Case Study: Predictive Maintenance of Multiple Assets for one of the Largest Oil and Gas Company

About the Client

The Client is based in Middle East is one of the largest Oil and Gas Companies in the world. A global automation company partnered with us for the implementation of the predictive maintenance solution.

Business Problem

The Client had over 1500 types of critical assets to monitor. In order to avoid the production downtime, the client was doing a regular preventive maintenance of these assets. However, it was proving expensive. Some of the asset parts were replaced even if there were not near end of life fearing a downtime. The Client was hence looking for a predictive maintenance solution which could predict asset failures proactively. The Client would then want to focus on these assets and do the required maintenance activities

Solution

The Client decided to use a third party tool Sure Sense for this purpose. Our role was help the client in implementation of the Sure Sense Predictive Maintenance and Condition Monitoring platform.

Types of Assets: Compressor (motor-driven, steam-driven), Pump, Steam Turbine, Motor, Heat Exchanger

Sub-Systems of an Asset: In a single asset, there are many sub-systems involved. All the sub-systems of an asset are considered while creating any project in Sure Sense. A single project has one predictive model per sub-system. For example, a compressor has following sub-systems:

1. Vibrations & Temperatures
2. Process system
3. Seal Gas system
4. Lube Oil system

Hence, for a compressor, there will be 4 predictive models used in Sure Sense.

The important attributes for an Asset

The attributes considered for any asset while building predictive model in Sure Sense are as follows:

- Drive-end (DE) & Nondrive-end (NDE) temperatures
- DE, NDE radial bearing & thrust bearing vibrations
- Suction and discharge pressure, flow, temperature
- Seal gas – primary seal gas pressure, temperature, flow & secondary seal gas pressure, temperature, flow
- Lube oil – Lube oil tank level, temperature, pressures

SURE SENSE STUDIO

- Sure Sense uses advanced predictive modeling techniques that learn a high-fidelity model of an asset from a sample of its normal operating data.
- Given a new observation from the asset, the model provides an accurate estimate for each observed signal.
- Each estimated signal is compared to its actual signal counterpart using fault detection algorithms to determine whether the actual signal agrees with the learned model. This result is then used to detect equipment failure.

Implementation

Typically, a project contains the necessary information to estimate the expected signal values for the monitored asset given an observation of its actual signals. The project includes the specifications for acquiring the incoming data, various settings to optimize the performance of the signal validation & asset monitoring procedures.

- The calibration data should encompass the expected normal operating states of the asset that will be monitored.
- Test data is used to verify acceptable performance of the calibrated project model before deployment.
- Each correlation model has one phase determiner. The phase determiner takes an observed signal as parameter to set the phases. It is used to determine the operating modes of an asset. For example, you can establish separate phases for determining whether the compressor is running or in shutdown. If you set “Compressor speed” as the phase determiner signal and set 2 operating modes (phases) - one for compressor in working condition (speed range 5000-10000) & one for compressor in shutdown (speed range 0-5000).

  Phase 1 –running ->5000 to 10000

  Phase 2- shutdown ->0 to 5000

  You have an option to deselect any phase that you do not want to monitor.
- Next step is to select the input signals that will be monitored by the correlation model. You need to confirm that there is adequate correlation between the selected signals within the correlation model.
- There is also an option of data filtering in each operating mode (phase) to eliminate abnormal data (outliers) during calibration.
- A single correlation model may contain any number of phases.
- A single correlation model may contain any number of predictive models as well. For example, a correlation model contains 4 different predictive model for 4 systems of a compressor. Any input signal may be a part of more than one predictive model. However, a predictive model should contain at least 2 signals.
- The fault detectors operate on a signal’s residual (residual is difference between actual & predicted values) and determine whether a time series of residuals fits the probability distribution of the calibration data’s residuals.

For example, while testing, if the residual of a predicted signal is out of standard deviation of the residual of its actual counterpart (this is calculated during model calibration) for say, 5 successive data points, an alert may be generated for that signal.

- After training & evaluating the project, you can adjust the predictive model and fault detector settings as needed to optimize the model performance.
- Online datasets allow the project to connect to & read data periodically from a real-time data source. Online data sources can be virtually any type of object that provides real time data for example, memory locations, COM/DCOM objects, TCP/IP ports, databases and so on.

  Data streams in the data source are bound to the observed tags defined in the project.

  Online reader configuration variables include user IDs, passwords, date & time etc.
- After a project has been calibrated & evaluated, it can be used for online monitoring. You have to select an online dataset for online monitoring. After online monitoring is initiated, faults are reported in the design tab & in the monitoring reports. Reports are generated when the number of monitored observations exceeds the monitoring report threshold (user can specify this in project settings option in Sure Sense toolbar).