Update on Our Journey with the PI System at DCP Midstream

Joe Hill – PI System Development Lead
Our Story

- DCP Midstream at a Glance
- Our Journey with the PI System
- PI System –Integration, applications & Analytics Infrastructure

Areas of Presentation Focus

- Accomplishments since PI World 2018
- New Use Case Examples
- Priorities for 2019
DCP Midstream - Who We Are

• We provide the full range of midstream services
  • Gas gathering, compression, treating, and processing
  • Natural gas liquid (NGL) production and fractionation
  • Condensate recovery
  • Transportation, storage and sale of residue gas, NGL and propane

• One of the largest U.S. natural gas processing companies
• One of the largest U.S. producers of NGLs
• One of the largest NGL pipeline operators

Fast Facts

- 63 Operating Gas Plants
- 11 Operating Frac Plants
- 57,000 Miles of gathering PL
- >400 Booster Stations
- 1400+ Compression Units
- 1M+ gathering system HP
- >42,000 meters
- >500K BPD NGL capacity
- 4,500 miles NGL PL
The Integrated Collaboration Center (ICC)

Transformation – People, Processes, Technology
Our Journey with the PI System

2017

- EA Kick Off Meeting & PI AF Jump start/SME training
- Rapid Rollout of PI System Infrastructure
- Initial ICC begins 4 Gas Plants on-boarded in ICC
- 1st ICC Coordinator hired

Q1

- Construction Begins for new ICC

Q2

- ICC moved to 23rd Floor in Denver HQ

Q3

- Begin Gas Control Standup
- 6 ICC Coordinators driving integrated decisions

Q4

- 35 Total Gas Plants & 5 Frac Plants supported by the ICC
- 1st Full Regional Rollout

2018

- Began Integrated Engineering support
- First of Month (FOM) Targeting Alignment coordination begins from ICC

Q1

- 60 Gas & 11 Frac Plants supported by the ICC

Q2

- 35 Total Gas Plants & 5 Frac Plants supported by the ICC

Q3

- 60 Gas & 11 Frac Plants supported by the ICC

Q4

- 60 Gas & 11 Frac Plants supported by the ICC
DCP Midstream PI System Development

Building the Tools for Reliability

PI Asset Framework (PI AF)
- Develop Hierarchy of Gas Plant, Compressor Station, Pipeline Assets
- Organization of Data Into Useful Sets
- Templates for Scalability
- Translation/Integration With Other Business Systems

PI Vision
- Dashboards for Operational Monitoring
- Multiple Sources of Data Combined Into Single View
- Pair Analytics w/Real-Time Values
- Single Point Access Across Organization

PI Alerts & PI Notification
- 24/7 Monitoring & Communication of Anomalies
- Failure Detection, Efficiency Monitoring, Work Mgmt.
- Improve “Digging” for Issues
Example of an OT Data Integration Infrastructure

- **Plant DCS** (OPC, RDBMS, FXBAIS)
- **Wonderware SCADA** (OPC, RDBMS)
- **Allegro** – Market Prices (RDBMS)
- **Windrock Spotlight** (Connector for UFL)
- **VMGSim** (OPC – bidirectional data flow)
- **ACI Compression Modeling** (custom utility – bidirectional data flow)
- **Current local temperature** (custom utility)
- **FlowCal** - Volumes and GC (RDBMS)
- **SkyBitz** – remote tank monitoring (UFL)
- **ALS** – lab tests of oil samples (UFL)
- **SolarWinds** – network equipment status (Connector for UFL)
- **FieldSquared** – Operator rounds (custom utility and UFL)

Reference: DCP Midstream’s PI World 2018 Presentation
Templates, Templates, Templates
Configured via Agile Method by the SMEs with Governance

Elements
- Templates: 408
- Instances: 11,898
  - 29 times as many instances as templates

Analysis
- Templates: 807
- Instances: 84,020
  - 104 times as many instances as templates

Notifications
- Templates: 109
- Instances: 42,336
  - 388 times as many instances as templates

Event Frames Generated
- 1,331,017
The Smart Gas Plant – “Layers of Analytics”
The PI System as an Operational Analytics Infrastructure

- End to end view of plant
- Operational and financial targets
- PvA calculations

**Digital Gas Plant**

- Gas Plant asset configurable templates
- Financial Table
  - Real-time Commodity Pricing
  - Financials based on contract mix

**Physical Gas Plant**

- Optimized Model
  - Real-time/streaming Calculations & Analytics
  - QPC Client Link

**Gas Plant Visualization including mobile**

- “Human Analytics”
- “Advanced Analytics”
- PI AF Linked Table
- PI AF Linked Table

**Visual Analytics**

- Dashboards & Multidimensional Assessment

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Real-Time Compression Optimization
Using PI AF & First Principles Models to Predict Compressor Operations

Case Study: Real-time Compressor Optimization using PI Data and First Principles Models

**CHALLENGE**
- Historically, we run compressor performance curves during design and then periodically to confirm proper performance
- Changes in gas volume, composition, field pressures can significantly change the optimal operating point

**SOLUTION**
- Compression Health Monitoring Team runs first principle models using real-time PI data. Model output is used to define optimal compressor settings for current operation.
- PI Vision displays provides operating conditions based on optimal load step

**RESULTS**
- More quickly identify optimal compressor operating parameters
- Reduced operating costs
- Improved equipment reliability
Linking Operational to Geographic Data

Using Operational and Geospatial Data to Optimize Gas Flow and Gathering Performance

**CHALLENGE**

- DCP’s assets are spread over a wide area, requiring lots of driving miles for operations and maintenance
- With its long distances and extensive interconnections, our gathering system operations must consider geography of our assets

**SOLUTION**

- Linking operating data with geospatial wellhead and gathering system information will allow rapid understanding of issues and responses to normal and upset conditions.

**RESULTS**

- Optimal gas routing
- Increased volumes
- Greater reliability
- Fewer miles driven
Integrated Landing Page

Support System is our Company Overview and Path to all Tools
Regional Field Status Board

Violations of Set Points are Notes for Easy Identification
Reporting using Microsoft Power BI

**CHALLENGE**
- Find a consistent way to standardize reports across our systems utilizing our PI data

**SOLUTION**
- Using Power BI to help us make this possible.

**RESULTS**
- Standard look and feel
- Flexible platform
- Easily reached outside our network
Reporting using Microsoft Power BI

**CHALLENGE**
- Find a consistent way to standardize reports across our systems utilizing our PI data

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- Standard look and feel
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Advanced Analytics Using Seeq

CHALLENGE
• Identifying under performing equipment and it’s impact on production
• Resulting in lost margin

SOLUTION
• Bring in Seeq for a POC
• Training and Kick start provided
• Use advanced analytics to better enable our ICC Coordinators and Engineers to troubleshoot issues

RESULTS
• Being able to identify the problem and Solution
• Determine it’s impact
• Revenue back in our pockets
• After taking action / dedicating resources
2018 Areas of Focus and Accomplishments

• Continue the growth of PI AF – a never ending journey

• Expand the role of PI Vision (External facing)

• Trained Hundreds of employees on PI Vision and PI Datalink

• PI Interface Architecture Upgrades

• More robust PI Analytics

• Implement the Decision Support System
Our Focus for 2019 with the PI System

1. Expand the use of data and automation throughout the company
2. Automate as many manual processes as possible
3. Grow the Decision Support System for Corporate use
4. Expand our reporting capabilities
5. Edge data gathering
6. Data quality monitoring
7. Expanding scope of real time process modeling
8. Building a Community of Practice around PI
Speaker Information

Joe Hill
PI System Development Lead
DCP Midstream
jhill@dcpmistream.com
Continuing to Leverage the PI System for Real-Time Operational Intelligence

PI World 2019 Update

Nick Galizia, Oscar Smith, Matt Whiteman
Agenda

• Equitrans Company History & Asset base
• PI System Background & Initial Rollout

Areas of Presentation Focus

• Operational Event Frame Analysis with TIBCO Spotfire Integration

• 2019 Initiatives:
  • Continued system build-out, integration and reporting initiatives;
  • Event Frame process integration with Maximo Asset/Work Management system;
  • Real-time integration – Engine / Compressor modeling tool;
  • Actual vs Theoretical Revenue Calculator;

• Summary
PI World – Equitrans Midstream

Equitrans Overview
Equitrans Midstream Corporation (NYSE: ETRN)

- Premier natural gas midstream company in the Marcellus and Utica shale
- 3rd largest gas gatherer in the United States
- 700 miles of high pressure gathering pipeline
- 950-mile FERC-regulated interstate pipeline
- ~ 500,000 HP of compression
- #1 customer is the largest gas producer in the U.S.
Operational Intelligence System

### "What it IS NOT"

<table>
<thead>
<tr>
<th>Quadrant 1</th>
<th>Quadrant 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Urgent</strong></td>
<td><strong>Not Urgent</strong></td>
</tr>
<tr>
<td>SCADA Alarm</td>
<td>Operational Intelligence System</td>
</tr>
<tr>
<td>GAS Control</td>
<td>Notifications</td>
</tr>
<tr>
<td>Control System Alarm</td>
<td>Activities</td>
</tr>
</tbody>
</table>

### "What it IS"

<table>
<thead>
<tr>
<th>Quadrant 3</th>
<th>Quadrant 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Important</strong></td>
<td><strong>Not Important</strong></td>
</tr>
</tbody>
</table>

#### Activities
- Interruptions, some callers
- Some email, some reports
- Some meetings
- Proximate, pressing matters
- Popular activities

#### Results
- Short term focus
- Crisis management
- Reputation – chameleon character
- See goals/plans as worthless
- Feel victimized, out of control
- Shallow or broken relationships

#### Activities
- Trivia, busy work
- Some email
- Personal social media
- Some phone calls
- Time wasters
- Pleasant activities

#### Results
- Total irresponsibility
- Dependent on others
- or institutions for basics

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 [562x14]#PIWorld [567x14]©2019 OSIsoft, LLC [614x14]©2019 OSIsoft, LLC [659x14]SAN FRANCISCO 2019 [683x14]©2019 OSIsoft, LLC
Operations Intelligence System Journey

Expanding Digital Footprint

- **2015 – Pilot – One Gathering Site**
  - Saturn Compressor Station
  - 7 Engine/Compressor Units
  - ~9000 TAGS

- **By End of 2019 – 41 locations**
  - 93 Engine/Compressor Units
  - 575,000 Horsepower
  - 16 Gathering facilities
  - 10 Transmission facilities
  - 1 Storage facility
  - 10 M&R sites
  - 4 Interconnect Sites

- **More than 150,000 TAGS/sec**

**PI System (AF) Metrics:**
- 1400 Analysis templates
- 16700 Analyses
- 186 Element templates
- 4200 Elements
- 828 Notification rule templates
- Supported by 2 FTE resources
Operational Intelligence System Preventive Maintenance / Work Management Data Flow and Infrastructure Diagram

- Asset ID's
- MID #'s
- Asset Theoretical Burn Rates (TBR's)
- WO Status and Acknowledgement

- Data &/or Asset WO Triggers
- Asset Runtime Hours

Operating Parameters
- Running
- Pressures
- Temp
- RPM
- Vibration
- Oil Level

Visualize Asset Operation
- Alerts and Notifications
- Compliance Reporting
- Predictive Analytics
- Trends
- Optimize

PI Interfaces

PI Notifications
PI Event Frames
PI Analytics
PI Asset Framework
PI Data Archive

PI Vision
PI ProcessBook
PI DataLink
PI WebParts

OLEDB - Enterprise
Tibco Spotfire
Operations Intelligence System Overview

Compressor Site Overview

Compressor Units
- Engine Data/History
- Compressor Data
- Critical Shutdowns
- Process Data
- Oil Analysis
- Analyst Information
- Maintenance/Work History

Dehydration
- Gas Moisture
- Operating Hours
- Reboiler/Tower
- Process Information
- Glycol Analysis
- Maintenance/Work History

Electric Power
- Generator Data
- Operating Hours
- Power Usage
- Faults
- Maintenance/Work History

ESD System
- Emergency Shutdown System Status
- Valve Positions
- Gas Detector Data
- Faults/Trips

Gas Measurement
- Gas Flow
- Rates/Pressures
- Meter Health
- Valve Positions
- Gas Quality
Operations Intelligence System Overview

System Network Architecture

ETRN Management
KPI Reporting
(Sharepoint/Cognos)

ETRN General
Users

ETRN Compressor
Tech Services

ETRN Operations
Center of Excellence
Monitoring

ETRN Field
Operations

Remote ETRN
Monitoring
Users

Data Archiving &
Visualization
Enterprise Historian

24/7 Analytical
Server

MPLS
Network

Redundant PI

Cygnet SCADA
Operational
Data System

MAXIMO
Work MGMT

(FUTURE)
FlowCal
Measurement

(FUTURE)
JD Edwards
Costing Data
Interface

(FUTURE)
GIS
ESRI
System

Fluid Analysis

Windrock Engine
Analyst Data

Redundant Remote
Collector

Modicon/
Bristol PLC

CAT
Diagnostic
Interface

ETRN Local Control Systems

Typical High Availability Station
Operations Intelligence System Overview

Features and Functionality - Improving Reliability with Prevention & Predictive Modeling

PI Asset Framework (PI AF)
- Develop Hierarchy of Compressor Station Assets
- Organization of Data Into Useful Sets
- Standardization Across Sites
- Templates for Scalability
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PI Vision
- Dashboards for Operational Monitoring
- Multiple Sources of Data Combined Into Single View
- Pair Analytics w/Real-Time Values
- Single Point Access Across Organization

PI Event Frames & Notifications
- 24/7 Monitoring & Communication of Anomalies
- Failure Detection, Efficiency Monitoring, Work Mgmt.
- Improve Operational Awareness
- Eliminate “Digging” for Issues
PI World – Equitrans Midstream

Operational Event Frame Analysis
Event Frame Dashboard

- Generating 100-200 email notifications per day
- No good way to analyze events with email notifications
- Wanted to leverage Spotfire’s data visualization and analysis tools
- Utilized PI OLEDB Enterprise -> SQL Query & TIBCO Spotfire
PI Event Frame Dashboard

- Classified Event Frames by Type
- Reliability personnel review notifications and work with Ops Center to create Maximo work orders
- EF Notification reduction of 70%
- Next steps to integrate with Shutdown process
### Event Frame Summary

**Events per Month - Select Date Range**

<table>
<thead>
<tr>
<th>Month</th>
<th>Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>5827</td>
</tr>
<tr>
<td>Feb</td>
<td>4173</td>
</tr>
<tr>
<td>Mar</td>
<td>2636</td>
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<td>Apr</td>
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<td>May</td>
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<td>Sep</td>
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<td>537</td>
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<td>Nov</td>
<td>1028</td>
</tr>
<tr>
<td>Dec</td>
<td>1245</td>
</tr>
<tr>
<td>Jan</td>
<td>1506</td>
</tr>
<tr>
<td>Mar</td>
<td>1329</td>
</tr>
</tbody>
</table>

**Start Timer (Month)**

2018

---

**Events Per Station - Select Stations of Interest**

No available values.

---

**Event Categories**

- c.Event_Categories

**Assets**

- c.Asset

**7 Columns from PIENTFRAME**

- c.Station_Code
- c.Event_Type
- c.Event_Categories
- c.Vision_Link
- c.StartTimer
- c.EndTimer

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PI World – Equitrans Midstream

2019 Initiatives
2019 Goals and Initiatives

Operations Intelligence System

Objectives:

• Digitally Transform Equitrans business functions with a focus on people, process & technology
• Automate, streamline and digitize the Midstream business

Initiatives:

• Continued roll-out to greenfield compressor stations
• Equipment diagnostics and virtual inspections
• Environmental reporting

• Asset shutdown process
  - PI Event Frame Integration
• Engine / Compressor Modeling Tool
  - Real time integration
Current State

Challenges:
- Current process is manual
- Does not leverage existing technology and PI data
- Email /Text communication not available for future troubleshooting
- Maximo data incomplete

Benefits:
- Provide immediate data
- Memorialize prior shutdowns
- Streamline documentation process

Future State
2019 Initiatives

Asset Shutdown Process (Integrate PI Event Frames with Maximo EAM System)
2019 Initiatives

Integrating PI Vision into Compressor Shutdown Process

NOTIFICATION SUMMARY:

Notification Name: TEST - Jupiter - Unit 2 - Shutdown Event - Compressor - Compressor Overload

Trigger Time: 3/20/2019 4:19:08 AM Eastern Daylight Time (GMT-04:00:00)

Triggering Element Location: ECM\PA\Waynesburg\Gathering\Jupiter\Unit 2\Compressor

Severity: None

Compressor Status: COMPRESSOR OVERLOAD

Engine Status: STOPPED

Compressor Speed: 0.22905233503388

Engine Speed: 0

Load Step: 5

Suction Control Valve: 100

AMP Load: 0

sRCM Current Torque: 100

CAT Engine Load: 0

Triggering Condition: [Error inserting result]

Event Frame Details: Event Details Hyperlink
2019 Initiatives

Actual vs. Predictive Modeling
2019 Initiatives

Predictive Thermodynamic Compressor Modeling Tool
2019 Initiatives

Modeling Tool - PI System Explorer – Analysis / Calculations
2019 Initiatives

Business Case – Actual versus Theoretical Revenue Calculator

Flow Deviation ~4.5%
2019 Initiatives

Business Case – Actual versus Theoretical Revenue Calculator

Numbers are for Illustration only – do not represent actual information

eRCM 187 MMSCFD
Vs
ACTUAL 173 MMSCFD
2019 Initiatives

Business Case – Actual versus Theoretical Revenue Calculator

Numbers are for Illustration only – do not represent actual information.
Leveraging the PI System for Real-Time Operational Intelligence

**CHALLENGE**

Continue our Digital Transformation with new Business Focused Applications

- Great initial value from leveraging the PI System as an operational data integration, applications, and analytics infrastructure
- Meet Organizational request for more operational intelligence

**SOLUTION**

Developed 2019 Areas of Focus to Guide Development; Continue to Leverage the PI System as an operational data infrastructure

- Enhanced Operational Intelligence
- Act. vs Pred. Compressor Modeling
- Act. Vs Theoretical Financial Performance
- Integration with Maximo
  - PI Event Frames
  - Compressor Shutdown Process

**RESULTS**

Continued Strong Business Value and Organizational Cultural Change

- Enhanced, proactive decision making from self-serve access to contextualized operational intelligence
- Increased asset utilization
- Increased financial performance via reduced O&M and Increase in effective system capacity
Speaker Information

Oscar Smith
Sr. Principal Engineer
Equitrans Midstream
OSmith@equitransmidstream.com

Matthew Whiteman
Lead SCADA Specialist
Equitrans Midstream
MWhiteman@equitransmidstream.com

Nicholas Galizia
Sr. Engineer
Equitrans Midstream
NGalizia@equitransmidstream.com
Questions?

Please wait for the **microphone**

State your **name & company**

Please remember

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