The next industrial revolution in oil and gas

Where operational efficiency is the new normal

IBM Institute for Business Value

Fueling the future

During the years that crude oil surged beyond USD 100 per barrel, oil companies made fabulous profits without having to be particularly smart, efficient or innovative. That's all changed. Between 2014 and 2016, a global glut in supplies and fear of market-share loss sent oil futures into free fall, as the price per barrel was slashed roughly in half.[1] Even though oil prices are expected to gain traction in 2018, oil companies cannot rely on the bygone, long-term luxury of higher prices.[2] Instead, they must embrace new types of technology to create a new normal.

The business case(s) for IoT

The Fourth Industrial Revolution, as so named by author Klaus Schwab, will be born of emerging technologies that fuse the physical and digital worlds. In oil and gas, the next industrial revolution is characterized by breakthroughs in artificial intelligence (AI) and the Internet of Things (IoT).[3] The IoT helps companies explore new ways to execute their strategies to improve productivity, enable predictive maintenance and expand operational insights. For oil and gas producers in particular, IoT can deliver information-based value creation by:

– applying predictive asset optimization

– optimizing upstream and midstream operations

– modernizing technologies for environmental and human monitoring and logistics

To motivate the power of AI and IoT in oil and gas, we selected nine IoT specific use cases from client projects that clearly exemplify information-based operational improvements in the upstream, midstream and downstream. The first three detail *upstream* operations and asset optimization:

1. *Well drilling optimization.* The drilling process is complex and requires precise engineering. For example, when lowering pipe into the ground, it can easily become wedged in the bore hole. Advanced analytics of sensor data allows real-time preventive detection and a potential decrease of up to 85-percent reduction in stuck pipes.

2. *Well predictive asset optimization.* Equipment failures make it difficult to meet production targets. A predictive model can help keep production steady and more accurately forecast equipment failure — by more than 85 percent — days in advance of an event.

3. *Well production optimization.* Sensors that detect production anomalies can help deter major problems and increase operational efficiency by up to 5 percent. For example, when pumping heavy oil out of the ground, steam must first be injected into the well to warm and thin it. If too much steam enters, the well can become unstable.

"Without data, you're just another person with an opinion."

W. Edwards Deming, American statistician[5]

Case study: Well predictive asset optimization[4]

Santos Ltd., a leading oil and gas producer in Asia Pacific, operates an exploration and production business in Australia. Using IoT technologies, such as supervisory control and data acquisition (SCADA), a system of software and hardware that control processes, Santos can measure temperature, vibration and voltage on an asset-by-asset basis. Santos pulled structured and unstructured data from multiple sources, including:

- The speed at which a compressor is operating
- The operator shift log where field operatives record their activity
- A computerized maintenance management system that contains a record of assets and maintenance history
- The asset loss and availability system, an accounting solution used to trace the sources of production losses

Based on this data, multiple models were developed, including:

- Wellhead tank and pump models to provide early warning of refill, leaks, blockages and user error, creating a savings of AUD 1.1 million annually.
- Wellhead power models to provide early warning of battery and solar panel faults, resulting in initial savings of AUD 0.5 million per year. The addition of machine learning increased savings to AUD 3 million annually.
- Sensor models to warn of sensor failure or temperature events, which saved approximately AUD 4 million annually.

The next three use cases detail *midstream* operations and asset optimization:

4. *Pipeline monitoring and leak detection.* Standard remote pressure sensors have relatively low accuracy and are prone to false alarms and over-sensitivity to environmental conditions. A system using advanced analytics and visual or acoustic sensors can detect leak points with high precision in near real-time, resulting in efficient leak detection and localization.

5. *Refinery predictive asset optimization.* Complex machineries require extensive maintenance. Advanced analytics applied on automated measurements or manual inspections can predict corrosion and wear and tear to reduce inspection and repair costs. System analysis can trace operational problems back to a root cause to correct the core problem, rather than fighting its symptoms.

6. *Augmented reality support.* Blurring the line between reality and computer-generation, augmented reality glasses project contextual information. An operator sees information relevant to the process. An engineer can view step-by-step instructions while working construction or other tasks. Such initiatives eliminate time needed to search for and retrieve information with a projected 10-percent increase in staff efficiency.

The final three use cases detail *downstream* logistics and asset optimization:

7. *Enhanced oil tanker scheduling and navigation.* When vessels are not fully stocked and routes are not fully optimized, material balancing and inaccuracy of ship schedules increase operating costs. Advanced analytics, using real-time ship locations, can improve scheduling and navigation accuracy and lead to more than a 10-percent increase in naval logistics efficiency.

8. *Enhanced truck scheduling.* What is true for oil tankers is also true for trucks. Advanced analytics that use real-time truck locations and inventory information can lead to significant increases in land logistics efficiency. Combined with other data on relative vendor effectiveness and driver efficiency, enhanced scheduling can lead to a 15-percent increase in land logistics efficiency.

9. *Office building management.* Lights shining day and night, facilities heated while empty and failing machines burden building management. Linking equipment to a central system can optimize building operations and improve space utilization and work atmosphere. Although energy savings and maintenance cost reductions due to improved space utilization vary per case, such initiatives could generate efficiencies of up to USD 5 million annually.

Value in the flow of information

We have assessed and positioned the nine selected use cases by estimated value if successfully rolled out on an industry-wide scale. Value estimates follow from Fermi estimates — approximate calculations about quantities and their variance — based on confidential client examples and industry data. For the oil and gas industry, selected use cases represent a potential value realization of USD 55 billion annually (see Figure 1).

Actual value and the relative positioning of use cases will differ for each oil and gas company, depending on scale, complexity and technological readiness. Four use cases are identified as business proven: well predictive asset optimization, refinery predictive asset optimization, enhanced truck scheduling and office building management.

Figure 1
Value of IoT use cases (USD 55 billion)

Use Case	Estimated value (USD billion/year)	Scaling complexity	Technological readiness
Well drilling optimization	3	High	Business ready
Well predictive asset optimization	14	Medium	Business proven
Well production optimization	22	High	Business ready
Pipeline monitoring and leak detection	0.3	Low	Experimental
Refinery predictive asset optimization	2	Medium	Business proven
Augmented reality	11	High	Experimental
Enhanced oil tanker scheduling and navigation	1	Medium	Business ready
Enhanced truck scheduling	1	High	Business proven
Office building management	1	Low	Business proven
Total	55		

Business proven:
Proven or matured technology which has shown acceptable performance and reliability within predefined criteria

Business ready:
Prototypes operated successfully, ready for scaling

Experimental:
New technologies being prototyped

Making it real

Oil and gas organizations ready to embrace digital technologies should begin with a roadmap of delivery components and timing. Some of the nine use cases can run in parallel, while others are a logical continuation of earlier transformation activities based on the readiness of the oil and gas producer concerned. The IoT journey comprises the following two steps:

– *Select, deploy and extend.* Prioritize use cases based on value and stakeholder support. Implement point of views (POVs) at favorable locations using rapid prototyping. Last, when successful, scale consistently to obtain full value.

– *Implement an enabling foundation.* An IoT platform should address three basic technological components. It should address interconnectedness to integrate data from various data sources and platforms. It should use cognitive analytics and AI to keep pace with the volume, complexity and unpredictability of unstructured information. Finally, it should also have robust security, particularly since IoT systems have a direct and powerful impact on their physical environment.

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