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Harness the Power of Sensors and Digital Twins for Oil and Gas

Executive Summary by

Oil & Gas iQ

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INTRODUCTION:

From an onshore control room, operators monitor the performance of an offshore oil and gas rig. Alerts pop up automatically to let operators know of potential problems and make suggestions on how to optimize production, reduce energy consumption, and lower emissions. In the future, these human operators won't even be necessary as the rig will be able to self correct and adjust as necessary for optimum operation.

The above scenario is no longer the domain of science fiction. The oil and gas industry is making rapid strides towards a future where offshore rigs are the domain of robots rather than people. Fully autonomous oil and gas operations that are self-monitoring, correcting, and maintaining are getting closer thanks to advances in digital technologies.

It's boon for an industry struggling to attract workers who want to work in such remote and challenging environments.

While it takes a complex interplay of technologies to deliver autonomous operations, at the foundation is a connected ecosystem where digital sensors monitor critical aspects of operational processes and equipment.

Sensor data and applied analytics have become the essence of automation and digital transformation, explains Sunny Awasthi, Client Technical Leader at Kyndryl, an IT infrastructure firm, during a recent webinar hosted by Oil and Gas IQ.

While autonomous operations - or heavily automated operations - may be one of the goals, Awashti explains that oil and gas companies can get many other benefits out of applying advanced analytics to sensor-based data to identify trends, predict events, and quickly respond to potential problems.

Some of the benefits of analyzing trends and insights coming from digital sensors applied to operational technology include:

- Increased visibility into the measured environment
- Improved worker safety and productivity
- Increased operational efficiency
- Reduced machine downtime in plants
- Reduced maintenance costs

But how can oil and gas companies successfully leverage sensor data and analytics in order to realize these benefits? The following write up summarizes the webinar, The Power of Sensor Data Based Analytics in Oil and Gas, Utilities and Chemicals Industry, and offers industry use-cases for utilizing sensor-based predictive analytics and practical advice on how to successfully leverage sensor data for advanced uses such as digital twins.

Watch the full webinar On Demand. Presented by Bruce Dargus and Sunny Awasthi, Client Technical Leaders at Kyndryl.

Digitalization and analytics are transforming business processes and decision making in oil and gas

Oil and gas operations are awash with information – tank pressures, drilling speeds, fluid levels, equipment temperatures, gas levels, etc. Industrial companies have long used data like this to run more efficient operations, identify potential failure modes, improve maintenance regimes, and reduce safety risks.

While in the past much of this data had to be collected manually – often by operators walking around with paper and pen - the digital revolution means that data collection can now be automated via sensors on physical assets and analyzed in real time.

This gives the oil and gas industry an unprecedented opportunity to make better decisions and optimize operations like never before.

Indeed, consultancy McKinsey has done work with offshore oil and gas operators and found that deploying connected digital tools and analytics, "operators can reduce costs, including operational and capital expenditures, by 20 to 25 percent per barrel".

Example use cases in the oil and gas sector include:

Upstream	Midstream	Downstream
• Managing seismic data to determine petroleum source locations and volume • Optimizing drilling process with customized predictive models that forecast potential equipment failures • Improving reservoir engineering to drive performance and profitability	• Ensuring safe logistics of energy products • Detecting abnormalities in pipelines and tankers • Preventing environmental accidents with insights into cracks, corrosion, ground movements, and more	• Reducing downtimes and maintenance costs with detailed equipment performance analysis • Improving asset management with insights into historical and current operating performance • Managing operational costs with failure rate analysis and end-of-life asset criteria

Table source: "The Power of Sensor Data Based Analytics in Oil and Gas, Utilities and Chemicals Industry"

Using Sensor Data for Digital Twins

One of the more advanced uses for sensor data is to incorporate it into a digital twin, a virtual representation of a physical object, component, or system.

Companies use digital twins to create simulations to better understand and predict behavior of an asset (for instance, to identify when a piece of equipment might fail). A digital twin can even be updated in real time if IoT-based sensors are applied to the physical asset (the "Physical Twin").

The digital twin predicts statistically likely behavior and allows operators to conduct root-cause analysis or flag potential problems in advance.

"You're not only getting intelligence on what could go wrong," says Awashti. "You're also getting intelligence on prescriptive solutions."

Oil and gas companies are increasingly looking at implementing digital twins. By mid-2023, 37% of oil and gas companies are expected to have a digital twin in place and by 2025 that number is expected to rise to over two thirds of companies, according to Bruce Dargus, Client Technical Lead at Kyndryl.

But what gets lost in the focus on digital twins is the fact that it is only as good as the information it gets from the physical word.

"Everybody is talking about the digital twin, but not everyone is talking about the physical twin and that's where this whole concept interacts," observes Dargus.

Digital twins seek to "predict or determine the future behavior of the associated physical twin." By representing physical objects in a virtual world, companies can analyze trends, examine common failure modes and build predictive capability for better operations.

The table below offers uses cases for how Energy, Oil, Gas, and Chemicals operators might be able to benefit from sensor data incorporated into with analytics and digital twins:

Site well pump production flow analysis

- Improve time and calculation of estimated pumping
- Identification of potential problems with future oil production, including mitigation of methane emissions

Optimizing asset performance

- Identify impact of storms in real time to determine probability of an asset failure
- Reduce response time to a potential outage

Equipment evaluation

- Predictive equipment failure eliminated false negatives
- Improvement in retention times for expensive equipment and decreased repair times

Smart load management

- Strategically manage peak user demand
- Manage and switch between disparate and distributed energy sources, whether they are fossil fuel based or green energy

Safety and accident prevention

- Awareness of chemical usage, storage, and transportation
- Governance to monitor and counter levels of secondary gases or chemical byproducts

Energy usage and management

- Intelligence that leverages smart manufacturing techniques
- Enablement of new and innovative manufacturing methods to increase plant productivity

Table source: "The Power of Sensor Data Based Analytics in Oil and Gas, Utilities and Chemicals Industry"

The Cybernetic Feedback Loop

As the physical twin and digital twin interact, organizations can start to make use of a "cybernetic feedback loop" where the entire system becomes self regulating. Data from the physical twin feeds into and informs the digital twin about what is happening on the asset in real time. The digital twin is able to recommend actions and make adjustments automatically to the physical asset in order to optimize production processes.

"The physical twin is the one linked up with all the sensors and that feeds and build the digital representation of that physical object or component inside this virtual world," explains Dargus.

Common Challenges with Using Sensors

It's clear that there are numerous benefits and use cases for sensor data and digital twins. But it takes more than just deploying sensors on a few machines to truly realize the benefits and opportunities of these technologies.

One of the first challenges is ensuring the integrity and availability of data. First and foremost, data coming from sensors must be accurate since it will be used to inform and guide action. Secondly, it must be available in a timely manner to enable humans or machines to optimize operations. Finally, it must be transformed into information to enable appropriate action.

What do you need to know? What does the data tell you? What action do you need to take next based on what the data tells you?

Data governance systems are critical building blocks to ensure the success of any sensor and digital twin program.

"Oil and gas companies that have inadequate governance on their digital twin will have higher than average costs and slower than average automation programs," observes Dargus.

How to Leverage Sensors and Drive Value from a Digital Twin

There are five key things that energy, oil, gas, and chemical companies should do when looking at how sensors can support better operations:

#1: Start with your most critical business processes

It's important to start by looking at your most critical business processes first because that help you determine the association of sensors to your core business processes, says Awashti. Focusing on critical business processes first will help drive ROI and deliver sensor insight and analytics in areas that make the biggest impact on the bottom line.

#2: Work across siloes (not within)

Business processes and data cut across an enterprise and it is important to think about applying sensors through the chain of production from start to finish. This will enable better insight into the digital thread that connects your business and identify the opportunities for improvements and optimization.

Similarly, your sensor approach itself should be driven by experts in both the IT and OT sides of your business.

What can happen is that you have IT people who don't necessarily understand the operational technology running the systems that the operation environment relies on, explains Dargus.

"A digital twin program that is successful will be advised by operational technology experts – the people who really understand drilling and oil and refining - so that the digital twin takes into account certain physical characteristics that might not be easy for the IT team to capture by itself," he says. "IT and OT have an opportunity to converge even further in the digitalization push."

#3: Make data accessible

"Sensor data analytics is only as good as the available data set," observes Awashti. He explains that too often companies do a great job of setting up sensors in their production environment, but they don't think about how they're going to store and access the related data. If the data is not stored and readily accessible it will be hard to discern much useable insight from it.

Oil and gas companies must think about how they will access sensor data and use it to drive practical action within their operations.

"Take a holistic view of what you're doing," says Awashti. "See your vulnerable points. Where can I have additional insights to have intelligence that I don't currently have so I can make a more empowered decision?"

#4: Work with industry partners who have experience

Qualified systems integrators and solution providers have decades worth of practical experience applying and leveraging sensors in other organizations. Oil and gas companies should seek to make use of that experience by working hand in hand with their solution providers.

"It has to be a true partnership where you expose your whole applicable of sensors and their corresponding data sets to your partners," says Awashti.

#5: Set up your governance structures

In the rush to get to the most exciting parts of digital transformance, governance issues can sometimes be neglected. But how you're going to administer, oversee, and evolve your approach to sensors and data is a critical building block to consider.

"There are going to be digital twins everywhere and you need to manage them in a responsible manner," says Dargus.

Conclusion:

Future-focused oil and gas companies are already starting to see the benefits from applying advanced analytics to sensor-based data to identify trends, predict events, and quickly respond to or prevent problems in their operations.

Industrial companies may want to use sensor data as a basis for their digital twins to model and predict the behavior of physical objects and equipment.

While there are many ways that organizations can benefit from utilizing sensor data and digital twins, it requires a thoughtful approach to realize the true ROI of these technologies.

Companies can better leverage sensors and digital twins by focusing on their most critical business processes first, working across business silos, making the data accessible, working with industry partners and establishing appropriate governance structures.

By following these key steps, oil and gas companies can unleash the power of sensor data and generate meaningful insights into their business operations in a way that drives value and unlocks operational improvements.

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About Kyndryl

As the world's largest provider of IT infrastructure services, Kyndryl is committed to the health and continuous improvement of the vital systems at the heart of the digital economy. With our partners and thousands of customers worldwide, we co-create solutions to help enterprises reach their peak digital performance.