Avoid Unwanted Maintenance Events & Increase Uptime with Aspen Mtell “Prescriptive Maintenance”

Creating a World That Doesn’t Break Down

AspenTech

A central pillar of AspenTech’s mission is digitalization of the world’s most capital-intensive industries

Using the combination of domain knowledge and machine learning analytics

For an operating company this is the powerful and necessary blend to:

*identify the sources of uptime losses and margin leakage and to promote the best possible outcomes*

Asset Lifecycle

OPERATE

Prevent Process Disruptions
(Operational Analytics)

MAINTAIN

Avoid Unplanned Downtime
(Prescriptive Maintenance)

Aspen Fidelis Reliability

Improve Asset Availability
(Reliability, Availability & Maintainability)
Current Key “Initiatives”

Industrie 4.0

Digitalization

IIoT

Data Science

Cloud

Edge

Digital Twin

That’s the answer
– what’s the question?

The initiative is always ...

to improve Operational Excellence
Digital Transformation for Managing Operational Excellence

These 3 protect the license to operate

- Harming people?
- Injuring the environment?
- Breaking the law?
- Assuring our equipment is always on?
- Using the minimum energy?
- Producing maximum, quality product?

These 3 are optimization functions

Utilization is THE most important

The Most Important Function in Terms of Everything Digitalization

Uptime

the cornerstone of IIoT, Industrie 4.0, Digitalization
A New Direction

NOT Maintenance Execution

Asset Optimization

$ $$ $$

Ask for the white paper "Prevent the Next Catastrophe"

Maintenance Optimization with Prescriptive Operations Analysis

What’s the Issue
World-wide Manufacturing: a $14 Trillion Business

Losses

$1.4T
from unplanned downtime

Average: 15% gross margin losses from unplanned downtime – best-in-class 4-5% loss >> OPPORTUNITY

What’s Being Challenged?

Industrial Maintenance Best Practices

Run to Failure  Calendar  Usage  Condition  RCM
Let’s Improve Maintenance

85% equipment fails in spite of calendar maintenance - Boeing

63% scheduled maintenance is unnecessary – automation vendor

The problem is here: process-induced

The spend is here: wear-and-tear

The New Technology Approach
## Customer Requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Description</th>
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<tbody>
<tr>
<td>Earlier &amp; more accurate</td>
<td>... better than the competition ... weeks/months not just days</td>
</tr>
<tr>
<td>Low-touch</td>
<td>... automated 24/7</td>
</tr>
<tr>
<td>Only current skills needed</td>
<td>... faster, easier app building ... no analytics/data science skills</td>
</tr>
<tr>
<td>No false alerts</td>
<td></td>
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<tr>
<td>Simple/fast alert response</td>
<td>... analysis &amp; results in seconds</td>
</tr>
<tr>
<td>Adapts and adjusts</td>
<td>... when process conditions change</td>
</tr>
<tr>
<td>Scales easily and rapidly</td>
<td>... to add more assets</td>
</tr>
</tbody>
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## They all do it, it’s all the same, right ...

<table>
<thead>
<tr>
<th>Toolkits</th>
<th>You are not doing:</th>
</tr>
</thead>
</table>
| Big Data 
Analytics 
MACHINE LEARNING |

These are Toolkits .... not “products” made for you

| Banking 
Facial Recognition |
|------------------------|

| Fraud 
Driverless Vehicles | |
|-------------------------|
Industrialized Machine Learning: Where Science Enters the Picture

Solve the critical problem
Unplanned Downtime

But, the investment and analyst community greatly underestimates the critical need for manufacturing domain expertise.

The importance of preventing manufacturing machine breakdowns has been recognized by startups, mature product and services providers alike.

The divorce rate in the US state of Maine & Consumption of margarine correlate with a 99.26% probability.

The issue: Machine Learning is not a silver bullet ...

Importing More Mexican Lemons Reduces Highway Deaths
A New Direction: Prescriptive Maintenance

Symptom Analysis
Diagnosis
Consideration of Treatments
Prescription for Action

Extreme Early Alerts That Tell You ...

WHEN

O

WHY

an asset will fail ... and WHAT to do

giving time to plan

Not easy - Many make that claim ... but can they really do it?
The assertion that a library of models is an advantage is FALSE

Models vs. Agents

MONTHS
Engineering Equations + Statistical Methods = Digital Models

DAYS
MEASURE Patterns of Equipment Behavior + AUTOMATIC Methodology = AGENTS with Machine Learning

Rapidly Scalable
Easy to Do
Greater Accuracy
Earlier Alerts
False Alarms
Model Drift

11/25/2019
Simplify the Application

The iPhone…

complex technology made simple for the masses

not just a great screen, but a whole package … where your finger is the stylus

Aspen Mtell: Joe Normal can do it

inline, real-time, results in seconds – easily scales and sustains
Automated – Low-Touch

All Autonomous Agents run live 24/7 ... forever
Capture Degradation Patterns that will lead to failure if not intercepted
Interpret every failure signal, every minute of the day and tell you what will happen, when, why and how to avoid it
Anomaly Agents find both failures & changes in normal operation and tune automatically to keep up with all process behavioral changes
Failure Agents, train from work order events, find precise degradation patterns before failure occurs ... attached to a root cause ... NOT an anomaly technique

Software does the work, so you don’t have to!

Hidden … machine learning, adaptive, big data, predictive and prescriptive action

Precision

Root Cause

a specific root cause matches a unique and exact degradation pattern
Cast a Wider Net

- **Upstream Process Sensors**
- **Process Sensors** e.g. Press, Temp, Level, Flow...
- **Machine Sensors** e.g., Vibrations

Sensors “on and around machines” ensure agents alert root cause of issues

Time: Do Things That Humans & Other Technologies Cannot and Do Not

- **See things earlier**
  - months versus days
  - more time for investigation & planning
- **See things they cannot**
  - to prevent process-induced damage
- **Attach failure to root cause**
  - in EAM system for guidance
  - Operations integrity

Analytics to predict when maintenance is unavoidable
Analytics prevent bad operations activities – “do no harm”
Prescriptive: digital work-scope ex EAM
Know how to avoid it
Or fix it

The software knows how to stop machines breaking
More Time = Better Decisions

- Much Earlier Detection
- Extra Lead Time
- To Make Good Decisions

Bearing vibration: TOO LATE

Vibration dominates just before failure

Machine learning temporal, multi-variate signals across time & many sensors humans cannot do this

Catch Operational Errors and Avoid Maintenance

- Process Monitoring
- No Degradation

Cass a Wider Net
Detect Inappropriate Upstream Operation
Do No Harm
Alert Early
Avoid extreme damage
Avoid the maintenance … completely

No Damage

This technology can step up to address 100% of degradation issues
Use Cases

Any Asset ... Any Industry ... Any Failure Mode ...

- Pumps & Compressors
- Motors & Drives
- Electrical Transformers
- Vehicles
- Process Equipment

- Transportation
- Water / Wastewater
- Oil & Gas
- Chemicals
- Pharma
Decades long compressor issues in spite of vibration and RCM systems – Costing millions of dollars to shutdown & repair every few months

Alert on valve damage seven weeks before vibration
Avoided three seal and bearing failures due to liquid carry-over

Persistent failures every few months costing as much as $4M each time in losses and repairs
Unplanned Shutdown of Hyper-Compressors

VALVE FAILURES

PACKING FAILURES

hyper-compressor packing
plunger displacement ...
LDPE production stops
lost profit
maintenance costs
missed deliveries

Poppet Valve

Unplanned shutdowns cost

CHALLENGE
Reduce Unplanned Downtime

SOLUTION
Increases notification time for seal and valve problems

BENEFITS
30 to 50 days’ notice
avoids shutdowns lasting 5 - 7 days
eliminates all false alarms
worth several $MMs/incident & several per year

DRIVES BETTER BUSINESS OUTCOMES
detects earlier, minimizes service interruptions
detects process issues & avoid failures ... altogether

27 days
advanced warning of
central valve failure
Natural Gas Plant

**CHALLENGE**
regular propane compressor failures
3 identical trains – repeat failures
economic loss $40 MM USD each time
owner-operator inspected – no success

**SOLUTION**
Mtell pilot for low-touch machine learning
9 days to build Live Agents
solution scales readily and rapidly
Failure Agents

**BENEFITS**
Stellar results
Achieved all pilot objectives
49 days’ lead on one failure – 51 days’ on another
Failure Agents rapidly transferred for 61 days’ lead on 2nd train

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PMC Production Column: Flooding

Mtell learned Flooding pattern with extreme accuracy
20-day lead time > 30k EU loss avoidance opportunity
## Results on Hydrogen Make-up Compressors

<table>
<thead>
<tr>
<th>ASSET</th>
<th>FAILURE MODE</th>
<th># Fails</th>
<th>DATE</th>
<th>LEAD TIME</th>
<th>ACCURACY</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP 10450</td>
<td>H2 leak into packing</td>
<td>11.00%</td>
<td>08/13/14</td>
<td>21 days</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td>Valve failure</td>
<td>100%</td>
<td>02/18/14</td>
<td>54 days</td>
<td>85%</td>
</tr>
<tr>
<td>CP 10451</td>
<td>Relay problem</td>
<td>100%</td>
<td>12/04/14</td>
<td>55 Days</td>
<td>88%</td>
</tr>
<tr>
<td>CP 10452</td>
<td>Valve failure due to liquid</td>
<td>85%</td>
<td>09/06/15</td>
<td>&gt; 50 days</td>
<td>91%</td>
</tr>
<tr>
<td></td>
<td>Hold-down bolts</td>
<td></td>
<td></td>
<td>31 days</td>
<td>87%</td>
</tr>
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All of these failures were unplanned maintenance events.

- Industry average with only a people process
- 10 days for valve failure
- Not consistent

Mtell average valve failure lead time 48 Days
Detected automatically without people intervening
Very consistent
Results

- Machines stop breaking down
- Machines last longer
- Net output increases dramatically
- Maintenance costs decrease dramatically

The Leading Solution

Must afford ...

- Precise Failure Detection: Tells you WHEN and HOW an asset will fail and WHAT to do to prevent it
- A Tool That Fits You: You do not need to fit the Tool, does not require you to know more than you already know
- Agents do what experts can’t do: Automatic, every few minutes, all day, every day, forever learning
- “Getting Better All the Time”: No false Alerts: Anomaly alerts convert to more accurate failure alerts automatically adapts to process changes
- Transfer Learning: Inoculates similar assets with the same safety and breakdown protection
- External Process Issues: Approaches the 82% of process-induced issues & the 18% mechanical degradation faults
Every Minute That Goes By ...

... is costing you money and exposing you to unnecessary risk

Thankyou

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