Introduction to PRiSM for Predictive Analytics

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Schneider Electric
Enterprise APM

Comprehensive Schneider Electric Solution

Generate
Collect
Analyze
Act
Visualize

DCS
PLC
SCADA

Online Process Data
Non-Instrumented Plant Data

Machine Learning
Rules

Work Order Management
Notification
Workflows

KPIs
Reports
Asset Health Dashboard

Industrial Asset Analytics Platform

Optimize
Maintenance Programs

- **Strategic, Proactive, Optimized**
  - **Risk-Based Maintenance**
    - Requires a comprehensive maintenance infrastructure
  - **Predictive Maintenance**
    - APR and diagnostics to predict impending failure
  - **Condition-Based Maintenance**
    - Rules-based logic using sensor data
  - **Preventative Maintenance**
    - Planned based on time or usage statistics
  - **Reactive Maintenance**
    - Run to failure
Predictive Asset Analytics

- Advanced pattern recognition for online equipment condition monitoring
- Utilizes historical data to describe how a piece of equipment operates and builds a model
- Monitors equipment behavior continuously, in real-time
- Alerts when current operation deviates from the historical norm
- Early warning detection of equipment problems
- Fault diagnostics capabilities
Monitoring without Advanced Analytics

As your fleet continues to expand, how will you manage the additional assets and data streams?
Subtle Changes – Can you tell?

Outboard Bearing Temp (°F)

Date and Time

Actual Value - Predicted Value

Residual

First Pattern Recognition Alarm
Situational Awareness: Only Emerging Trends

Deviation = How much the condition has changed
PRiSM Uses Sensor Relationships and Operational History

- Model groups data into smaller modes of operation
Match Fault Pattern with Known Conditions (Library)

Likely Fault Condition

Signal Contribution to Change in Health Status
# Intelligent Alert List – Situational Awareness Screen

<table>
<thead>
<tr>
<th>Name</th>
<th>Rating</th>
<th>Criticality</th>
<th>Current Status</th>
<th>Tech Exam Date</th>
<th>Tech Exam Status</th>
<th>Earliest Event</th>
<th>Latest Event</th>
<th>Alarms</th>
<th>Warnings</th>
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Transient Analysis – Event Capture
Model Building is Easy – Use a Template
Predictive Analytics – Transformative Technology

Centralized, Continuous, Real-time Monitoring
- For more informed business decisions

Reduce Reactive Maintenance
- Move from unplanned to planned maintenance
- Provides situational awareness

Extend Maintenance Intervals
- Support of Condition-Based Maintenance
- Avoid over servicing

Knowledge Capture
- Events do not repeat themselves
- Train younger engineers

Prioritize Maintenance
- Risk assessment of abnormal conditions – can we stay online?

Studies show that only 18 percent of asset failure patterns are age related.
*Most would require a predictive component to detect.

- ARC Advisory Group
decision tool for action. Most manufacturers of equipment now provide for some level of data sensing. As mentioned above, temperature and vibration analysis are the most common. Some equipment manufacturers (such as bearings maker SKF Group) may provide tools and services that are proprietary as well, such as vibration detection and monitoring equipment. Similarly, a number of companies will provide third-party aftermarket monitoring tools (for example, Azima), which is particularly important for older equipment that is not prewired for condition monitoring. The potential for numerous factors being managed and then each having its own unique threshold of tolerance to be established can be onerous, although SmartSignal (now part of GE Intelligent Platforms) and PRISM by InStep Software bypass this constraint by having a process to capture "the normal operating envelope," and then report exception to this even if there are multiple parameters in play.

The backbone of the software being deployed will be the EAM systems (component-based or as an ERP module). Determine whether the EAM system has a condition trigger capability to create work orders when a value past a certain level is reached. Most newer versions of mainstream products will have this (for example, SAP, IBM Maximo, Ventyx, Oracle, Infor, Invesys Avantis and so on). Ideally, in their newer versions, they will have multiple thresholds programmable for the same piece of equipment (for example, a warning/inspection and a replacement level). Where the EAM system does not have a condition-based trigger and an upgrade is not practical, there are software
Vertical Markets and Equipment Types

- Turbine
- Compressor
- Electric Generator
- Pumps – Centrifugal, Integral
- VFD’s
- Fans, blowers
- Heat Exchanger, Boiler, Oven, Kiln
- Air Heaters
- Water Heaters
- Pulverizer, Crusher
- Condenser
- Transformers, Breakers, Capacitors
- Agitators, blender, Mixer
- Gearbox
- Chillers
- Seal systems
Leading Companies Use PRiSM

Over 480,000 MW Monitored Globally

- **Exelon**: Fleet-wide Nuclear; 2 Awards TIP & Tech Transfer; 22 Units
- **Duke Energy**: Fleet-wide; Over 12,000 Gas & Coal models, Nuclear & Renewables; 191 Units
- **Eskom**: Fleet-Wide Generation Monitoring & Transformer Monitoring; 86 Units
- **Southern Company**: Fleet-wide; Deployed Across Fossil Plants; 76 Units
- **AEP**: Centralized Monitoring of Generation Fleet; Gas & Coal; 46 Units
- **EDF**: Fleet-wide; Gas Turbine, Hydroelectric and Nuclear Monitoring; Over 100 Units

Confidential & Proprietary.
Case Study: Southern Company

- **Customer Portfolio**
  - 40,000 MW
  - 63 coal-fired units (Supercritical, Large & Small Drum)
  - 10 combined cycle units (2 on 1)
  - 2 cogen units (Steam generators)
  - 1 fluidized bed unit
  - 2,700 models

**Savings in 2014**
- $4M avoided cost

**Real Savings**
- Southern estimates that the real savings is closer to $40M when considering savings from AGC, repair costs and labor costs
Sample Number of Observations

- Gas Turbine: 389
- HRSG: 116
- Steam Turbine: 50
- Boiler Feed Pump: 158
- BOP: 133
- Compliance: 23
- Nacogdoches: 18

Total Model Count vs. Observations YTD
BFP Coupling Shim Pack

**Observation:**
- Model is indicating an increase in vibration on multiple bearings

**Result:**
- A BFP coupling shim pack that was on the verge of failure

**Estimated $260,000 Savings**
Letter of Thanks from Plant Manager

- Plant manager sent an email stating:

  "I just wanted to let you know what a great job your guys are doing. We received a call this morning from the M&D Center notifying us of a change in vibration that was noticed on our 5B BFP. Further investigation has revealed that we had a coupling shim pack that was on the verge of failure. Had it not been for the attentive work of the M&D Center staff we could have been facing a potentially catastrophic event. Thanks to their dedication and commitment to excellence we potentially averted a disaster. We still have some work to do to make repairs and return the pump to service, but we are truly grateful that we are not facing a worse situation thanks to your team."
Case Study: Air Heater

Observation:
- Air heater amps spiked from 14 amps to 18 amps

Result:
- Plant found a leak on the hydrovactor on the floor above that saturated the AH insulation, causing expansion issues with the shroud
Forensic Analysis

Situation
• Analyzed 110MW ST on Indian grid
• Maintenance records show sporadic issues and escalating condition that results in unit shutdown

Goal
• Determine if an APR model would detect fault patterns
• How much advanced warning given

APR = Advanced Pattern Recognition
Predictive Model Results

APR Model triggered 9 early warning alarms

- (3) October, (1) Nov, (1) Feb, (1) Mar, (2) May, (1) June

APR = Advanced Pattern Recognition
Results – Initial Fault Detected - Oct
Fault Causing Turbine Trip - March

Cause of Trip
High vibrations and/or Differential/Overall Expansion trip set points.
Summary of Results

• Because root cause not identified in October the turbine continued to experience problems
  • Problems exacerbated over time
  • Multiple outages and equipment damage occurs without APR
• Evidence in the APR Fault Pattern Alarms
  • Feb – Casing Thermal growth and rotor thermal expansion
  • Mar – HP/MP Turbine alignment issues and bearing vibrations/wear
  • May - Misalignment of Turbine and Generator
• Early Warning 6 months prior to failure
• Fault pattern clearly indicates that thermal expansion issues were the symptom
• If maintenance taken to greased standards, thermal expansion would have been corrected and significant savings on maintenance repair costs, and unit availability.
• Possible savings: 2.3 crore
  • 35 days offline (840 hrs), .25Rs per unit energy@110,000 units

*APR = Advanced Pattern Recognition
Benefits

**Strategic**
(increased asset utilization, improved performance and better maintenance planning)

**Operational**
(reduce downtime, asset utilization, improved quality, production performance)

**Engineering**
(decision support, less-time analyzing and more time acting, mobile solutions)

**Financial**
(reduced operational and maintenance costs)

**Safety**
(reduced risk, early warning of impending catastrophic equipment failures)

**IT**
(data quality, utilization, improved models, real-time and predictive insights)
Thank you!