Predictive Maintenance

*Transforming Maintenance with Predictive Analytics*

Fixed Before It’s Broken!
How Predictive Maintenance is a *proven* capability that leaders have already embraced to deliver *significant ROI*.

How does *Predictive Maintenance* work?

‘*I’ll have what she’s having*’ – How Predictive Maintenance borrows from *data rich* industries.

How to *succeed* with Predictive Maintenance.
Today’s topics

How Predictive Maintenance is a proven capability that leaders have already embraced to deliver significant RoI

‘I’ll have what she’s having’ – How Predictive Maintenance borrows from data rich industries

How does Predictive Maintenance work?

How to succeed with Predictive Maintenance.
Predictive Maintenance

The manufacturing world is going through a ‘digital revolution’

Pressure on Margins
‘Sweat the assets’

Quality and Regulations
‘Ever increasing consumer expectations – mass personalisation’

Internet of Things
‘Cheap and Easy Sensoring’

Use of Unstructured Data
‘Data format is unimportant’

Predictive Maintenance

Where Industry 4.0 Leaders are going
Industry Research
*Industries using Predictive Maintenance*

**Source:** Frost & Sullivan 2015

- **Life Sciences**
  - (Pharma, Medical and Biotech)
- **Automotive and Aerospace**
- **Oil and Gas**
- **Food and Beverage**
- **Chemical**
- **Minning**
- **Pulp and Paper**
- **Power Generation**
- **Others**
  - (industrial equipment, hi-tech and general manufacturing)

**IT Spend as a Percent of Vertical Revenue**

**Big Data and Analytics Manufacturing Opportunity**
(Based on volume and applications)
Industry Research
How are they using Predictive Maintenance applications

Opportunity for Analytics at a Production Line Level

Opportunity for Analytics at a Plant Level

Enterprise/End User Penetration Level

LOW

HIGH

Production Line Level

Plant Level

Source: Frost & Sullivan 2015
Predictive Maintenance
Transforming of Maintenance Business Model

1. $18 \text{ /hp p.a.}
2. 75% Reduction in breakdown
3. 15% Time spent on Predictive Maintenance only
4. More data = More accuracy = More value

$13 \text{ /hp p.a.}
$9 \text{ /hp p.a.}

Source: Roland Berger 2014
Predictive Maintenance
Various industries are realising significant value

80%
Reduction in scrap rate in 12 weeks

<1%
Reduction in equipment failure probability

$10M
Reduction in annual total warranty costs

$1B
Savings per oil platform

98%
Level of accuracy predicting alarms

$100k
Savings in capital plan expenditures

5%
Reduction in aircraft-on-ground events

$75k
Reduction in fuel costs per turbine
Today’s topics

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How does **Predictive Maintenance** work?

How to **succeed** with Predictive Maintenance.
1. **ANALYTICS IS AWESOME**
   (but show me the money!)

2. Don’t ignore your ‘gut’, just *make sure to test it*

3. *Analytics helps to simplify* not to over-complicate

4. Numerous Incremental Projects = Radical overall benefit

5. Zero the distance Between information and action

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The right solution for the right business problem?

- Reporting
- Prescriptive Analytics
- Predictive Analytics
- Analysis & Monitoring

What happened?
Why did it happen?
What should I do next?
What will happen?
The right solution for the right business problem?
The right solution for the right business problem?

Root Cause, Preventative and Conditional Maintenance

Predictive Maintenance
Predictive Maintenance

What does it mean?

Unearthing characteristics that lead to an increased frequency of failures

Finding patterns in maintenance operations that could point to opportunities for improvements

Identifying assets at risk of failure even when they have no previous failure history

Manufacturing
Predictive Maintenance

What does it mean?

Predictive Maintenance is about **understanding the patterns** in data to determine the areas of **greatest risk** and directing resources **before risk becomes reality**.

- Increase asset reliability and lifecycle
- Reduce interruptions in production/service
- Optimize resources scheduling and allocation
- Improve capital planning and financial positioning
- Increase warranty recoveries and after-sales support/customer satisfactions
Predictive Maintenance

How does it work?

What if I could tell you that a specific asset is 90% likely to fail within one week for Reasons A, B and C?
Evolution of Analytics in the Maintenance Domain for Manufacturing

- **PHASE 1**: Reactive Maintenance
- **PHASE 2**: Planned Maintenance
- **PHASE 3**: Condition Based Maintenance
- **PHASE 4**: Predictive Maintenance
Predictive Maintenance

What does it look like?
Predictive Maintenance
What does it look like?

Body & Weld

Specifications

<table>
<thead>
<tr>
<th>Controlled axes (Note 1)</th>
<th>6 axes (J1, J2, J3, J4, J5, J6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reach</td>
<td>1,437mm</td>
</tr>
<tr>
<td>Installation</td>
<td>Floor, Upside down, Angle mount</td>
</tr>
<tr>
<td>Motion range</td>
<td></td>
</tr>
<tr>
<td>(Maximum speed)</td>
<td></td>
</tr>
<tr>
<td>(Note 2, 3)</td>
<td></td>
</tr>
<tr>
<td>J1 axis rotation</td>
<td>1,225°/s, 6.28 rad/s, 3.99 rad/s</td>
</tr>
<tr>
<td>J2 axis rotation</td>
<td>250°/s, 215°/s, 4.36 rad/s, 3.75 rad/s</td>
</tr>
<tr>
<td>J3 axis rotation</td>
<td>455°/s, 225°/s, 7.94 rad/s, 3.93 rad/s</td>
</tr>
<tr>
<td>J4 axis rotation</td>
<td>720°/s, 425°/s, 8.53 rad/s, 7.42 rad/s</td>
</tr>
<tr>
<td>J5 axis wrist swing</td>
<td>280°/s, 425°/s, 8.99 rad/s, 7.42 rad/s</td>
</tr>
<tr>
<td>J6 axis wrist rotation</td>
<td>280°/s, 425°/s, 12.17 rad/10.91 rad/s</td>
</tr>
</tbody>
</table>

| Maximum load capacity at wrist | 3 kg |
| Allowable load               | 8.9 N·m |
| moment at wrist              | 8.9 N·m |
| J5 axis                      | 3.6 N·m |
| J6 axis                      | 8.290 kg·m² |
| Allowable load               | 0.290 kg·m² |
| inertia at wrist             | 0.005 kg·m² |
| Repeatability               | ± 0.000mm |
| Robot mass                   | 110 kg |
| Installation environment     | Ambient temperature: 0 ~ 45°C |
|                             | Ambient humidity: Normal 75% RH or less |
|                             | (No dew nor frost allowed) |
|                             | Short term: 95% RH or less |
|                             | (within one month) |
|                             | Vibration: 0.5G or less |
Predictive Maintenance
What does it look like?
Predictive Maintenance
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Predictive Maintenance
Nothing New?

Asset Lifetime
Estimated time to asset failure or maintenance

SURVIVAL ANALYSIS

What is the expected time for survival during treatment?
Sensor Anomalies
Highlight unusual sensor activity leading to or indicating sub-optimal asset performance

Which claims appear fraudulent as they have a claim value vastly different than expected?
Predictive Maintenance
Nothing New?

Maintenance Insights
Uncovered additional details added to maintenance logs

What are the key topics raised and customer sentiments expressed for call centre wrap notes?
Predictive Maintenance

Nothing New?

Event Associations
What log events occur together leading to maintenance or failures

Root Cause Analysis
Key characteristics and factors leading to asset failure or maintenance
Predictive Maintenance
Nothing New?

WHAT INFORMATION DO MANUFACTURING INDUSTRIES USE FOR PREDICTIVE MAINTENANCE?

A
Asset Data: Age, Material, Warranty

E
Environment Data: Weather, Location

U
Operations Data: Sensors, Temperature, Energy Consumption

I
Interactions Data: Maintenance, Failure Logs

Start where you can, with what you have. Expand incrementally overtime...
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How does Predictive Maintenance work?

How to succeed with Predictive Maintenance.
What **issues** have the **highest impact** on my business?

Which areas are costing me the most downtime/maintenance costs?

Can I *execute* and *operationalize* results?

Do I have *enough data* and in the *right formats*?
Predictive Maintenance

Key tenets of success

What *issues* have the *highest impact* on my business?

Can I *execute* and *operationalize* results?

Do I have *enough data* and in the *right formats*?
Predictive Maintenance
Data Readiness Assessments

Is my data good enough for Predictive Maintenance?

It is most likely good enough to start

Feasibility Ratings:
- History,
- Quality,
- Analytics Capability

Insights from Text Mining of Maintenance Logs

Sensor Anomaly Detection to Highlight problem areas
What *issues* have the *highest impact* on my business?

Can I *execute* and *operationalize* results?

Do I have *enough data* and in the *right formats*?

When do I need results and in what format?
What *issues* have the *highest impact* on my business?

Can I *execute* and *operationalize* results?

Do I have *enough data* and in the *right formats*?

**ACTIONABLE INSIGHTS**

**Lack of Focus**

**Low Adoption**

**Poor Results**
Predictive Maintenance

Key tenets of success

Business Domain Expertise

End User and Change Management

Data and Analytics Specialist
Predictive Maintenance
What does it look like?
# Potential range of impact by employing Predictive Maintenance

<table>
<thead>
<tr>
<th>expense</th>
<th>potential improvements*</th>
</tr>
</thead>
<tbody>
<tr>
<td>annual cost of <strong>unplanned</strong> downtime</td>
<td>reduce by 60% to 90%</td>
</tr>
<tr>
<td>excess capacity required to compensate for unplanned downtime</td>
<td>reduce by up to 90%</td>
</tr>
<tr>
<td>scrap or re-work</td>
<td>reduce by up to 50%</td>
</tr>
<tr>
<td>asset useful life</td>
<td>extend life by 5% to 15%</td>
</tr>
</tbody>
</table>

* Based on Nucleus Research analysis
End to End Advanced Analytics Framework Approach

Learn & discover how Advanced Analytics can transform your organisation

Prepare yourself for success in Advanced Analytics

Improve business performance

Sustain improved performance
Thank you for attending

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