BP North Sea

Driving value from Digital

Speakers: Peter Severs & Erik Lindhjem
Machinery Condition Monitoring

Industry Drivers

- Safety and environmental compliance
- Capacity & availability
  - Productivity
  - Operating Expense
- Machinery expertise

Motivation

We are a mature and proactive shop, but…

89% of failures are NOT time-based

Using Foresight & Insight to ...

- Minimize...
  - Forced outages
  - Extra starts
- Improve...
  - Unit performance
  - Labor
  - Spares

Source: Nowlan and Heap study

(Primarily random wear) 89%
BP North Sea
Value Realisation
Supporting BP’s modernization and transformation agenda

• 2011 - BP expands its investment in Condition and Performance solutions to Brownfield installations

• 2012 - With a focus on improving uptime through defect elimination, BP’s Reliability and Maintenance team engage GE Bently Nevada Supporting Services

• 2013 - Go live for Remote Connection on 2 North Sea Production Facilities (BP Clair & BP Magnus)

• 2014 - Adoption of GE Predictive Analytics (SmartSignal) to supplement remote monitoring and early warning of developing abnormal conditions

• 2015/16 – Systems and service scope extended to all 5 North Sea production facilities and commencement of commissioning on 2 new facilities (Glen Lyon & Clair Ridge)
Program objectives

• Safe and reliable operations
• Improve uptime using systematic defect detection and predictive maintenance techniques
• Systematic defect elimination and early vulnerability detection
• Improved planning for maintenance and turnarounds
• Standardization and consistent deployment across North Sea Production Assets
Deployment Challenges

Deployment on Brownfield operational assets raise various challenges:

- Network connectivity
- Variety of control systems and data repositories
- An array of rotating equipment supplied by various different package vendors
- Aging controls and instrumentation
- People on board and production constraints
Key tools and technology

- GE SmartSignal, which is powered by GE’s Predix™ platform works by leveraging the existing data and infrastructure (such as a PI historian) to provide early and actionable warnings of impending equipment and process problems.

- This tool can provide ***foresight*** into arising issues well before classical methods of modeling could.
Key tools and technology

System 1 is GE Energy’s patented software platform for real-time optimization of equipment and selected processes, condition monitoring, and event diagnostics.

It allows detailed review of data in very high resolution to provide the user with a detailed understanding and insight into the machine’s condition.
Defining a repeatable process

- Monitor
- Report
- Review and discuss case
- Plan and raise a work order
- On-site work
- Review findings from on-site work
- Build on learnings / Optimize
Case History – Seal System Vulnerability

- Identified a developing issue on the dry gas seal system for a hydrocarbon compressor
- Tags are part of a 2 out of 2 voting executive action creating the potential for a single point of failure as well as found to be out of calibration
- Similar events due to compromised instrumentation have resulted in production deferrals of **30 MBOE**, Gross.
- This intervention identified and removed a vulnerability that could have resulted in a compressor outage of up to **12 weeks** based on time to investigate and replace a failed seal.
Case History - Export Compressor Vulnerability

Deviation Detected

GE remote monitoring team detects a change in machine operating condition and notifies on-site support engineer.
Case History - Export Compressor Vulnerability

Initial Review

The BHGE site lead reviews and identifies that the increased direct levels of vibration is made up of a sub-synchronous component.

Insights Developed

Further review finds identifies the potential presence of oil whirl characteristics based on the before and during sub-synchronous behavior.
Case History - Export Compressor Vulnerability

Immediate Actions

• Increase machine loading by increasing recycle.
• Amended operating practices to avoid similar conditions occurring.
• Longer term plan put in place to improve the quality of the seal oil through the use of a kidney loop system.

Value

Total value could have been up to **149,000 Standard Barrels** of deferred production avoided.
BP’s Digital investment

Process
Every 6 months, BP and BHGE jointly review agreed contract Key Performance Indicators and report value contributions by the team.

Value
In 2016, the following results were generated:

- An estimated value of approximately **118 MBOE Gross** of deferred production was avoided during the selected 6 month period
- The team initiated and investigated **44 Cases** during the last 6 month period
- The top value stories from 2016 evaluated generated **6.5** times the current 12 month renewal contract value
Return on Investment – BP North Sea

2014
5.1 ROI

2015
5.6 ROI

2016
6.5 ROI
Reference Architecture

BP Production Facility
- Tactical Machinery Diagnostics
- Device Connectivity

BP Enterprise Level
- Combined SmartSignal and System 1
- Data Replication and Remote Access
- Proactive Machinery Condition Monitoring

System1 Data and Advisories into POA
- Asset Strategy Optimization
- EAM Integration

Core machine connectivity
Live data analysis

Detect machinery problems
Diagnose fault condition and priority

Propagate actionable information
Manage machinery fleet

BP Plant Operations Advisor

Machine A
Trend Data, Level 3 Alarm, Bearing Defect, Priority 3 “Next Opportunity”

Machine Insights

BP hosing environment
Predix™ Cloud

Machine A
Mechanical and Process Data

BP Plant Operations Advisor

Predix

Business

Trend Data, Level 3 Alarm, Bearing Defect, Priority 3 “Next Opportunity”

Machine Insights

BP hosing environment
Predix™ Cloud
What Lies Ahead?
Providing a seamless data journey

SYSTEM 1
DATA ACQUISITION
MACHINE ANALYTICS
MACHINE INSIGHTS
MACHINE DIAGNOSTICS

ENTERPRISE IMPACT
SOURCE AGGREGATION
DOMAIN ANALYTICS
FLEET PRIORITIES
DOMAIN VISUALIZATION

APM
ASSET STRATEGY
STRATEGY PERFORMANCE
FAILURE ELIMINATION
MECH INTEGRITY
RISK INSPECTION
BENCHMARKING

DIAGNOSES
PRIORITY
STRATEGIES

SCOUT
ADAPT
vbOnline Pro
2300
TDISecure
Encore
3500
Product Roadmap – System 1

What’s new? 17.2 Nov release

• Getting started … Recip compressors
• Improvements for Turbomachinery, Complex Gearboxes, and General CM
• Data Management
• Complex Diagnostics
• Database Migration ... 6.x & Ascent
• Database Replication ... Scalability
• CM Detection - Extractions
• Report Workflow

What’s next? 18.1 and 18.2

• Standardize migration services
• Continue to improve Turbomachinery, Complex Gearbox, Recip Compressors and General CM
• Support more legacy BN devices
• Scalable edge and enterprise
• 3rd party device integration
Product Roadmap – Enterprise Impact

What’s new?
• iOS and Android mobile applications
• Thermal performance modeling and visualization
• Improvement for managing events
• Internationalization
• Getting started ... GE APM integration

What’s next, 2018?
• Scaling APM/Predix connectivity and usage
• Alarm management & filtering
• Predictive extractions
• Compress Advisor ... Wash, Surge, Stall
• Extended EVM beyond centrifugal machines
Driving World Class Outcomes

Work Identification
- Data Acquisition, Anomaly Detection, & Diagnostics

Work Evaluation
- Risk Definition, Strategy Validation

Work Execution
- Operational Changes, Proactive Maintenance, & Intervention

Confidence to be Proactive
Questions