Maintenance 101:
The Evolution, History, and Application of Current Maintenance Strategies

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ISO 18436-2 Cat. III
Syserco Inc.
Introduction

- US Navy veteran
- Graduate of The College of Emporia
- ISO 18436-2 Category III Vibration Analyst (ANSI) through The Vibration Institute
- Certified Reliability Leader (Association of Asset Management Professionals)
- More than 40 years in Physical Asset Operations, Maintenance, Management, & Leadership Coaching

- Married for 32 years
- Two adult sons, One daughter-in-law, and a 1-yr. old grandson (I have pictures)
- Reading, Garden Work, Golf
- Living my life’s dream
Agenda

Introduction

The History of Maintenance

- Reactive Maintenance
- Preventive Maintenance
- Asset Condition Management
- Reliability-Centered Maintenance
- The Internet of Things/Data Analytics

What’s the Best Strategy?
The History of Physical Asset Maintenance

<1940's

Reactive
Reactive (Breakdown) Maintenance

Repairs are performed when equipment has already broken.

Effort and activity is focused on restoring the broken equipment to it’s normal operating context.

Symptoms of a Reactive Maintenance strategy:
- Unusually loud noises
- Lots of yelling
- Even more running
- Then everything gets quiet
- Your phone rings
The History of Physical Asset Maintenance

<table>
<thead>
<tr>
<th>&lt;1940’s</th>
<th>1960’s</th>
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<tbody>
<tr>
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Preventive Maintenance

Preventive Maintenance is the planned maintenance of plant infrastructure and equipment with the goal of improving equipment life by preventing excess depreciation and impairment.

This maintenance includes, but is not limited to, adjustments, cleaning, lubrication, repairs, replacements, and the extension of equipment life.
Preventive Maintenance

Actions performed on a time- or machine-run-based schedule that protect, preclude, or mitigate degradation of component or system with the aim of sustaining or extending its useful life through controlling degradation to an acceptable level.
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Preventive Maintenance

Inspect:
- Chair back
- Seat
- 4 legs touching the floor
- Foreign objects (MSDS)

Replacement Assets
Preventive Maintenance

Actions performed on a time- or machine-run-based schedule that protect, preclude, or mitigate degradation of component or system with the aim of sustaining or extending its useful life through controlling degradation to an acceptable level.
How Often Should PMs Be Done?

Mean Time Between Failures (MTBF)

The predicted elapsed time between inherent failures of a system during operation.

PM intervals are calculated at 70% of MTBF for the component to be maintained.
Preventive Maintenance

Inspect:
- Chair back
- Seat
- 4 legs touching the floor
- Foreign objects (MSDS)

Replacement Assets
Preventive Maintenance

Stan Nowlan & Howard Heap (1978)

“...Without a precise definition of what condition represents a failure, there is no way to assess its consequences or to define the physical evidence for which to inspect.”
Preventive Maintenance

Inspect:
- Chair back
- Seat
- 4 legs touching the floor
- Foreign objects (MSDS)

Replacement Assets
Preventive Maintenance Flaws

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*ACM*: After the Clean-Up Movement
Predictive Maintenance (Asset Condition Monitoring)

Measurements that detect the onset of system or component degradation (lower functional state), thereby allowing casual stressors to be eliminated or controlled prior to any significant deterioration in the component physical state.

Results indicate current and future functional capability.
The History of Physical Asset Maintenance

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<td>RCM</td>
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Informing the Right Strategy

What is the functional performance requirement for a primary chilled water pump?

How does it fail to do that?

What may cause the failure?

What happens when it does fail?

What is the effect of the failure?

What can be done to prevent or predict the failure?

What if that doesn’t work?
The Correct Application?

<table>
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<tr>
<th>Area Served</th>
<th>Risk</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Critical Environments</td>
<td>10 Safety</td>
<td>10 75-100%+ Asset Life</td>
</tr>
<tr>
<td>7 Occupied Spaces</td>
<td>10 Asset Protection</td>
<td>7 Reconditioning Overdue</td>
</tr>
<tr>
<td>5 Common Areas</td>
<td>7 Energy Consumption</td>
<td>5 Median</td>
</tr>
<tr>
<td>3 Equipment Support</td>
<td>5 Comfort/Satisfaction</td>
<td>2 Refurbished</td>
</tr>
<tr>
<td>1 Material Storage</td>
<td>0 Little or None</td>
<td>1 Newly Installed</td>
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<tr>
<th>O&amp;M Cost</th>
<th>Equipment History</th>
<th>Redundancy</th>
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<tbody>
<tr>
<td>10 OEM Support Required</td>
<td>10 High Failure Rate</td>
<td>10 Not Redundant</td>
</tr>
<tr>
<td>7 Outsourced Repairs</td>
<td>7 High Incident Rate</td>
<td>5 Seasonal Redundancy</td>
</tr>
<tr>
<td>5 Outsourced Maintenance</td>
<td>3 Few Anomalies</td>
<td>3 1:1 Redundancy</td>
</tr>
<tr>
<td>3 Self-Performed</td>
<td>1 PM Activities Only</td>
<td>2 1:2+ Redundancy</td>
</tr>
<tr>
<td>1 Little or None</td>
<td>0 No History</td>
<td>1 Not Always in Service</td>
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The History of Physical Asset Maintenance

- **<1940’s**: Reactive
- **1960’s**: Preventive
- **1970’s**: ACM
- **1980’s**: RCM
- **Now**: IoT
Monitoring-Based Physical Asset Management (IoT)

- Continuous monitoring of parameters
- Fault detection, diagnostics, and analytics
- Dashboarding and visualization
- Democratization of computing (Cloud)
Final Thoughts (Before the Fun Begins)

What problem are we trying to solve?

How often does it happen?

What can we do about it?

The Role of the CMMS Administrator
(Planner/Scheduler)
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