PETRONAS ROTATING EQUIPMENT ANALYTICS (PROTEAN)

Presented by

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Company Overview

Petroleum Nasional Berhad (PETRONAS) is Malaysia’s fully integrated oil & gas multinational with proven capabilities in a broad spectrum of the petroleum chain value. Established in August 17, 1974, PETRONAS’ vision is to be a Leading Oil and Gas Multinational of Choice.

PETRONAS mission statements are:

- We are a business entity
- Petroleum is our core business
- Our primary responsibility is to develop and add value to this national resource
- Our objective is to contribute to the well-being of the people and the nation
PETRONAS Core Business

UPSTREAM

Natural Gas

Crude Oil

Exploration, Development & Production

Liquefaction

Processing

Refining

Processed Gas

Petroleum Products

DOWNSTREAM

Liquefied Natural Gas (LNG)

Liquefied Natural Gas (LNG)

Regasification Terminal

Processed Gas/Peninsular Gas Utilisation (PGU) System

Liquefied Petroleum Gas (LPG)

Petrochemical Plant

Commercial

Retail

Transportation Sector

Power Sector

Industrial Sector

Residential Sector

Commercial Sector

Industrial & Agricultural Sector

Export
Initial Problem Statement

Over 130 pieces of gas turbine driven equipment
Numerous manufacturers
Centrifugal Gas Compressor
Generator
30+ Pieces of Super Critical Equipment – single duty high value
Numerous Reciprocating engines and pumps
OEM and 3rd Party solutions mean financial commitment would be considerable
Management directive to go digital
PETRONAS Maintenance & Engineering team looked at how to perform diagnostics using unit data on one single unit cost effectively.

- **May 2015**: Utilized Operation Data Management system (ODMS) which is a data capture system using handheld data loggers.
- **August 2015**: Team compiled monthly report using running data and equipment vibration and lube oil health status.
- **October 2015**: Team developed the process flow and investigated ways to improve the overall monitoring system.
- **December 2015**:
<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
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<tbody>
<tr>
<td>Understand data</td>
<td>Unable to run macro to bring data in from spreadsheet automatically</td>
</tr>
<tr>
<td>Monitoring actual data</td>
<td>Poor data entry by operators</td>
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<tr>
<td>Monthly report was produced showing health of the unit</td>
<td>Numerous errors in data capture</td>
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<tr>
<td>Visualized data</td>
<td>Manual process to capture data from ODMS</td>
</tr>
<tr>
<td>Captured a few issues</td>
<td></td>
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<tr>
<td>Understand process flow</td>
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Basic Design Brief

• Not to duplicate machinery HMI
• Not to duplicate the unit control system
• Powerful automatic analytical tools to identify issues before they become issues
  • Simple visuals whilst providing as much relevant information to the engineer as possible
  • Trends and graphs take human process power to look for issue 😞
• Automated alert system
  • Email
• Ability to review historical data
• Not limited to Major Rotating Equipment
  • Support other disciplines
  • Electrical health
  • Pumps
  • Vessels
• Ability to evolve system
  • Visuals
  • Algorithms
  • Integrate with other systems

ADD Value to PETRONAS
Lessons Learnt and Limitations

Understanding the need for management of a system

Excel not ideal as very processor heavy: constant

Difficult to integrate into other PETRONAS systems

Very manual to understand alerts

No automatic email notifications

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System Solution Architecture

1. Data Sources
   - Real Time

2. Data Management

3. Applications
   - PI System

4. Workflows & Integration
   - Business Process Automation Engine
   - Analysis & Predictive Engines
   - Optimization Engines

5. Smart Visualization

6. Informed Decisions
   - Monitoring & Surveillance
   - Analysis & Predictive
   - Action & Optimization
Design Brief for next step November 2016

Clear aim on the system to be developed with element of People, process & Technology

Visuals should be meaningful

System does the hard work and complex thinking processes

Link with other PETRONAS software solutions

Human to make final decision
How do OSIsoft help PROTEAN

- PI Data Archive: Excel not ideal as very processor heavy and constant
- Asset Analytics: No algorithm embedded to the systems
- PI Coresight: Very manual to understand alerts
- Dashboard: Excel not ideal as very processor heavy: constant
- Notifications: No automatic email notifications
- PI AF: Difficult to integrate into other PETRONAS systems
Early development of PROTEAN

<table>
<thead>
<tr>
<th>01</th>
<th>Developed system for 2 critical gas turbine driven compressor units</th>
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<tbody>
<tr>
<td>02</td>
<td>Utilized PETRONAS PI System for data collection and algorithms. Utilized PI Coresight for visuals</td>
</tr>
<tr>
<td>03</td>
<td>Automatic e-mail notifications of issues proved difficult and unreliable. Email notification of unit shutdown successful</td>
</tr>
<tr>
<td>04</td>
<td>Data dump when unit shuts down to aid RCFA : CSV file on shared drive</td>
</tr>
<tr>
<td>05</td>
<td>Data points analyzed based on criticality of data point</td>
</tr>
<tr>
<td>06</td>
<td>Analytic page simple but effective</td>
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</tbody>
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Developed PROTEAN in PI System Environment
Did it Work?

- Yes
- System alerted to numerous concerns over a 2 month period
- Email notifications worked
- Visuals worked well
- PROTEAN Dashboard
During development and implementation May 2017

Increase number of units covered and ISO 14224 system classification

Multiple data point comparisons Increase number of units covered

Understanding of PI AF structure and power

Better email notifications. More information to recipient. Utilized Event Frame process

Create templates for algorithm. Reduce processor and server loading. Not all algorithms are required on all data points

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Current Look and Feel
PROTEAN as tools in PETRONAS Integrated Operation (IO)
PROTEAN in demand!

No of unit in December 2017

32
Next Development

- CMMS, PETRONAS Asset Management, online drawings and other system integrations
- Further Supercritical and C1 units to be incorporated – 100 + units by 2019
- Research more complex algorithms and OSIsoft PI System add-on
- Ability for individuals to run reports on equipment and compare between regions
- Technical Condition Index (TCI) for systems and unit for easy visualization of equipment health
- Develop fault tree to assist engineers with investigation and diagnosis of alerts
- Develop risk based maintenance philosophy (condition based) and move away from fixed periodic maintenance schedules
PROTEAN is developing very well and meeting expectations.

Low cost and high return on investment predicted.

Evolution rather than revolution.

270 man hours each unit to replicate due to template system.

PROTEAN future upgrades will be based on benefit to user.
The Future

Pattern recognition

Baseline scoring

Future data - prediction

Spare part optimization

Analysis tools
Final Thoughts

Why pay the OEM for Remote Monitoring and Diagnostics (RM&D) when the OEM is receiving all the data for R&D? The OEM should be paying the operator for the data... business model change?
THE FUN PART IS WE DESIGNED A FANTASTIC LOGO!!!!

Symbolizes the rotating element

Symbolizes the machinery heartbeat

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Questions

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