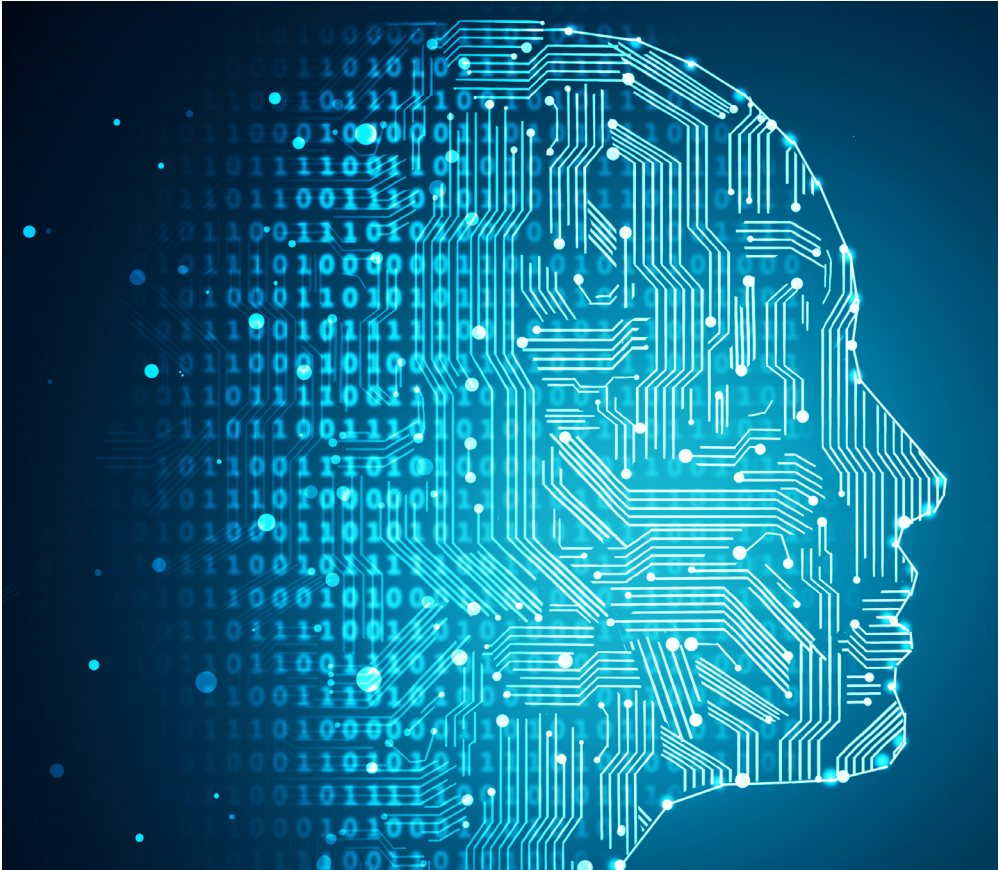**ARTIFICIAL INTELLIGENCE**

AI – reality or hype?

According to some experts artificial intelligence could transform oil and gas sector operational performance more in the next five years than the last 25. What is the real potential upstream and downstream? *Brian Davis* **reports.**

Artificial intelligence (AI) has advanced considerably in the last couple of years using machine learning, predictive analytics and other AI-based technologies. Driven by the cut in oil prices and increased competition from renewables, the oil and gas sector is starting to look at innovative ways to use AI to improve efficiency, reduce costs and minimise downtime upstream, as well as optimise downstream performance. This is just the beginning of the journey, but the potential opportunities are mouthwatering.

Analysts at McKinsey forecast that over $50bn could be achieved in savings and operational improvements using AI in upstream oil and gas. Progress is due to advances in computer processing power and the development of sophisticated algorithms by Amazon, Google and others in the finance world, retail, healthcare and manufacturing sectors.

The big driver has been the development of advanced analytic tools and software solutions with complex machine learning algorithms that are capable of sifting through mountains of data to identify patterns, make predictions and provide recommendations to optimise control and management of assets.

High-level automation looks set to bypass human operators; adjusting parameters automatically, such as well penetration and chemical injection

AI is a significant game-changer for the oil and gas industry, driven by development of advanced analystic tools and complex machine learning algorithms
Photo: Shutterstock

rates for optimal production and efficiency. However, supervisory oilfield management is unlikely to be taken out of the loop for several years say analysts, given the value of human experience and the high risks involved in the oil and gas business.

Basically, machine learning algorithms are able to process billions of data points to identify trends and patterns that would be laborious and time consuming to detect using human engineers. AI can apparently handle structured or unstructured data with ease. Machine learning software (like 'Seeq', developed in Seattle) can be used to optimise drilling decisions, taking into account equipment ratings, seismic vibration, strata permeability, thermal gradients and other factors. Technical operators are freed up to monitor overall performance, predict equipment failure, reduce unplanned downtime and make more informed decisions.

Predictive analytics can be used to analyse data to avoid potentially catastrophic events such as blow-outs, stuck pipe or lost circulation. Furthermore, AI can reduce non-productive time, saving millions of dollars daily.

Case-based reasoning (CBR), for example, can scour databases of documented problems to identify similar issues being encountered, and is increasingly being used by the drilling sector to provide operators with recommendations on how to deal with a variety of downhole-related issues.

AI also has significant potential in exploration to discover and model oil reserves using advanced imaging technologies in concert with fuzzy logic (to predict when information is unreliable or incomplete), where today the characteristics of reservoirs are obtained by drilling tests and pilot wells.

Downstream, AI is also being used for predictive analytics to model maintenance and performance of refining and petrochemical plants; to streamline transport and distribution; and analyse data on consumer patterns, economic conditions, weather and other factors to forecast demand.

Pioneering applications

Interesting AI applications are already underway. Shell, for example, has launched an AI assistant for customers of a large range of lubricants and related products. It uses virtual assistants (avatars) called Emma and Ethan to help customers discover products using natural language chatbots. The Shell virtual assistant handles over 100,000 data sheets for 3,000 products. The company has also integrated AI with an autonomous inspection vehicle from Subsea 7 to handle routine observational tasks and data gathering. In addition, it has developed a virtual assistant called Amelia to respond to enquiries from suppliers on invoicing.

Meanwhile, Dan Walker, who leads the emerging technology team in BP's Group Technology, says: 'Using AI processes (algorithms), we'll be able to combine datasets about areas such as flow rates and pressures and equipment vibration with data from the natural environment, such as seismic information and ocean wave height, to transform the way we run and optimise our E&P operations.'

Since 2013, Total has run the annual ARGOS (Autonomous Robot for Gas & Oil Sites) challenge in a quest to encourage the development of prototypes of autonomous surface robots using AI to operate on oil and gas sites. In May 2017, Shell selected a German/Austrian team to develop the ARGONAUTS robot. ExxonMobil is also working on a robot project with MIT's Energy Initiative.

Tapping AI potential

In June 2017, Gazprom Neft and Yandex Data Factory, part of Russia's leading internet company Yandex, entered into a cooperation agreement to tap into AI and machine learning for roll-out in potential initiatives in drilling and well completion, modeling oil-refining strategies and optimising other technological processes.

Jane Zavalishina, CEO of Yandex Data Factory sees AI as a 'universal optimiser' that can analyse vast amounts of data, consider hundreds of thousands of factors simultaneously, then single out patterns to build predictions. 'So you automatically become more efficient in making operational decisions,' she says.

Zavalishina suggests there are significant benefits to be gained in terms of AI investment both upstream and downstream, in terms of increased speed and throughput; reduced energy use; decreased defect rates, breakdowns and downtime; and less accidents.

Examples of AI-based optimistation are:

- Early anomaly detection – during drilling, such as stuck pipe and lost circulation.

- Drilling speed optimisation – an AI-based system would automatically recommend optimal drilling parameters to decrease drilling time by 3–5%.

- Prediction of oil output after hydraulic fracturing – an AI-based solution can boost production by 8% compared to current forecasting techniques using sample testing.

- Gas fractionation optimisation – using AI to 'virtually' detect changes in the incoming gas stream and recommend optimal parameters for a fractionation unit, to decrease energy use by 5–7%.

Applications could also be optimised in other high-volume continuous processes, such as refining, catalytic cracking and pyrolysis.

Zavalishina says: 'It is still early days for AI in the oil and gas upstream sector, but significant results have already been achieved using these algorithms in petrochemicals, processing and other areas like steelmaking.' What's more, it doesn't require huge computing power on the customer side. Yandex has its own AI algorithms, offering a complex predictive model that can work with real-time data, to make individual decisions and predictions for particular customer applications.

Handling unstructured data

Oil and gas enterprise solution provider Wipro also offers next generation integrated AI solutions for the digital oil field. Vasuki Upadhyay, Digital Lead for Oil and Gas at Wipro, sees AI as a concept that can be applied to the oil and gas sector in many shapes and forms, to improve efficiency and take out costs. He is enthusiastic about the ability to handle unstructured data, as paper-based or historical documents can easily be converted into digital data.

'AI has a big role to play in transforming scanned documents and historical information into meaningful information which is available in multiple modes (including natural language recognition), like a Google or smart search,' he says, so large manuals could be searched on the fly.

One AI pilot for a supermajor is designed to handle engineering plans for project hand-over, using real-time tags on historian systems. Today, somebody has to read the document, figure out sensor points (re temperature, pressure etc), then extract the information, create a spreadsheet and configure these data points onto a historian system. Upadhyay explains: 'To automate this process you have to create a knowledge base of engineering standards which will extract feature points on those drawings, and use the knowledge base to create tags on the system automatically.'

Wipro has created a proprietary AI solution, called Holmes, based on open source technology, which is trained to solve particular user-case problems. An AI chatbot has been developed for 80,000 users for a supermajor, with a claimed productivity gain of 30–40% efficiency, because it is able to learn and solve problems without physical intervention.

'About 80% of data is lying around in the oil and gas sector in unstructured documents. AI will help extract that data to a structured big data format which can be used for multiple purposes,' says Upadhyay. Wipro has AI products for analysing prospect evaluation, for example. At present, much of the data in the oil and gas sector is protected and siloed. However, an AI-powered smart search solution could access this information from anywhere in the data lake.

In the downstream arena, AI can be used to optimise vendor management and onboarding (the mechanism through which new vendors are assessed before becoming suppliers). One supermajor is onboarding about 800 vendors using an AI smart search solution to check credit worthiness, financial statements and other factors. AI is also useful for customer service management.

'Today, people are going after the quick wins with AI. In the medium term there will be more self-managing processes, particularly for sub-routines. Then you will have to connect all the pieces in a common knowledge base. But the industry will expect over 98% reliability before allowing full automation of the decision process in a high risk sector like the oil and gas industry,' concludes Upadhyay.

> 'Improved production performance may be the single largest area of potential (of AI) for the oil and gas sector over the next five to 10 years.'
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> **Anders Brun, McKinsey**

Total transformation

'In the next seven or so years, the potential of AI that can be unlocked by industry players is totally transformational,' claims Anders Brun, Global Leader in Advanced Analytics and Digital Transformation at McKinsey. 'AI is a broad term which mimics cognitive behaviours, can solve problems and assist in making decisions – it is a learning tool that is able to process and learn from vast amounts of data.'

McKinsey has identified three digital technologies which can potentially unlock the oil and gas value chain: artificial intelligence; robotics process automation; and Industry 4.0 – which incorporates technologies such as sensors, IoT (the Internet of Things) and robotics for increased productivity.

By 2025, AI will significantly improve production performance upstream and downstream; boost exploration hit rates; and improve recovery from reservoirs through data-driven practice. However, Brun notes: 'Digital transformation is not all about AI. It's about the combination of the above three technology areas coming together to form a total operating model. Improved production performance may be the single largest area of potential for the oil and gas sector over the next five to 10 years. But AI will also play a major role for predictive maintenance, both upstream and downstream.'

McKinsey has been working with one of the highest producing assets in the North Sea, with a production reliability of 95%, and has determined that AI could increase throughput by a further 2–3%, more than halving unplanned downtime and theoretical production loss. About 40% of the information to develop the algorithms was partially or totally unstructured. 'The real power of AI tools is the ability to combine this type of data, using natural language processing and image recognition,' Brun says, and estimates that throughput on an average platform could be boosted by 5–10%.

Downstream, refineries could gain a 4–8% increase in margins using AI algorithms to reduce energy use, change the production mix and improve operational reliability.

'The business case for using AI is staggering. Typically it takes four to six months to implement on North Sea operations, using development tools like R or Titan,

which are huge libraries of algorithms developed by other sectors. McKinsey is working with small and mid-sized independents as well as supermajors and national oil companies on developing AI capabilities. Most are occupied with AI applications for optimisation of production, exploration and reservoir management,' says Brun.

Digital transformation of exploration operations is extremely data intensive, requiring sophisticated use of simulators and large computing power to interpret seismic data. But momentum is building in this area also. Firstly, to process and identify patterns in the large data pools companies have. Secondly, to help geologists understand the rules separating operations and risk assessment. McKinsey has also developed an algorithm for seismic interpretation that is able to process data pools which are 100 times larger than the typical geologist approach. 'Ultimately, AI offers higher hit rates, lower exploration costs and more discovered volumes,' Brun remarks.

So, will many geologists lose their jobs? 'No, in general they will become more effective. We are not forseeing major lay-offs with the adoption of AI tools, but more effective work in new ways,' reflects Brun.

The third area of opportunity for AI is reservoir management. Here again, AI is unlocking new potential. McKinsey is working with a mid-sized independent in the US onshore that is using AI to optimise well design and placement. The company claims to have increased average production per dollar spent by 15–20% using AI tools. McKinsey is also working with a European onshore player to optimise well intervention using advanced AI tools, in anticipation of reducing average production cost per dollar spent by 15–17%.

Brun reckons the biggest challenge for AI adoption is change management, ie the need to change working processes, as it all comes down to changing the capabilities of the people. 'We have developed an AI algorithm capability that is able to predict and mitigate on issues which people with 20 or 30 years of experience are not able to do. The first reaction is disbelief, but they are intrigued. Explainability is a significant challenge for AI adoption and has to be dealt with.'

So, will AI replace human

workers? 'Going forward there will be a need for operators as well as decision makers working with different tools. They will be working and collaborating differently between man and machine, with different functions that are mostly carried out in siloes today. There will be a need for people to supervise the machines, to make decisions and receive advice from the machines, rather than machines just performing actions for them. We don't see humans being significantly replaced in the near or mid-term, but working with different tools,' says Brun.

He continues: 'I believe the oil and gas industry will change more in the next five years than in the past 25. Companies will have to adopt an agile approach to IT, as a key enabler for digital transformation. This will be one of the key challenges.' McKinsey has examined 2,000 transformations in different sectors globally and found that 70% of large-scale transformations fail, not because of poor technology or lack of funds, but mostly because of the softer issues like lack of leadership alignment, failure to develop people within the company, work process change and the like.

There are also plenty of opportunities. Brun suggests the oil and gas industry has an opportunity to use AI to improve productivity and become increasingly competitive with other energy sources in the global energy landscape. AI can also help reposition the oil and gas sector in the eyes of talent that is currently going elsewhere. Finally, AI is the operating model of the future, for a safer, cleaner and more sustainable business.