

INTRODUCTION TO RELIABILITY CENTERED MAINTENANCE

November 2005

Why Do We Do Maintenance?

- To preserve assets?
 - NO!
- To preserve the FUNCTIONS of the assets
- The FUNCTION of an asset is whatever the user wants it to do, as defined by performance standards

What are PM & PdM for?

- Preventing Failures?
 - NO!
- Avoiding, Reducing or Eliminating the CONSEQUENCES of Failures
- We should only spend time, resources, and money where there are adverse consequences of failures.

Is Most Equipment More Likely To Fail As It Gets Older?

- Surprisingly, NO!
- Most equipment failures are NOT due to age.
- Therefore, performing time-based replacements or overhauls usually DO NOT increase equipment reliability.
- When technically feasible and worth doing, Condition Based Tasks should be performed.

What Should Determine The Frequency Of Condition-Based Tasks?

- Mean Time Between Failure?
 - NO!
- Lead Time To Failure
 - Time from detection of deterioration to the loss of function
 - Most failures do not occur instantaneously, they develop over time

Should we just use OEM manuals as the Maintenance Plan?

- No - They are NOT good enough!
- When developing a maintenance plan, always consider:
 - Operating Context
 - Functions
 - Desired Performance Standards

WHAT IS RCM?

- RCM is a process used to determine the maintenance requirements of any physical asset in its operating context.
- RCM is a method which identifies **applicable** and **effective** maintenance tasks needed to maintain the inherent reliability of equipment at minimum cost.

7 Basic Questions of RCM

1. What are the functions of the asset in its present operating context?
2. In what ways does it fail to fulfill its functions?
3. What causes each functional failure?
4. What happens when each failure occurs?
5. In what way does each failure matter?
6. What can be done to predict or prevent each failure?
7. What should be done if a suitable proactive task cannot be found?

Who Answers These Questions?

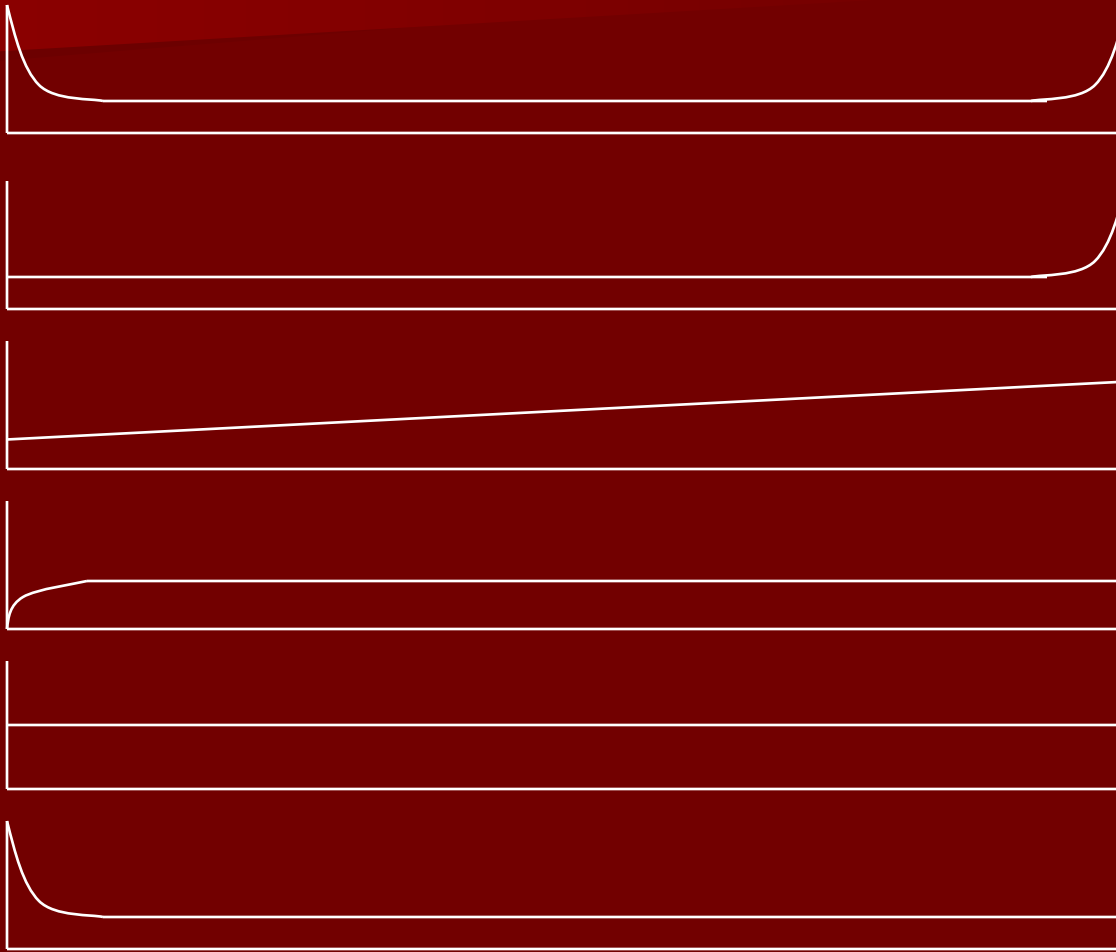
- RCM Teams May Include:
 - Maintenance Supervisor
 - Maintenance Planner
 - Craftsmen
 - Operations Supervisor
 - Operator
 - Engineer
 - Building Manager
 - RCM Facilitator

What Is The Result of RCM?

- Optimized Maintenance Schedule including PdM & PM
 - *The right maintenance at the right time*
- Operating Procedures
- Design modifications
- Global understanding of Functions and Performance Expectations
- Improved Effectiveness and Efficiency of Maintenance
- And, of course...**MORE RELIABLE EQUIPMENT!**

Failure Patterns

Conditional probability of failure



A

B

C

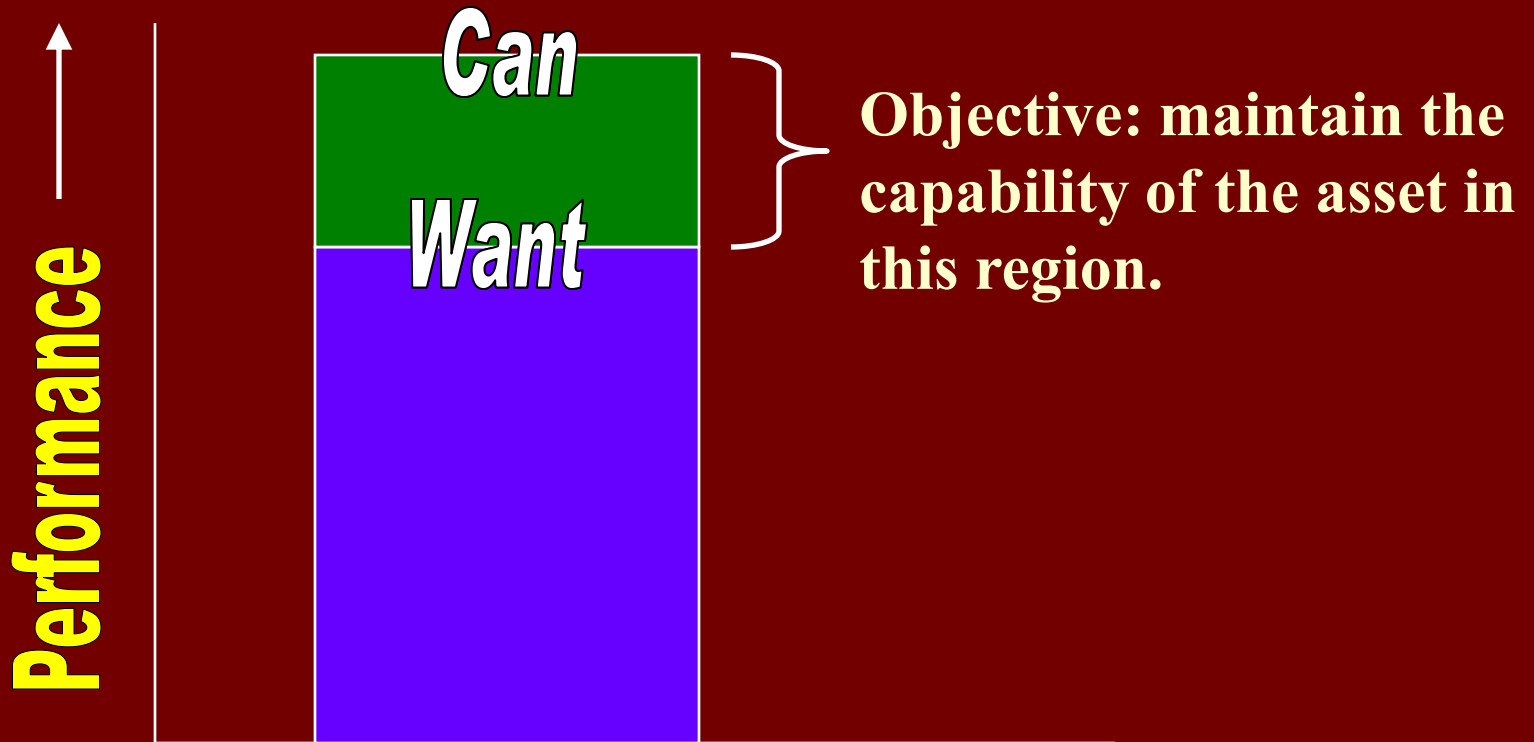
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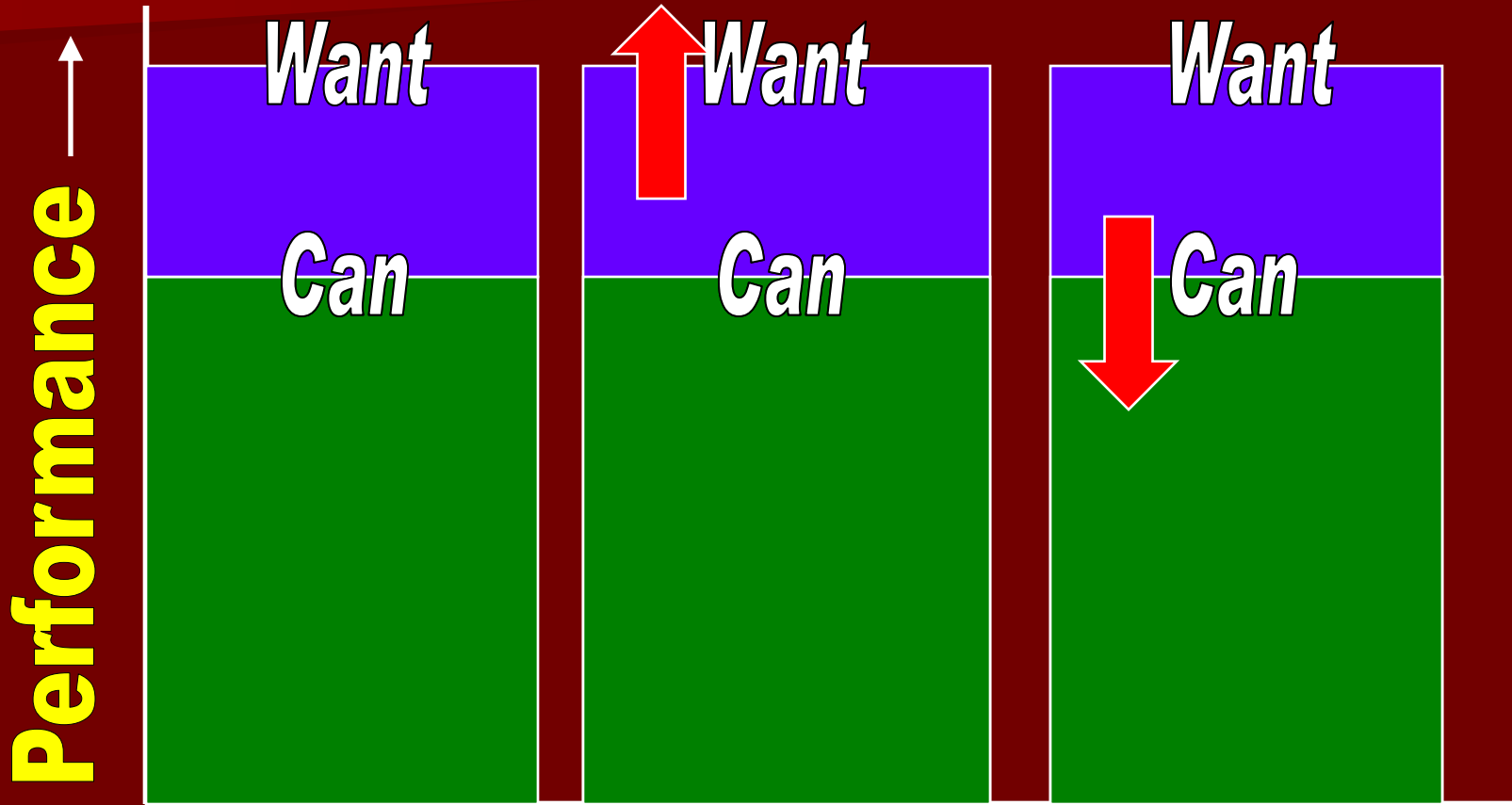
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Time

Performance Standards: Maintainable Assets



Performance Standards: Non-maintainable situations



Operating Context

- A brief description of the overall operating environment and use of the asset.
- Provides clear understanding of the system and what is expected of it.
- The foundation for listing functions.

Functions

What are the functions & associated performance standards?

- **Primary Function:**
 - the main reason why the asset exists
- **Secondary Functions:**
 - **E**nvironmental integrity
 - **S**afety/Structural integrity
 - **C**ontrol/Containment/Comfort
 - **A**ppearance
 - **P**rotection
 - **E**conomy/Efficiency
 - **S**uperfluous functions

Functional Failures

In what way does it fail to fulfill its function?

- The inability of any asset to fulfill a function to a standard of performance which is acceptable to the user.
- Performance standards are determined in functions.
- Partial & Total loss of function.

Failure Modes

What causes each functional failure?

- Get to appropriate level of root cause
- Failure modes which have occurred before
- Failure modes which are now being prevented by PM (zero-based)
- Failure modes which have not yet occurred but are considered real possibilities

Failure Effects

What happens when each failure occurs?

- List for each failure mode:
 - What evidence that the failure has occurred
 - In what ways it poses a threat to safety or the environment
 - In what ways it affects production
 - What physical damage is caused by the failure
 - What must be done to repair the failure

Consequences:

In what way does each failure matter?

Proactive maintenance has much more to do with avoiding or reducing the consequences of failure than it has to do with preventing the failures themselves.

- Hidden or Evident?
- Safety/Environmental
- Operational
- Non-operational

Decisions

What can be done to predict or prevent each failure?

- A task must be ***technically feasible*** and ***worth doing***.
- Decision hierarchy:
 - On-condition tasks
 - Scheduled restoration tasks
 - Scheduled discard task
 - Default tasks

Default Tasks

What should be done if a suitable proactive task cannot be found?

- Failure Finding tasks (hidden failures)
- Redesigns
- Run-to-failure

Process for an RCM Project

- Select asset based on criticality
- Define boundaries
- Select & train the facilitator & team
- Perform RCM analysis
- Perform audit of recommendations
- Prioritize & implement recommendations
- Measure results
- Update RCM documents to include changes (at least annually)

Outcomes/Benefits of RCM

- Greater safety & environmental integrity
- Enhanced understanding of equipment
- Increased availability & reliability
- Greater maintenance efficiency
- Longer equipment life
- Better teamwork
- Complete maintenance strategy

