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Building Effective Analytics for Oil and Gas

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Summary

The global oil and gas industry faces unprecedented challenges to reduce costs without increasing risk, especially related to safety or unplanned downtime. The need to balance these risks is driven, and being addressed, in innovative new ways. At the heart of this is innovation and the need to reinvent. This reinvention comes from new ways of leveraging analytics, re-skilling/up-skilling the workforce, and relentlessly driving for continued operational efficiency.

The workforce skill gap poses unique challenges for this industry. Many experienced individuals with critical knowledge are reaching retirement age. Companies must find ways to transition this expertise back into the business before these workers leave. This requires new ways of addressing knowledge management, driven by data capture and delivery to new workers, who are just starting to come on board.

In this cost- and human resource-constrained environment, companies struggle to maintain regulatory compliance, ensure employee safety, maintain continuous uptime, and sustain varied and often far-flung and/or aging production and automation assets. Data is also at the heart of this transition: it becomes the new oil, driving value from uncovered sources of wealth.

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While an abundance of data continues to be collected, often very little gets analyzed into actionable information and knowledge. This problem is typically due to continued reliance on dated, ineffective approaches to data management and analysis.

Moving beyond traditional limitations requires companies to embrace innovation where they have limited domain expertise or experience, such as predictive analytics, deep learning, and natural language processing. Many find it difficult to understand how these innovations differ and where and why they should be applied.

By focusing on a few key data and analytics capabilities, oil and gas companies can find analytics solutions that deliver quick, high-value improvements as well as provide a guided pathway for long-term success. These capabilities include:

- Methods for end-to-end management of data challenges specific to the oil and gas industry so that analytics can be scaled
- Incorporation of existing models and intellectual property to accelerate time to value of analytics
- Role-based knowledge transfer tools to ensure adoption and use of analytics by a range of users, ultimately broadening the value data can deliver

It is crucial for the industry to build modern analytics tools and deploy data-enabled knowledge. Doing so will drive new levels of efficiency into upstream, midstream and downstream operations while addressing the human skills gap.

Overcoming Data Challenges

Analytics consists of two overarching processes: capturing and provisioning data; and, extracting value via rules, statistics, algorithms, and models. Within the industry, these two steps each have their own challenges that must be managed. For data connectivity and integration, poor data input leads to poor analysis, regardless of model quality or mathematical technique. For value extraction, the wrong techniques can be applied against data sets, rendering the analysis ineffective or the findings inaccurate.

Capture and Provisioning

The problem for companies is not a lack of data across the oil and gas value chain. There is plenty of data to work with. An average off-shore oil plat-form can generate between 1TB and 2TB of data per day via sensors, operational, and financial sources. However, accessing the data and presenting it for analysis can be very difficult. It is estimated that only between 1-3 percent of this data is currently analyzed.

Why is this the case?

- The data first needs treatment and cleansing. This requires core competencies in data capture and provisioning: security, extraction, normalization, integration, mapping, querying, transmission, storage, etc.
- The data is broadly dispersed across systems, tightly siloed and controlled, and/or never used. The range of formats and quality can be overwhelming. Some reside in pre-Internet protocol (IP) automation, logic, and control systems. Copious amounts of data reside in enterprise technology. Streaming data is pouring from devices' intelligent infrastructure via Wi-Fi and Ethernet (IIoT). Still more data is found on paper, tables, audio files, work logs, emails, manuals and many other structured, unstructured, and semi-structured formats.

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Many companies are turning to modern software to solve the data capturing and provisioning challenge. Microservice software can access and connect to a variety of data systems and sources via a range of prebuilt adapters. Device discovery can also be man-aged in the same way, providing a means for creating and visualizing asset hierarchies and mapping their data. As the data is brought in, machine intelligence can be applied to improve feature extraction, indexing, filtering and modeling. At the same time, externally sourced data, such as weather patterns or trends can be integrated to improve the quality of the overall dataset.

Extracting Value

Once the challenge of data capture and provisioning is solved, analytics need to be applied. Companies must understand what analytics methods are ideal for a use case and data set. They must ask questions such as: when would physics work versus black-box analytics? Do some methods scale better than others? What should be done with existing analytics models? Which techniques are more suitable as uncertainty increases? What is the best way to keep models up-to-date as data changes?

Energy costs could be reduced by double digit percentages. Months of time could be shaved from exploration and production. Millions of dollars of operating and maintenance budget could be saved by improving maintenance strategies.

To answer these questions, companies must be capable of understanding and applying a range of analytics methods. This breadth encompasses physics, probability, and deep learning. A solution that provides such diversity ensures an analytics strategy can account for and adapt to inevitable differences in levels of complexity, uncertainty, and data that will be present across a variety of upstream, midstream, and down-stream use cases.

For example, neural network analysis work well for things like modeling, tag mapping, and image recognition. For other scenarios a single, simpler method may be the chosen course of action. Alarm management is a good illustration of this. Using it, statistics can filter data noise, leaving operators with an accurate, real-time view of key signals and trends.

Other instances, such as asset failure detection, might require a combined model deployed via machine learning. Unsupervised machine learning can effectively detect failure signals. Supervised learning can then be applied to identify anomaly causes, such as excess vibration. In combination, these methods provide a much earlier window into asset failure than threshold and condition-based monitoring. This method is also particularly suited for adapting to differences in operating conditions.

Each of these examples requires a different set of challenges to overcome. Adopting a singular technique (i.e. probability) or employing a narrow approach (i.e. statistics) with analytics simply won't work in any scalable fashion.

By employing a range of methods, companies can expect to realize a broader set of operational benefits. Energy costs could be reduced by double digit percentages. Months of time could be shaved from exploration and production. Millions of dollars of operating and maintenance budget could be saved by improving maintenance strategies. And days, and even weeks, can be saved in identifying patterns leading to catastrophic failure of assets.

Accelerating Time to Value

Oil and gas companies must also consider how new, diverse methods integrate into the processes and analytics already in place. Doing so speeds time to value by providing quick-win improvements, which are often necessary springboards for enterprise adoption.

Existing models are an ideal starting point. Companies have been creating, deploying, and managing analytics models for decades. These models encapsulate years of process knowledge and analytics fine tuning. Rather than setting them aside, begin by tapping this vast knowledge within these models and using new analytics tools to quickly make them more effective.

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Using modern methods, existing models can be used to easily move a company from historic to real-time analysis. This simple improvement provides high value by accelerating how quickly the insight can be acted upon, and who can access and leverage it. Additionally, the need for high-touch customization, done by just a few individuals, can be eliminated by managing an existing model in a modern analytics engine that can automate retraining processes based on prior actions taken.

As users, particularly operational subject matter experts (SMEs), improve existing models via modern analytics tools, they naturally will want to continue to extend them and create new ones. This is because they are best positioned to understand the data in its operational context.

With modern analytics tools, SMEs can combine deep operational knowledge with improved means of wringing value from data. By targeting existing models, organizations first improve what is well understood and already in place, which sets the stage for adopting new methods. Adding the ability to then seamlessly build additional, more advanced models. By leveraging capabilities for existing and new models, companies create a sustainable pathway for scaling their advanced analytics capabilities.

Role-based Knowledge Transfer

Given the value modern analytics can provide, there are going to be many within the organization who will want to create models and consume their output. This includes high-level math experts, such as data scientists, citizen data scientists (such as engineers), as well as field- and back-office workers. Broadening the consumption of analytics across this complex set of users is by no means a simple task.

These users often have specific, different, and sometimes competing perspectives on what data is valuable and how it is best used. Adding to this is the vast scale and scope of the oil-and-gas value chain, where like terms often have different meanings based on process application, multiple languages are used, and many individuals and roles are involved. This complexity can impact the adoption of analytics across the organization and must be accounted for within any solution.

How to Ensure Adoption:

Ensuring a high-level of adoption begins with designing analytics to account for different roles and the transfer of knowledge to them. Data and insights must be delivered in proper context for different users, ensuring the analytics can easily be acted upon.

Many well-understood artificial intelligence (AI) technologies assist in this role-based transfer of knowledge. Natural language processing (NLP) ensures an analytics application can interact with humans using common language. For example, a technician working in a difficult environment, elevated on an oil platform, can interact with an analytics application to discuss, identify problems, query knowledge sources, and receive feedback as the work is being undertaken. Semantic search can be used by SMEs that know what value they want from the data but have lacked easy means to access, combine, and explore it. This latter example is particularly true of historian data.

Other methods, such as auto-suggestion and grammar correction, can help manage language barriers, education variances, and domain specificity. Collectively, these AI tools and analytics can be combined to speed the productivity of users by unlocking the specific role-based context that turns data into value.

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AI technologies can also ensure dynamic knowledge transfer as data and operations change. As more data is fed into the knowledge engine, the analytics applied ensure the output becomes more refined and accurate. This process can be made continuous, so decisions are always enacted with the best knowledge available. And as more processes are digitalized, this knowledge case can scale to connect and serve more users and the roles they fill. This provides a visible trail into why decisions were made, which is invaluable when tied to tremendous cost implications.

Case Study

Baker Hughes GE is leveraging their Deep Learning, natural language processing, and recurrent neural network models with Nvidia's DGX computing platform. As diagnostics are also a key area, these products go past the traditional form of pattern matching to create models that better predict issues and detect faults.

An example of combining modern analytics methods and tools with data-enabled knowledge can be seen in a partnership between Baker Hughes, a GE company, and Nvidia. The two organizations collaborated to build computational models that add AI with analytics to absorb data from sensors, weather, drilling, and seismic data. The result is more predictive operations.

As part of the partnership, Baker Hughes GE is combining their domain expertise and Applied AI capabilities with the power of Nvidia's GPU processors to develop models and analytics software. The AI and physics-based models are combined with digital twins to improve operations. Specifically, Baker Hughes GE is leveraging their deep learning, natural language processing, and recurrent neural net-work models with Nvidia's DGX computing platform. As diagnostics are also a key area, these products go past the traditional form of pattern matching to create models that better predict issues and detect faults.

Conclusion

The oil and gas industry is going through radical transformation; it must reduce costs without increasing safety and asset failure risks. SMEs are retiring, new business models are emerging, and competition and pressure continue to intensify. Managing these disruptive market complexities re-quires new approaches to problem solving, particularly related to industry-specific data and knowledge. Modern analytics tools provide the means for tacking challenges in innovative, transformational ways while helping organizations connect and scale effectively.

Companies deploying analytics and knowledge solutions should focus on the benefits of driving business outcomes across organizational boundaries. Start with the operational realities. Approach them from a new vantage point. As companies move to embrace innovation, ARC recommends:

- Leverage What You Know as a starting point: analytics must enhance rather than replace the methods and models already in use. Tap the treasure trove of information that exists in data siloes, combined with the knowledge of what has worked to date.
- Ensure Methods Deployed Handle Diversity in Data. This diversity includes high volume, massive quantity, and irregular quality data. Physics-based, probabilistic, and deep learning will all be re-quired to support continuous learning. In many instances, hybrid models combining these methods will also be necessary.
- Employ Tools for Creating, Extending, and Cataloging Models. These key capabilities ensure analytics continue to provide value beyond initial use.
- Account for Ecosystem Complexity —downstream, midstream, and upstream—for knowledge capture and transfer. A means for managing variations in terms, processes, and knowledge application should be built into the analytic solution. Doing so ensures these high-value, data-driven insights can be consumed and executed upon by the widest range of users.

Modern analytics tools provide a pathway to success. Operations can be optimized while risk and cost are reduced. While many analytics solutions are available, not all are capable of dealing with the complex nature of oil and gas operations. Solutions must be designed to account for the specific challenges associated with oil and gas data, people, and processes, across every segment of the value chain. When done, true digital outcomes are achieved via a sustainable pathway for scaling advanced analytics.

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