The Evolution of the PI System at Noble Energy

The Journey Continues…

Presented by

Joe Hill, PI Team Lead – “The PI Guy”
Vincent Witzel, Real Time Data Practice Manager
• Noble Energy at a Glance….

• Noble’s Journey to an Enterprise Agreement (EA)

• Noble’s PI Project Highlight Reel
  – Calculation of Flash Gas to Oil Ratio (FGOR) with PI Connector for UFL
  – Ensuring Regulatory Compliance Using Notifications
  – Improving Situational Awareness Using Event Frames (EF)
  – Operational Workflow Improvement using PI Integrator for Esri ArcGIS

• Best Practices & Lessons Learned

• Continuing the Journey with the PI System®
Noble Energy at a Glance…

- **HQ** – Houston, TX
- **Operational Centers:**
  - Denver
  - Houston
  - Pittsburg
- Reserves of 1.4 billion barrels of oil (YE2015)
- ~400K BOED
- CapEx ~$1.5 billion
- **Shale/Unconventional:**
  - DJ Basin
  - Permian Basin
  - Eagle Ford
  - Marcellus
- **Deepwater**
  - Gulf Of Mexico,
  - Israel/Cyprus
  - Equatorial Guinea/Cameroon

Energizing the World, Bettering People's Lives®
Noble’s Journey to an Enterprise Agreement (EA)
Key Successes Lead to an Enterprise Agreement

- PI System® chosen in 2010
- Mari-B and AOT installed prior to start up system monitoring in 2011
- Domestic Pilots: Fit for use - Experiments with various use cases
- Gulf of Mexico: AF Structure and Analytics for multiple departments
- Tamar & Alen: 2012
- Marcellus: 2013
- Allegro & Merrick: Integration
- AF and Asset Analytics
- 2014
- 2015+
- Enterprise Agreement
PI System® At Noble Energy: Central System

Houston Central System
Deep Water Operations
Texas Onshore

~10 PI Servers™
~700k tags
~100 AF Templates
~400k Elements
~5k Notifications
Why the Enterprise Agreement (EA)?

• **Stay Relevant** with Business & Technology changes and challenges

• Enterprise Based **Strategic vs Tactical**
  – Infrastructure vs solution approach – enabling “Best of Breed”
  – Self-sufficiency vs Dependency
  – Analytics enablement

• **Predictable cost structure** for Enterprise Infrastructure

• **Acceleration of time to value** and value levels

• **Sustainment of value over time** - Use of new technologies/business models
Challenges we had to Overcome

• Recent heavy investments in SCADA – Why is this different?

• Finding the Money … minimal/no budget … the pooling of resources

• Education – getting to understanding and support from the org.

• Understanding of strategy and getting individual and team alignment

• Getting across the finish line
Positioning the PI System® & SCADA - Context

- Management
- Production, Accounting, Completions
- Engineering, EHSR
- Automation, Construction, Drilling
- Operators, Foremen, Optimization

Current Data Flow

DISTRICT 30 TREND DISPLAYS

MBU Field Summary

- SHL 1
- SHL 3
- SHL 5
- SHL 9
- WEB 4
- WEB 7
- SHL 17

MBU North Totals
- 346.08
- 136,631.41
- 129,548.47
- 133,621.41
- 742.80
- 737.98
- 2,611.76
- 2,660.36
- 162,368.37
- 27,061.40

MBU Totals
- 384.82
- 136,318.41
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- 133,621.41
- 742.80
- 737.98
- 2,611.76
- 2,660.36
- 162,368.37
- 27,061.40

Field Automation

Communications

SCADA

Kepware Technologies

Wonderware, InTouch
We Already have SCADA? – Executive Positioning

Data Sources Designed for Control & Operations

- SCADA
- DCS
- Other Control
- Other Data

Cyber Security/Firewall

Applications & Solutions
- People, Teams, & Enterprise
- Mgmt
- Eng
- PO
- PA
- RO
- EHS & R
- DO
- KPI

SCADA = Supervisory Control and Data Acquisition
DCS = Distributed Control System
Other Control Systems = (PLCs) Programmable Logic Controllers, etc.
Noble’s PI Project Highlight Reel
# Noble’s PI Project Highlight Reel

## Business Problem

<table>
<thead>
<tr>
<th>Problem</th>
<th>Description</th>
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<tbody>
<tr>
<td>Limited functionality of data visualization and reporting tools</td>
<td>Limited amount of historical data available within SCADA systems</td>
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<td>Tag based systems make data difficult to find</td>
<td>Inconsistency and inefficiency in the way wells are optimized by engineers</td>
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<td>Staying emissions compliant with new Colorado State and federal regulations require minimal tank venting to atmosphere</td>
<td>Environmental group had limited insight into control system alarms, and consequently, safety and compliance concerns that might result</td>
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<tr>
<td>Lack of situational awareness due to the large scale of global operations</td>
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## Technical Solution

<table>
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<tr>
<td>Real-time data historization, visualization, and reporting (PI tags and PI Performance Equations, PI Interfaces &amp; Connectors (UFL, OPC, etc.), ProcessBook displays, DataLink Reports)</td>
<td>Real-time data &amp; information contextualization using AF</td>
</tr>
<tr>
<td>Gas lift well optimization using <strong>PI Coresight displays and PI Analytics</strong></td>
<td>Calculating Flash Gas to Oil Ratio (FGOR) using <strong>Asset Analytics</strong></td>
</tr>
<tr>
<td>Tank Pressure Monitoring using <strong>Notifications</strong></td>
<td>Regulatory compliance tracking and reporting using <strong>Event Frames + PI Coresight + PI DataLink</strong></td>
</tr>
<tr>
<td>Environmental group had limited insight into control system alarms, and consequently, safety and compliance concerns that might result</td>
<td>Emergency response, routing, and geospatial situational awareness using the <strong>PI Integrator for Esri ArcGIS</strong></td>
</tr>
</tbody>
</table>

= PI-Based Solutions

= AF-Based Solutions
Best Practices - Creating an Enterprise Ecosystem for Noble’s PI System
Best Practices – First Step

• Rationalize and Ensure Standards are in Place:
  – Documentation
  – Security
  – Backups
  – Exception and Compression
  – Interface Configuration
  – Tuning Parameters
  – Performance Monitoring with Notifications

• Establish a COE, Training, and Certification Program
  – Do more with less
Best Practices – Executive Buy-In

Established Enterprise AF Guidelines and Governance;

• Executive Governance body with Business Value KPIs
Looking Ahead

• Journey to Geospatial Dashboards/Analytics

• More use of Asset Framework/Event Frame Use Cases

• Elevate awareness and strategic support for the PI System® at the executive level – reinforce with KPIs (generated in the PI System®) and business impact
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Questions

Please wait for the **microphone** before asking your questions.

State your name & company.

Please remember to...

Complete the Online Survey for this session.

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Thank You
Using PI DataLink® to Automate old Spreadsheet…Good Start…
Using PI Coresight™ to **ELIMINATE** Excel all together from the equation
Critical Velocity trends in PI Coresight™
Critical Velocity Visualization and Self Serve BI
PI Asset Analytics for Well Performance Calculations

Name: Critical Velocity

Description:

Categories:

Analysis Type: Expression

Name | Expression | Value | Output Attribute
--- | --- | --- | ---
PTBq | "Tubing Pressure" | 117.84 psi | Map
St | "Tubing Size" | 2.441 in | Map
T | if Badval('Allocation Meter Temperature') then 90 else 'Allocation Meter Temperature' | 43.925 deg F | Map
Z | 0.97 | 0.97 | Map
s1 | 7 | 7 | Map
ColemanSCV | 4.434*(((7.481*p_1)-0.0031*(P_TBQ)*0.25)/(0.0031*(P_TBQ)*0.5))*((P_1)*3.067*(P_TBQ)*(d_t^2)*1000)/(576*7*(T+460)) | 473.57 | Map
TurnersSCV | 5.62*(((7.481*p_1)-0.0031*(P_TBQ)*0.25)/(0.0031*(P_TBQ)*0.5))*((P_1)*3.067*(P_TBQ)*(d_t^2)*1000)/(576*7*(T+460)) | 500.24 | Map
CalculatedCV | IF(P_TBQ<1000)then(ColemanSCV)Else(TurnersSCV) | 473.57 | Critical Velocity

Add a new expression
PI UFL .ini file for reading PLC datalogs FGOR

Data log File

.INI File
**Example of the Power of PI AF: Calculation of FGOR**

**Developed Practice to Calculate the Flash-Gas-to-Oil-Ratio (FGOR) / A. Mandel**

The application of a FGOR value (ft\(^3\) of gas/bbl of liquids) to total oil production provides an estimate of total gas production. FGOR values vary with the crude oil production rate, change with the extent of reservoir depletion and may become erratic at certain critical flow rates (e.g., due to slug flow conditions, reciprocating pumping actions, gas breakthrough in the reservoir, and other effects).

Consider the following process flow diagram of a typical legacy site, containing one HP-separator, one 300-bbl storage tank (12' x 15') and one burner:

![Process flow diagram](image)

**Fig. 1 – Process flow diagram of a hypothetical site**

**Solution (case 2 - flow of flash gas down the pipe to the VOC burner):**

1. Head Space volume = 50% * \(\pi \times \frac{(12f)^2}{4}\) * 15 ft = 848.23 ft\(^3\)

2. Calculate number of moles of gas (at the tank) at the start of the well cycle (above ambient pressure):
   
   \[ n_t = \frac{848.23 \text{ ft}^3}{35.3144621 \text{ ft}^3/\text{m}^3} \times \frac{2 \text{ oz}}{\text{in}^2} \times \frac{430.922223 \text{ Pa} \text{ m}^3}{1 \text{ in}^2 \text{ kPa}} \times \frac{\text{mol-K}}{8.3144 \text{ Pa.kPa}298.15 \text{K}} = 20.76 \text{ mol} \]

3. Calculate number of moles of gas (at the tank) at the end of VOC burner cycle (above ambient pressure):
   
   \[ n_f = \frac{848.23 \text{ ft}^3}{35.3144621 \text{ ft}^3/\text{m}^3} \times \frac{2 \text{ oz}}{\text{in}^2} \times \frac{430.922223 \text{ Pa} \text{ m}^3}{1 \text{ in}^2 \text{ kPa}} \times \frac{\text{mol-K}}{8.3144 \text{ Pa.kPa}298.15 \text{K}} = 8.35 \text{ mol} \]

4. Calculate total number of moles generated from flash = 20.76 - 8.35 = 12.41 moles

5. Calculate volume of generated vapor from flash:
   
   a. \[ V = \frac{12.41 \text{ mol} \times 8.3144 \text{ mol-K}^{-1} \text{Pa}^{-1} \text{m}^3}{273.15 \text{K}} \times \frac{35.3144621 \text{ ft}^3}{101325 \text{Pa}} = 9.822 \text{ scf} \]
   
   b. Convert to actual conditions: \[ V = \frac{9.822 \text{ scf}}{8499.72 \text{ Pa}} \times \frac{298.15 \text{K}}{273.15 \text{K}} = 12.78 \text{ acf} \]

6. Subtract the volume calculated in (5) from the Fox Flow reading = 200 - 12.78 = 187.21 acf

7. Total volume of feed entering the tank = 5.5 gal/dump * 5 dump/cycle = 27.5 gal/cycle

8. Convert total feed volume to bbl = 27.5 gal/cycle * 42 gal/bbl = 0.65 bbl/cycle

9. Calculate FGOR in acf/bbl = 187.21/0.65 = 288.027 acf/bbl
FGOR System Overview

Well Battery

O/G/W Flow

PLC

Data Log

CSV File

PI Folder on Share Drive

Future Coresight

PI UFL Interface

.INI File

Mapping
**Effect of PI Notifications**

**GOAL**
Develop a process to **stay compliant** with newly introduced Colorado emissions regulations

**CHALLENGE**
New Colorado State regulations require minimal tank venting to atmosphere

We need to:
- Quickly dispatch repair teams
- Remediate in order to minimize fines

**SOLUTION**
Developed method to gather tank data and notify EHS&R

We built a solution including
- UFL Interface
- Notifications

**RESULTS**
EHS&R is able to respond quickly to field issues and resolve them much quicker

- Staying compliant with the state
- Keeping our emissions lower in the process
Effect of PI Notifications (cont’d.)
## Improving Situational Awareness Using Event Frames

### GOAL

Raise visibility of alarm conditions outside of Operations to improve the situational awareness of Noble’s Environmental, Health, Safety & Regulatory (EHS&R) group.

### CHALLENGE

EHS&R had little, to no insight into control system alarms

- No direct SCADA access
- Consequently, unaware of safety and compliance concerns that might result

### SOLUTION

Developed reports and displays to raise EHS&R level of awareness

- Asset Analytics to generate Event Frames for use in PI DataLink® and PI Coresight™
- EHS&R trained to interpret reports and displays

### RESULTS

EHS&R is able to understand the scale of alarms being triggered in the field without needing to access a SCADA system

- ~2,800 EFs generated, including temperature, level, and pressure alarms.
- EHS&R can be proactive about alarm mitigation
Improving Situational Awareness Using Event Frames (cont’d.)

Briggsdale Event Frame Statistics

Event Frame Frequency Distribution

Event Frame Count

- Total Events: 28
Operational Workflow Improvement using PI Integrator for Esri ArcGIS™

**GOAL**

**Improve the efficiency** of business workflows and situational awareness for Noble’s upstream operations

**CHALLENGE**

Noble Energy has thousands of offshore and onshore assets worldwide but, no single visualization tool to tie together asset data, real-time data and weather feeds.

This compromises the ability to:
- Route personnel to remote locations
- Respond to inclement weather
- Respond to emergency situations
- Ensure compliance of service providers

**SOLUTION**

Combine real-time data from the PI System and other sources, such as weather feeds with traditional asset data

Interactive real-time maps with
- Vehicles
- Weather Radar
- Asset Management using the PI Integrator for Esri ArcGIS and Esri ArcGIS web maps

**RESULTS**

A single standard visualization tool to view remote asset status, asset production rates and weather data in a geographical context.

- Many sources of disparate data
- Map can be configured to reveal as much or as little information as needed at each zoom level.