purchased satisfactory? (use of standard documents, selection of equipment)
2. Are purchasing arrangements satisfactory? (no mistakes in the arrangements, delivery times, process, selection of manufacturers)
3. Have vendor's estimates been thoroughly reviewed? (prices, delivery times, details)

Source: TPM, Productivity Press

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## Reduction of Early Breakdowns (Comparing Similar Types of Equipment - Tokai Rubber Industries)



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Source: TPM by Productivity Press

## Maintenance Prevention (MP)

- MP should be performed for capital projects, redesign or modification of current assets, equipment installation and commissioning, and replacement parts and components planning
- The quality of a company's MP program depends on the following factors:
  - Technical skills and design sense of the engineering and design engineers
  - Quality and quantity of technical data available
  - Ease with which this technical data can be used

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