Optimizing Drilling and Production Operations with Advanced Functionality of the PI System

Presented by Ken Startz – Marathon Oil Company
Marathon Oil – A global E & P Company

- Established in 1887
- Market Cap: ~ $26 billion (as of 7/26/13)
- Revenues: $15.7 billion
- Net Income: $1.6 billion
- Capital Expenditures*: $5.1 billion
- Net Liquid Hydrocarbon Sales: 282,000 BPD
- Net Natural Gas Sales: 902 million CFD
- Net Synthetic Crude Oil Sales: 47,000 BPD
- Net Proved Liquid Hydrocarbon, Natural Gas and Synthetic Crude Oil Reserves: 2.0 billion BOE
- Employees: ~3,400
- Headquartered in Houston, Texas

*Excludes acquisitions and includes accruals. Unless otherwise stated, financial and operating statistics noted are as of 12/31/12
The Journey of the PI System at Marathon Oil

- **1987**: PI System selected in Refining as standard real-time data “historian”
- **1988**: My First PI System Install – Robinson, Ill Refinery
- **2005-2006**: PI System selected as integration and applications infrastructure in Upstream for Equatorial Guinea
- **2006-2010**: PI System Installed in Norway to integrate and enable remote monitoring and collaboration; Droshky Gulf of Mexico
- **2012**: PI System used for remote Drilling monitoring and optimization
- **2011**: Separation of Marathon into Marathon Petroleum (Downstream) & Marathon Oil (Upstream)
Business Challenges for 2014

• Develop infrastructure for high frequency data needed for Drilling.

• Leverage PI System investment in the new unconventional resource plays.

• Transfer knowledge to newer professionals (Great Crew change Skill Builder Phase).

• Provide easy self-service visualization for engineers.

• Deliver mobility solutions for Operators on iPad.
Agenda

- Illustrative Case Studies
  - Maradrill™ – Onshore Remote Drilling Monitoring and Optimization
MaraDrill™ Background

- Land-based drilling rigs in Eagle Ford and Bakken.
- Primarily oil.
- Horizontal wells.
- Factory drilling.
- Rigs operated by Helmerich & Payne (H & P).
- Data extracted from OMRON Control System and aggregated with 3rd party vendor data, using PI Interface for OPC HDA.
- POC started January 2011.
MaraDrill™ Doghouse
Common Drilling Data Tags

Engineering Units

ROP = Rate of Penetration – Ft / Hr
WOB = Weight on Bit – K Pounds
RPM = Revolutions per Minute – RPM
Mud Flow Rate – GPM
Torque – kFt*Lbs

Need 1 second time stamp resolution!
Data Workflow

MaraDrill™

H&P 463 Eagle Ford

MaraDrill™

H&P 256 Bakken

MaraDrill™

H&P 458 Eagle Ford

Mobile Rig Network Architecture

MaraDrill™

PI System Tags

Historized values

PI Coresight

PI Server

PI DataLink

Houston Tower
MaraDrill™ – Data Acquisition: PI DataLink

Collect MaraDrill™ data from PI DataLink

- Functions that retrieve single value
  - Current value
  - Value at a specific time
  - Tag attributes

- Functions that retrieve series of values
  - Evenly spaced (sampled) data
  - Compressed (archived) data
  - Sampled data for a user-specified array of timestamps
Pre-MaraDrill™ vs. MaraDrill™ Technology

### Pre-MaraDrill™

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<th>Manually entered Parameters</th>
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### MaraDrill™ Technology

- Pason Data Calculator Spreadsheet
- Intermediary Application
- Tool for Advanced Analytics
- PI Server
- PI DataLink
- PI JDBC 2010 Provider
- Spotfire®
PI Coresight – Stick-Slip Identification: H&P 463

“Perfect” drilling

**Stick-slip:** Non-uniform rotation of the bit/BHA
- Sticking phase → bit stops
- Slipping phase → bit “breaks” free

Drillstring torsional oscillations
Real-Time Optimization PI Coresight

Stick-Slip Identification → …few stands later… → Stick-Slip Mitigation

40% Sustained Increase in Rate of Penetration

Avg. ROP for stand is 144 ft/hr

“Acceptable” Moderate Severe

Avg. ROP for stand is 201 ft/hr

Driller has taken suggestion

40% Sustained Increase in Rate of Penetration

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PI Coresight/SpotFire – Stick-Slip Analyses

- Importance of 1 second data
PI Coresight - Stick-Slip

Stick-Slip is Expensive

• Increased bit cost due to number of runs, repair/replacement charges
• Increased hourly cost due to motor usage
• Increased drilling time due to accelerated dulling (low ROP)
• Increased trip time due to number of runs
• Increased costs associated with downhole tool damage (MWD, LWD)
PI Coresight View with XML Data Export

Enables integration with WellView data

Enables integration with Spotfire visualization
Custom Spotfire Interface

Enables integration with PI System data from PI Coresight

Guided analytics
Guided Analysis – Time Based or Depth Based
Post-Well Science Using MaraDrill™ Data in SpotFire

Modeling the rock strength & predicting ROP’s on subsequent wells in the area to improve logistics and planning.
Days vs Depth Curves for MaraDrill™ Rigs
Black = MD, Teal = No MD
Post-Well Science Using MaraDrill™ Data in SpotFire
Formation Sweet-Spot Analysis

3D Scatter Plot: G vs T vs H
Sweet-Spot Analysis: Greener = Faster, Smaller = more efficient
MaraDrill™ Benefits

• May replace third party real-time data aggregation software.
• Accessible real-time data at the rig and to remote employees, enabling more efficient decision making.
• Consistent and easy-to-access data. More eyes on the data.
• Drilling time and capital well cost savings:
  • Potential $1 MM / rig / yr for every 5% reduction in drill time.
• Reduced vibration and damage to downhole tools
• Continuous optimization onsite and retrospective post-well analysis
Agenda

• Illustrative Case Studies
  – MaraProd™ – Production Operations by Exception
Scope of North America SCADA

Spans Six States
Thousands of miles
Marathon Oil Company Real-Time Architecture for Global Production Operations

**NAPO**
- North Dakota
- Wyoming
- Colorado
- Oklahoma
- Gulf of Mexico
- Wonderware DCS
- Industrial SQL
- PI Interface for OPC

**IPO - EG**
- MEGPL Alba B 2
- MEGPL Gas Plant
- Experion DCS
- Honeywell PHD
- PI Interface for PHD
- PI DataLink

**Outside Operated**
- Industrial Evolution
- PI Server
- PI to PI Interface

**IPO - Norway**
- Alvheim
- Kongsberg/Rapid
- PI Server

**Fairfield**
- Intellution iFix SCADA
- Proficy Historian
- PI Data Publisher

**Gulf of Mexico**
- Aker Solutions MCS
- PI Interface for OPC
  - OPC DA Interface

**Cody Dickinson**
- LOWIS

**PI WebParts Server 2010 R2 (SharePoint 2010)**

**PI ACE Server**
MaraProd™ Background

- Will cover 5,200+ Automated Wells in U.S.
- Enables Production by Exception Mindset
- Pilot (Jan 2014) for Eagle Ford Asset
- Initially released on iOS Devices. Programs written by Marathon developers.
- Geospatially enabled.
- Both Well Surveillance and Calculations based on PI AF V 2.5.
MaraProd™ Data Tags

TBG_PRESS  Tubing Pressure
CSG_PRESS  Casing Pressure
YVOL  OIL
TVOL  GAS
PVOL  WATER
Drill Down by Asset Team, Field Office, and Well Elements
Attributes for each Well in Eagle Ford

Standard 11 Data Tags pulled for every well on the route.

PDEN ID is the well header ID from TOW.
Summary

1. Use and value of the PI System has evolved over the last 25 years…and has become strategic to our information infrastructure

2. Significant benefits in model integration and SME enablement

3. PI System combined with PI Coresight has value in Drilling!

4. PI AF has huge value in enabling standard Production Ops queries.
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