Tech Mahindra

OPTIMIZING DRILLING EFFICIENCIES WITH THE POWER OF DATA SCIENCE

WHITEPAPER

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Abstract

Drilling efficiency is not about drilling faster by pushing an accelerator. Perhaps efficient drilling can occur much slower than capacity of the drilling equipment thereby avoiding errors. Humans who are responsible for drilling have to consume and comprehend lot of information, evaluate outcomes and take decisions. It is not humanly possible to do all of this in a short span of time. Computers can be fed with analytical capability required to perform the job. Data science is enabling this process to overcome limitations of human capacity. Application of intelligent algorithms helps in removing guess work and facilitates informed decisions.

This paper summarizes findings from secondary research on the topic. The paper also integrates TechM experience from programs delivering digitalization of rig operations and drilling data management, TechM's data science platform capability and partner solutions.

Key takeaways

Maximize profitability by optimizing drilling operations to reduce associated costs

Merely acquiring and storing drilling data has no value , if there isn't any supporting analytics program / platform to mine the data

Data Science is an essential part of Automated Drilling roadmap

AI & Machine Learning is the next big transformation for oil and gas industry. Requires mainstream focus for maximum gains.

Introduction

Offshore drilling rig technologies continue to evolve in response to increased demand for safer and more efficient systems. Higher cost pressures, lower oil price are driving innovations in drilling. In this field it's too expensive to make mistakes and in extreme situations, mistakes can cause substantial harm to people and the environment. Automated systems can also make errors, but the technology can help to stop error developing into a big problem. And computer can be trained to avoid repetition of errors. In short, with the help of automated operations, errors can be identified before they are committed.

" Some AI driven pilots in drilling optimization programs have delivered better results than veteran geologists and petroleum engineers" Findings from a research project

Drilling operations involve large number of people, all trying to carry out their individual, complex tasks. Each of these tasks must be carried out safely and correctly, often within a set time frame, for the rest of the operations to run smoothly. It needs great deal of discipline and surveillance to make it happen.

Computer-operated drilling is gradually changing how the oil and gas industry discovers natural resources. Drilling optimization can decrease the number of injuries and increase output and accuracy.

Tech Mahindra is providing data analytics and data visualization services to leading Oil Field Services and Drilling Services companies. We have observed significant contributions of 'Data Science' in this optimization journey amidst high cost pressures and low oil price.

Modernization of Rig operations

Operators and service companies in the E&P value chain agree that the industry needs technologies that improve safety, optimize operations, and reduce associated costs. Drilling automation (ADC), particularly drill floor automation, is one of the critical technologies that address these issues. It can minimize the human presence in harsh offshore environments while improving efficiency through increased precision and faster execution, thus reducing costs. There are evidences of drillers achieving up to 50% enhancement in rate of penetration (ROP) . Automated drilling has shifted a driller to a control room to control and monitor drilling jobs.

Increasing availability of digital drilling data and the emergence of reliable communication between offshore rigs and well operator's offices enabled a evolution of RTOCs (Real Time Operation Centers) in the early 2000s, spawning a collaborative environment to improve process safety and operational efficiency. RTOCs operate in a remote mode, have capability of monitoring rigs across the globe. Majority of RTOC software solutions are architected based on wellsite information transfer standard markup language (WITSML) data transmission , visualization. Most RTOC SW vendors now have lot of analytical models developed like Torque-n-Drag, Swab-n-surge, geo-steering, hydraulics etc.

Thus rig operations are becoming digital , but there are new data related challenges for rig operators to solve.

Drilling Data Sources and the 'Data' Challenge

Digital transformation of drilling provides an unprecedented stream of high-value rig information.

Data is the Oil & Gas Industry's most valuable resource.

Due to developments in computer hardware and software over the past few decades, and increased use of measurement-while-drilling (MWD) and logging-while-drilling (LWD) tools, wellsite data collection, storage, and consumption have increased many times in comparison to small volume of data available only a few years ago.

The largest source of data by volume are the control systems, which are usually sampled at the millisecond scale across thousands of traces. These contain sensor, alarm, set point and other data. Control systems data alone measures over 99% of the total volume generated by a drilling rig. EDRs produce the next greatest quantity, normally sampling at 1 Hz, and come in a variety of forms.

Additional sources like HSE, financial, maintenance, quality and personnel records demonstrates significant variations in terms of type of data and its frequency.

Greater than 75,000 Sensors

Modern offshore platforms have large number of sensors, which are expected to generate approximately 20PB of data during the life of an asset

Greater than 10TB daily

Data volumes per day per well are exceeding 10TB of data

Less than 5% data analyzed

It is not known what happens to remaining 95% or more , where does it go ? Is that used ?

Data from multiple rig systems can stream in using different formats and protocols, such as WITS, WITSML, LAS and FTP. Control systems on rig involve several communications protocols to transfer data, such as Modbus, Profibus and OPC UA. All of them require specialized handling for proper data transmission.

Thus, the amount of data collected during the drilling of the well and on the rig site has increased significantly. Operators, rig contractors and service companies all acquire and manage huge volumes of data. The shared use of information at the rig site or data transmitted in real time or offline to the office is used for a variety of purposes that provide real value to the operator. Typical characteristics of drilling data are shown below;

Speed of Data Generation	Very High
Speed of Data Transmission / Dissemination	Moderate
Speed of Data Consumption	Moderate
Percentage of data consumed	Very Low

Characteristics of drilling data Source: Tech Mahindra

There is an increasing trend of consuming data at high speed, but that often compromises with quality of data. The transformational effect of analytics provides insights on top of this data. The insights help to answer questions about what happened, what can happen in the future and what actions should be taken next. As the industry moves towards an analytics-driven future, it should pay attention to the reality that "Analytics are only as good as the quality of data provided."

Progression of data science in drilling optimization

Potential applications of data science for the drilling optimization appear unlimited. The International Energy Agency estimates widespread use of digital technologies could increase oil and gas reserves by about 5% and reduce production costs by 10% to 20%. AI and machine learning can enable companies to optimize well design, drilling and completion. Machines even can be used to carry out dangerous tasks on an unmanned basis. Use of AI and ML can improve oil and gas production rate and lower lifting cost. Due to advances in machine learning and AI, tools can be used to troubleshoot underperforming rigs, enhance well planning and carry out maintenance before problems arise.

In the drilling operations domain, making sense of extensive amounts of data can be a challenge. For example , valve positions, pump speeds, pressures at different places in the system, temperatures and flow rates, etc. AI allows companies to correlate and review the data in a shorter amount of time, discover patterns that likely were not previously evident and determine the best course of action.

Drilling engineers are in charge of monitoring processes and development of most detection algorithms, engaging the support of software experts when needed. The result is an optimized solution reached in a short period of collaborative development.

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Data analytics architectures have been evolving to match with the changing needs of data volume, variety, velocity, veracity and value. A more diligently integrated architecture and flexible data models can help reduce the points of failure, improve data quality and enhance the data management process in general. Starting with a data management foundation, and combining that with data acquisition and analysis tied together, oil and gas companies will be able to fully realize the potential of data. Such closely integrated architectures/solutions can deliver accurate analytics and enable decisions to be made more quickly with the confidence on quality of data.

Realizing the changing needs and the data silo problems, oil and gas industry has come together to promote open data standards like OSDU for a open data platform architecture.

Drilling optimization Use Cases

Application of data science techniques like data analysis/visualization, KPI computations, ML algorithms and AI models are very common now. Success of data science programs is highly dependent on how well the problem is defined, how good is the data, how well is the data understood. Time spent in defining the problem is significant portion of entire data science project efforts.

Another dimension to add here is 'to what stage of drilling the problem statement maps to', namely,

- Before Drilling a well (can be using offset wells)
- While drilling a well (mostly real time insights)
- After drilling a well (historical / lookback)

Top 5 measures that indicate how data science benefits Drilling sector

1. *Significant improvement of NPT, ILT and MDBF*
2. *Time spent on drilling a well can reduce by up to 20%.*
3. *MTTR improves significantly reducing cost of maintenance by 10% to 15%.*
4. *Rate of Penetration can increase up to 50%*
5. *Cost of drilling per feet can be significantly reduced*

Edge vs. Cloud : Choose and build

Speed of transmission of data from offshore rigs to office / cloud through low bandwidth satellite connection is not proportionate to the volume of data generated for a well during a day. Which means not all the data generated on a particular day will be available in office / cloud on same day.

In order to mitigate this limitation, analytics on the Edge is trending for need of real time decisions which can be taken on the rig. For example ROP optimization can be done by analyzing WOB, Torque, RPM on the rig almost instantaneously.

Common use cases and popular techniques used for problem solving

Formation Interpretations	Bayesian State Space Models and Monte Carlo simulations
Lithology Prediction	Combination of K-means clustering, t-SNE, PCA
Real time Torque & Drag Modeling	Neural Networks
Fault Interpretations	Deep Learning
Determine Facies & Rock characteristics	Data Clustering - Gaussian Mixture method to generate Facies

Source: Tech Mahindra

Way forward

Drilling contractors and E&P companies are experiencing significant drilling efficiencies with the help of data science that translate into competitive advantage. It is probably the time to consider how a company can begin to harness data science technologies to remain competitive. Power of this technology has enabled evolution of automated drilling operations. Although this is control systems play, data science is an implicit component. Autonomous drilling moves this a step ahead, using techniques and algorithms

- To map wells, perform complex calculations and take decisions on the fly,
- Drill in a continuous mode for extended periods without making costly mistakes.

There are two school of thoughts

- some see a evolution of mostly autonomous rigs powered by robotic drilling
- others say that, in the near future, rigs most likely will be controlled remotely. Drillers, geologists, and engineers can be working in office buildings rather than in the field. They can control multiple wells at once. Ability to remotely monitor drilling operations has been a blessing in the challenging times of COVID-19. Probably it can be the new normal.

Presently systems evolving to transform drilling rigs into something analogous to airplanes. As a result, similar to an airplane many functions of the rig will be automated, giving rig crew the ability to override the controls if they need to.

Oil and Gas industry has invested significantly in AI and Machine Learning in the last few years. Recent decades have experienced exponentially faster adoption rate of new technology than in the past. Notable collaboration efforts have taken place to develop AI/ML ecosystem that comprises of range of players from the giants to boutique firms. Perhaps there is lot more to come.

Tech Mahindra GAiA - Platform for enterprises to operationalize AI at scale.

Tech Mahindra is the Digital Change maker which strives to change the way the world, communities, businesses, and humans interact digitally. In Oil & Gas sector, we are engaged with very innovative digital transformation initiatives. TechM GAiA is focused on providing unified AI/ML experience to enterprises, data scientists and engineering teams. Please visit https://gaia.techmahindra.com/#/home for more details.

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