How digital oilfield solutions improve operational safety and profitability: Balancing evolution with revolution

Katrine Hilmen, Ph.D.
Business Area Manager, ABB, Norway

Havard Devold, Market & Technology, ABB, Global
Abstract

[...]
If you want to perform a lean operation in remote areas, such as the high north, away from populations, whilst maintaining a good understanding of the nature of the well and production facilities with active monitoring and good contingency planning, integrated operations are the way forward. In the Arctic, you cannot go into the ice to replace a failing turbine or any other piece of heavy machinery. Smaller elements can be flown in with helicopter, but heavy equipment cannot be delivered in the winter. If there is a failure and resultant spill in this environment there is no known technology for recovering oil under the ice. The only way that safe operation of wells in the Arctic will be made possible is through digital oilfield solutions.
Operations in the high north
Ensuring safe, efficient and sustainable operations
Challenges

- Cold climate, harsh environment
- Lack of infrastructure
- Long distance, remoteness
- Attract workforce
- Autonomy of operations

Issues

- License to operate
- Risk
- Environment
- Safety
- Latent developing faults
- Preparedness

Constraints and opportunities

Exploration  Reservoir
OPEX       IOR
Investments Lifting cost
Digital infrastructure enabling remote and integrated operations

Satellite / Fibre Optic / Broad-band Connection

Company Expert Resource Center

Operation Center

Control and Optimization

Supplier Support Centers
Integrated operations

Definition

Remote support

Onshore organization mainly acts as a support organization for the offshore operations; some of the routine tasks which can be conducted during normal office hours can be handled by onshore staff.

Remote monitoring

A continuous process to invoke condition, status and performance of inventory and transfer data and information to Onshore Maintenance Center (OMC). Operational liability will be allocated locally at the offshore facility.

Remote control

Remote control is defined as partly or fully remotely supported from an Onshore Control Center (OCC) in a pre-defined pattern, where roles, tasks and responsibilities is clearly defined between the two control room facilities.

Remote operations

Remote Operation is defined by that the entire offshore facility is controlled and operated from an Onshore Control Center (OCC). The operational responsibility is entirely transferred to the OCC.
How operational flexibility assure safe and reliable operations

Most safety incidents
are caused by human error
occur when the plant is in an ”unusual” operational mode
occur when several unusual operations are executed in parallel

Safety incidents are unlikely to occur when
the plant ”operates itself” – robust control
the alarm frequency is low – robust operation
the operator can have sufficient focus on unusual operational modes
an active safety and alarm management program is in place
How operational flexibility assure reliable operations

Situation
- Plant operating at reduced production due to maintenance on one of the compressor trains, resulting in an unstable operation
- Pigging of inter-field pipeline in progress
- Line testing of gas detectors in progress
- Maintenance of pressure sensors in progress

Result
- Operators overloaded with tasks, and due to a miscommunication, a pressure sensor on the firewater ring is not inhibited when it is disconnected
- Disconnected sensor results in an indication of insufficient firewater pressure to the safety system
- Full process shutdown
How operational flexibility assure reliable operations

Alternative outcome

- Plant is stable even during reduced production because control system is regularly tuned using a remote service
- Condition monitoring of gas detectors reduces requirements for testing. In this case, the testing is scheduled for a time with less operator load
- During a safety analysis of the planned activities, a ”high operator load” situation is identified. In such cases, control of parts of the process is being handed over to the onshore control room
- The result: The operators in the control room can give sufficient attention to their remaining tasks, and no incidents occur
- Savings per avoided shutdown 1-10 MUSD
Early adaptation, experiences from the North Sea

ENI Goliat

Shell
Ormen Lange

GDF Suez
Gjoa

BP Valhall
Example from the North Sea
Remote centers and integrated operations

Gjøa

How remote condition monitoring improve availability

Gjøa
High vibration suppressed due to startup conditions

Compressor trips due to high vibration in gearbox-compressor connection

Compressor tripping on high vibration

Sequence of analysis

High vibration suppressed due to startup conditions

Compressor trips due to high vibration in gearbox-compressor connection

Case

Moscow, Russia | 15-19 June, 2014

Performance Monitoring (Turbowatch) excludes surge as an issue

Resonance frequencies for the compressor train provided

Indications of excitations on resonance frequency 14-15 Hz, however this mismatches with compressor RPM (3900)

VSD monitoring reveals torque fluctuations of 14-15 Hz in motor when motor RPM is 800-900, Drive excluded as possible cause
Compressor tripping on high vibration

Root cause and solution

Trip caused by vibrations in 14-15 Hz regime
Resonance frequency of the compressor train in 14-15 Hz domain
Resonance frequency excited when motor RPM is 800-900
Detection of critical rotation speed via the VSD monitoring analyzing torque fluctuations

Solution: Fast acceleration through the critical rotation speed interval
Trip-multiply implemented from onshore location
Result  Minor changes in the protection system eliminated the problem.
      The platform can continue operating with minimal downtime

Enablers

GDF SUEZ strategy for Integrated Operations, Integrated Operation Strategy
"Based on criticality classification, all equipment and systems shall be designed for real time condition monitoring."
"The data shall be made available both onshore and offshore using high quality data/information transfer ...."

GDF SUEZ Operational Philosophy

Access to information for internal and external users and extensive use of service partners
Instrumentation to cater for condition based maintenance as a part of the project delivery
All relevant parameters for the compressor were monitored
   The process conditions and performance
   Vibration analyzes
   The electrical parts of the system monitored as a part of the compressor train

ABB Service Environment provided easy access to experts for discussions, analysis, data collection and problem solving.
Moscow, Russia | 15-19 June, 2014

Diagram:
- Right Information
- Right Data
- Outcome review
- Implementation
- Planning
- Decisions Trade-offs ranking
- Analysis Options Evaluation
- Situation Awareness
The North Sea experience

Integration value

Integration across companies

Integration across on- and offshore

Limited Integration

Traditional practices
- Self-sustained fields
- Specialised onshore units
- Periodical onshore support

Generation 1
- Integrated onshore and offshore processes and centres
- Continuous onshore support

Generation 2
- Integrated operator and supplier centres
- Automated processes
- Digital services and 24/7 operations

Time

Source: NOROG (OLF) – Integrated Work Processes, 10.2005
Example from the high north
Remote area integrated operations

Eni Goliat
The digital oilfield: A journey from vision to realization

Pull for digitalization and automation

Source: SPE 2001
Mature field redevelopment versus new fields developments
Conclusions

Personal reflections

People trump technology

- Technology will help you **enable** better maintenance
- People will **execute** better maintenance

There is no silver bullet

- Vendors will be good at different things
- Choose solutions that you know you will be able to utilize
- System integration that fit your people and way of working

Think condition monitoring when ordering long lead items

- Equipment must often be «maintenance enabled» out of the factories

Know what you want and challenge your vendors

- Include vendors in performance thinking
- Trust and ownership

Every asset is unique

- But they are also quite similar
- Learn from others and adapt
Katrine Hilmen, Ph.D.
Integrated Operations Manager
ABB, Norway

Author Biography

Educated NTNU (M.Sc., Ph.D.) in chemical engineering, modeling dynamics, advanced process control and systems engineering. In ABB since 2001, working with flow control and enhanced oil production, industrial IT and integrated operations services. Taken a central part in the pioneering age of digital oilfield in the North Sea and its adaptation to real practice. In 2005, Hilmen was awarded the prestigious TR35 top young innovators by MIT’s Technology Review for having developed online monitoring and management tools for offshore oil production platforms. Hilmen heads the integrated operations portfolio globalization and studies at ABB’s Industry Solutions Center in Oslo, Norway. SPE, AIChE member.