The Role of Preventative Maintenance in Asset Management

Tom DeLaura, P.E.
Eramosa International
David Vago, P.E.
Midwest Asset Management Consultants

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Asset Management Lifecycle

Manage the entire life of assets, and receive the best return on investments.
More than Preventative Maintenance

- Asset Management requires information from all your data sources and systems
- Success requires organizational alignment of people, process, and technology
- A Champion can help drive results
- Software app’s need integration
- Use Maintenance data to plan for the future
- Sustainability via Life Cycle approach
Defining “Maintenance”

Navigation:
“Maintain course and speed” = Continue sailing

Aviation:
“Maintain speed and altitude” = Continue flying

Business:
“Maintain profit margins” = Continue making money

Plant and System Operations:
“Maintain equipment” = FIX IT!

WHY???
Defined by the evolution of equipment maintenance activity
Components of a Fully Implemented AM Plan

- Continual Assessment of Asset Conditions
- Continual Assessment of Asset Appropriateness
- Continual Assessment of Asset Performance and Adequacy
- Asset value, cost and revenue
- QA/QC of Asset data
- Security of Asset data
Function: Day-to-day upkeep of dynamic assets

Objective: Directly effect levels of service by preventing deterioration of asset performance

Key Considerations:
- Is maintenance showing the design of the asset is adequate to its role?
- Is the condition of the asset adequate to its role?
- How are maintenance practices optimized?
- Is the maintenance management system focused on levels of service and is it user friendly?
- How are the costs/resources measured/justified?
- How are spare parts justified/managed/controlled?
### Maintenance Activity and Program Maturity

<table>
<thead>
<tr>
<th>Type Maintenance</th>
<th>Infant Organization</th>
<th>Developing Organization</th>
<th>Mature Organization</th>
<th>Best In Class Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactive</td>
<td>100%</td>
<td>40-60%</td>
<td>10-30%</td>
<td>&lt; 10%</td>
</tr>
<tr>
<td>Corrective</td>
<td>0%</td>
<td>30-40%</td>
<td>10-30%</td>
<td>&lt; 10%</td>
</tr>
<tr>
<td>Preventive</td>
<td>0%</td>
<td>10-20%</td>
<td>40-70%</td>
<td>&gt; 80%</td>
</tr>
<tr>
<td>Predictive</td>
<td>None</td>
<td>As Required</td>
<td>Frequently</td>
<td>Extensively, with PMs</td>
</tr>
<tr>
<td>Reliability</td>
<td>None</td>
<td>None</td>
<td>Periodically Reviews PMs</td>
<td>RCM methods to create and update PMs</td>
</tr>
<tr>
<td>Centered</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>On-Condition</td>
<td>None</td>
<td>None</td>
<td>Condition, performance, and value known for critical assets</td>
<td>Condition, performance, and value known for all assets</td>
</tr>
</tbody>
</table>
Define your terms:

PM
PdM
RCM
Major Elements of AM

Define Overall Strategy and Philosophy

Prepare Asset Inventory

Evaluate Equipment Criticality

Criticality Greater than Threshold

YES

Conduct Condition Assessment

NO

Conduct Risk Assessment

FMECA

Risk Greater than Threshold

YES

Evaluate Maintenance Effectiveness & Optimize

NO

Conduct Cost/Benefit Analysis (Maintenance/R&R)

Amount Greater than Threshold

YES

CIP Budget Process

NO

CMMS (The Tool)

Where Condition Assessment Fits in Asset Management
Condition and Performance Monitoring

Function: Operate systems to identify underperforming assets, predict when asset failures are likely to occur, ascertain reasons for performance deficiencies, determine corrective action and record asset failures.

Objective: Provide the ability to plan for and manage desired levels of service.

Key Considerations:
- Are asset condition gradings appropriate and relevant?
- Are asset condition monitoring processes effective?
- Are asset performance gradings appropriate and relevant?
Facility Assessment and Report on the current state of the Assets

Conduct investigations to identify defects selected

Identify and list any repairs that are required

Prioritize any required parts

Estimate the costs to repair, maintenance or replacement

Review current maintenance schedules and identify changes to improve value-added work
Equipment Condition Decay Profile

Condition Coding Concepts

Field Condition Code

- New Component
- Halfway through service life
- Replacement Criteria (Nominal limit of service life)
- No safety factor left
- Increasing risk of failure

Slope of this line depends on the environment; (Steeper for more aggressive environments)

Years from new

Imminent Failure

Tr
The Nessie Curve

Asset Performance/Reliability vs. Time

Peak Performance

Minimum Acceptable Performance
### Condition Monitoring – Levels of Assessment

<table>
<thead>
<tr>
<th>Rank</th>
<th>Method</th>
<th>Description</th>
<th>Confidence</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Employee Observation &amp; Assessment</td>
<td>Employee notes condition at the time work is performed on asset</td>
<td>LOW</td>
<td>$</td>
</tr>
<tr>
<td>3</td>
<td>Sampling &amp; Analysis</td>
<td>Non-Destructive test analysis of material or asset (oil analysis)</td>
<td>MEDIUM</td>
<td>$$</td>
</tr>
<tr>
<td>2</td>
<td>Simple Diagnostic Tools &amp; Analyzers</td>
<td>Technology – Simplified condition analysis tools</td>
<td>MEDIUM</td>
<td>$$</td>
</tr>
<tr>
<td>1</td>
<td>Specialized Diagnostic Analyzers –</td>
<td>Technology – High end analyzers – Spectral Vibration, Motor Signature</td>
<td>HIGH</td>
<td>$$$</td>
</tr>
</tbody>
</table>
Effectiveness of Levels of Assessment

Condition Coding Concepts

- Field Condition Code
- Halfway through service life: Slope of this line depends on the environment; (Steeper for more aggressive environments)
- Replacement Criteria (Nominal limit of service life)
- No safety factor left
- Increasing risk of failure
- Years from new
- Define Failure Threshold
- Define Performance Threshold
- Imminent Failure

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Condition Monitoring – Employee Observation & Assessment

Business Case
- Provide an asset condition assessment by employee assigned to maintain or repair an asset through a work order.

Methodology
- Once completed, employee notes condition of asset on work order. If condition assessment differs from previous condition noted in condition registry, supervisor reviews change and if approved, updates registry with updated asset condition code.

Confidence
- Confidence in employee assessment subjective, based on training and experience with asset. Assessment is screened by supervisor for final determination and action. (Low confidence)

Cost
- Minimal cost to do assessment, investment in training and observation.
- (Limited to labor to complete, 5–15 minutes to work order)
Condition Monitoring – Sampling & Analysis

Business Case
  ◦ Provide a asset condition assessment by simple sample collection or analysis to attain scientific assessment based on physical test method.

Methodology
  ◦ Employee assigned to collect sample of material from asset or detailed observation of components by measurement (simple tool such as volt meter, amp-probe, etc.)

Confidence
  ◦ Assessment based on physical measurement, reliability based on skill of analyst, accuracy of test and methodology. (Medium Confidence)

Cost
  ◦ Minimal cost of test, usually labor and use rate for instrument or test performed. (Usually under $30 total cost)
Condition Monitoring – Simple Diagnostic Tools & Analyzers

Business Case
- Update condition assessment of an asset using simplified diagnostic tools and analyzers with in-house, trained employees.

Methodology
- Measurement and analysis of asset by simple, specialized analyzers and instrumentation. First line of technological analysis of asset condition; analog IR gun, SKF vibration tool, motor analyzer (pf, ehp, kvar, kw, A, V), ultrasonic analyzer, thickness tester, moisture detector, etc.

Confidence
- Assessment based on physical measurement, reliability based on skill of analyst, accuracy of test and methodology. (Medium Confidence)

Cost
- Cost of in-house labor to conduct measurement and analyze data, use cost of instrument, time to report results. (labor – 10–20 minutes & use rate for instrument [instrument cost ~ $400 – $2500])
Business Case
- Update condition assessment of an asset using simplified diagnostic tools and analyzers, typically performed by specialized service provider/contractor.

Methodology
- Measurement and analysis of asset by highly specialized analyzers and instrumentation. High technology analysis such as spectral vibration analysis, x-ray, motor signature analysis, GC analysis, EMSA, Thermography, etc.

Confidence
- Based on highly specialized analysis methods, QA/QC validation methods, calibration traceability, skilled, certified test technicians, certified results. (High Confidence)

Cost
- Tests range from $50 to $?,??? per test, based on method, accuracy, time to complete, certified results.
## Condition Monitoring
### Basic Condition Coding Schema

<table>
<thead>
<tr>
<th>Condition Rank</th>
<th>Condition</th>
<th>Condition/Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Abandoned</td>
<td>No longer in service, by-passed, removed.</td>
</tr>
<tr>
<td>1</td>
<td>Very Good</td>
<td>Operable and well maintained, like new.</td>
</tr>
<tr>
<td>2</td>
<td>Good</td>
<td>Superficial wear and tear visible, not new.</td>
</tr>
<tr>
<td>3</td>
<td>Fair</td>
<td>Significant wear and tear, minor deficiencies.</td>
</tr>
<tr>
<td>4</td>
<td>Poor</td>
<td>Major deficiencies, marginal performance.</td>
</tr>
<tr>
<td>5</td>
<td>Very Poor</td>
<td>Obsolete, unserviceable, poor performance.</td>
</tr>
</tbody>
</table>
Your In-Plant Analysis Kit

- Hand held Ultrasonic Analyzer
- Infrared Heat Detection
- Analog Technology
- Hand Oil Sampling Pump
- Collection Bottle Sampling Form
- Hand-Held Vibration Meter
- Broadband Analysis
- Metal Thickness & Coatings Testing
Ultrasonic Detection

Hand held Ultrasonic Analyzer

Electrical Fault Detection

Pipe Leak Detection

Heat Exchanger Tube Leak Detection

Bearing and Lubrication Fault Analysis
Contamination materials captured on filtration paper

Wear Metals suspended in oil

Hand Oil Sampling Pump
Collection Bottle Sampling Form
Vibration Analysis

Hand-Held Vibration Meter
Broadband Analysis

Portable Vibration Analyzer
Spectral Analysis

Typical Spectral Signature Analysis
Thermographic Imaging

Image Technology
Vibration and IR Tell the Same Tale

Misalignment confirmed with two technologies

- Early detection by “IR” identifies potential failure
- Vibration signature confirmed IR diagnosis
- Diagnosis: Misaligned motor and compressor
- Cost of analysis = $75
- Savings = PRICELESS
Electrical Inspection
Thickness Testing
Sewer Inspection
When To Evaluate Condition:

The *Criticality* drives the *level of Analysis* while *Asset Value* drives the *frequency or intervals*, lesser critical and value require less levels of analysis and frequency or intervals of monitoring.
1. Develop and implement a condition monitoring program for plant assets with a focus on rotating equipment; log data into the inspection record screens within the CMMS for all condition data collected. Investigate additional assets for based on asset failures and excessive repairs.

2. Develop condition assessment standards of measurement/evaluation for condition monitoring and data collection. Train staff in use of instruments and methods, report results, trend data collected, and establish minimum performance standards to trigger corrective action.

3. Develop a condition monitoring program for in conjunction with the current sewer inspection and hydraulic model analysis. The program can be based on physical, performance, and criticality criteria that can be incorporated into a prioritization algorithm.

4. Include condition assessment data in the evaluation of R&R decisions and the prioritization process.

5. Institute periodic review of asset condition data from both the GIS and CMMS assets to prioritize planned maintenance activities and identify potential risks within the system.

6. Develop appropriate management reports to track progress.
1. Evaluate current maintenance routes and develop work order job plans in the CMMS to account for daily task activity.

2. Develop and manage PMs through the CMMS governing the sewer inspection and cleaning programs.

3. Track performance and problem areas of required PM activities in the GIS application by plotting or viewing work order activities by type in the GIS.

4. Develop applicable PM and PdM activities for all assets based on criticality, risk, and/or condition.
Questions?
Tom DeLaura, P.E.
Eramosa International
tom.delaura@eramosa.com – (313) 610-3559

David Vago, P.E.
Midwest Asset Management Consultants
dvago07@comcast.net – (313) 570-2496