DATA-DRIVEN DRILLING IN THE USA:

Barriers & Breakthroughs

By James Gavin

Introduction

The oil and gas industry mantra during the 2014-2017 oil price downturn has been all about doing more with less, as operators adapt to more straightened economic times. While the fourth quarter of 2017 has witnessed a firming of WTI crude prices above US$55 a barrel, higher than the US$40-50 levels of the previous year, there is little optimism that a return to the heady pre-2015 oil price environment is on the cards. "Lower for longer" is a consensus outlook, and that means a continued and sharpened focus on cost reduction.

According to Dr Keith Myers, President of consultancy Westwood Research, "If the industry is out of the emergency room in 2017, it is not yet out of hospital. Even if oil prices recover further, explorers will need to focus on finding low cost oil and gas profitable to develop at $40 per barrel or less.[1]"

And yet the uncertain economic environment offers a silver lining for the US upstream oil and gas sector, by refocusing attention on the benefits of being more effective with available resources. Such signals were not a priority when prices were averaging $100/b. In the US market, the recent economic context has amplified the importance of pushing digital drilling solutions, by showing how increased efficiency is an achievable goal.

One of the key tools in reducing the cost of drilling is through automating parts of the process using data-driven drilling solutions. "When oil prices are low, efficiency becomes business critical, so the spotlight turns to methods like data-driven solutions – and how this can lower the cost of producing oil," says Jim Rogers, who sits on the board of directors of the Houston-based Society of Petroleum Engineers (SPE's) Drilling Systems Automation Technology Section [2] (DSATS).

While technologies have long been deployed to extract more oil and gas cheaply, the downturn in crude oil prices has incentivised companies to be more active with their technology. ConocoPhillips for example has said that sensors scattered across its well fields helped it halve the time it once took to drill new wells in Eagle Ford shale basin of South Texas (Reuters).

There is a widespread acceptance that digital technology must play a key role in engineering a structural reduction in costs. A survey by consultancy EY[3] in 2016 found that of 75 large oil and gas companies, 68% of them had invested more than $100 million each in data analytics during the past two years. Nearly three-quarters of those firms planned to allocate between 6% and 10% of their capital budgets to digital technology.

"We can't really solve problems just by throwing money at them – we have to work smarter and use new technologies in order to be as efficient as possible," says Lang, director of drilling at Wood. "The market conditions in recent years have been a catalyst for the adoption of new technologies with Wood at the forefront and we are keen for this to continue."

1 https://www.westwoodenergy.com/news/press-release/group-predicts-brighter-outlook-global-oil-gas-exploration/

2 "Big Oil turns to big data to save big money on drilling", Reuters, June 23 2017

3 Reuters, June 23 2017

Data driven drilling applications

The current economic backdrop has encouraged the identification of field development opportunities through digital drilling techniques, and revealed how data-driven solutions can achieve remarkable efficiencies. According to by Kimberlite Oilfield Research[4], US oil & gas operators are drilling 20% longer laterals to increase initial production rates and accomplishing this task with 5.8% fewer drilling days. Technology-driven data applications are allowing US land operators to drill, on average 8,152 feet laterals, in less time than they drilled one year ago.

Predictive analytics has come to the fore, enabling companies to deploy algorithms to interpret the large volumes of data that are being generated from sensors. Interpretative software and visualisation tools are revolutionising the way drillers work – particularly with an increasing proportion of future US oil and gas reserves located in unconventional reservoirs, which renders predicting the performance of these wells more difficult.

Geophysics is pivotal and visualisation techniques to aid in drilling operations have witnessed some impressive breakthroughs in recent years. ConocoPhillips for example uses Tibco Software Inc's Spotfire data visualization package to analyse information from well sites.[5] These visualisation tools are significant in both training and enhancing operations, using both virtual reality (VR) and augmented reality type technologies.

Wood use software that deploys a powerful cloud-based visualisation engine that renders high definition (HD) 360-degree imagery to recreate any asset - regardless of location or size – by creating a virtual user environment that is "better than being there in person" the company states. Through visualisation, data can be interpreted and put into simulation models to improve and optimise the engineering plan for a work over.

BP is collaborating with Maersk Training in Houston[6], on a scheme under which BP staff and contractors can simulate the specific conditions of a drilling operation, including the same rocks, temperatures and pressures - even the same physical impact of the ocean currents - in order to replicate critical jobs on the rig. This has evident safety benefits and the hands-on, scenario-based approach allows drilling teams to practice events and joint procedures together as an integrated unit.

Automation is another hot bed of industry innovation. Automation of drilling systems offers significant value through consistency in performance, reduction in operating costs and improved safety. Automated drilling of shallow multi-lateral wells using downhole directional data and surface equipment input, has proven improvements in re-entry operations[7].

Uptake of automation in the North American market has been brisk by global standards. According to Kimberlite Oilfield Research[8], North American oil and gas operators report the highest planned future use globally of automated drilling technologies over the next 5 years with an estimated 46% of US land wells and 51% of Canadian wells planned to be drilled using automated drilling technologies. Operators cite the biggest benefits of automated drilling technologies as improved efficiency and well placement, resulting in lower overall cost and time savings while minimising personnel exposure and human error.

Predictive analytics

With increased diagnostic capacities, the oil and gas industry is slowly migrating from a reactive approach to one in which there is better prediction of future events. Predictive maintenance technologies enable a closer look at the performance data coming from equipment and to identify failure before it occurs, so that preventative maintenance measures can be undertaken, rather than fixing something after it has broken.

One example of predictive analytics arrived in 2016, when US-based National Oilwell Varco (NOV) unveiled its Rigsentry system[9], at which information is collected from the subsea blowout preventer (BOP) control system sensors in order to monitor cycle, flow, runtime, and time-in-service data from equipment components. The subsea equipment undergoes constant analysis to detect any latent failures. This an end-to-end predictive solution to foresee operational failures in critical components of subsea BOPs with a prediction horizon of 14 days.

4 https://www.kimberliteresearch.com/single-post/2017/09/25/US-Oil-Gas-Industry-Driving-Efficiencies-to-New-Levels

5 Reuters, June 23 2017

6 https://www.bp.com/en_us/bp-us/what-we-do/technology/bp-helps-maersk-training.html

7 https://www.onepetro.org/journal-paper/SPE-0916-0094-JPT

8 https://www.kimberliteresearch.com/single-post/2017/09/25/US-Oil-Gas-Industry-Driving-Efficiencies-to-New-Levels

9 https://www.nov.com/Segments/Rig_Systems/Aftermarket/RIGSENTRY.aspx

Conditions-based maintenance is another iteration of predictive maintenance. As an example, GE and Maersk Drilling announced a collaboration in November 2016[10], on a data analytic-driven pilot project aiming to increase Maersk's drilling vessels' productivity and reduce maintenance costs by up to 20%. Operational sensor data from critical equipment is connected to a historian -- a specialised server that stores the data needed to model the blueprint of the drilling operation. By building this "digital twin," the digital software can then help compare between assets and provide access to vessel performance against the ideal state. Big data is translated into clear dashboards with a holistic view of a vessel, which can help operators make more informed decisions.

Tim Schweikert, president and CEO, GE's Marine Solutions, said: "With the present period of prolonged energy price instability, we believe data analytics tools provide the right technology that will help the industry going through current downcycle and maintain sustainable growth for the future.[11]"

Condition based maintenance tools are designed to improve equipment maintenance on offshore rigs and are expected to be adopted more widely across the US oil and gas landscape. More real-time, shore-based control centres would facilitate this uptake. At the moment, these are mainly operating in a supervisory role, but will likely adopt a more controlling role over time when confidence in the technology develops.

The reason for predictive analytics' growing popularity is simple, says Moray Laing, chairman of SPE's DSATS. "If you don't have accurate sensors, then you need to be able to do some form of probability or understanding of uncertainty in your use of the physics."

He adds that with predictive analytics, you can understand that uncertainty and quantify it in real time. That enables better decisions to be made. "Its like the old red engine light we used to have in a car. Today this is enhanced with quantitative information about what the problem is and how many miles you can travel before you need a service. Predictive analytics enables us to take raw unconditioned information and enrich and condition it into information that enables better decisions."

Well integrity

Wood has developed iWIT, a comprehensive, web-based software toolkit designed to meet demand for integrity management of wells. Wells need continuous real-time integrity monitoring to avoid failures. iWIT automates and streamlines well data into a single environment that applies business rules for a comprehensive and consistent understanding of operational conditions and the integrity of all well types over the full life cycle. Integrating with existing systems, robust validation rules are applied to mitigate or identify erroneous data and deliver KPIs from a company level down to individual well levels. Traffic light monitoring supports early identification of well component failures and alerts are given of wells operating outside safe envelopes.

According to Wood's Lang, there has been a growing need for a more formalised approach to well integrity management among many operators. "The old school way of drilling a well, sticking a Xmas tree on top and producing your oil doesn't cut it any longer," he says.

A significant methane leak from an underground gas storage facility in the US a couple of years ago is a case in point. "This was a well integrity issue; the operator didn't have proactive warning of the state of its wells," says Lang. "However, the iWIT toolkit enables customers to get a much better picture of the status of their stock of wells, something that would not have happened in the past. It's very much allowing our customers to avoid issues before they occur."

10 https://www.gemarinesolutions.com/content/ge-and-maersk-drilling-pilot-marine-digital-transformation

11 https://www.gemarinesolutions.com/content/ge-and-maersk-drilling-pilot-marine-digital-transformation

Barriers to change

Data-driven drilling is not a new process in the US oil and gas sector. Rig sensors were first installed in the 1970s. But the impression remains that the industry could have made faster progress since then. The broader challenge facing the industry in the US is all to do with data standardisation and integration. Put simply, how can the huge amount of data from drilling operations be audited and put to work to improve operations? And can automation and analytics add value if the data cannot be properly interpreted?

The oil and gas sector has lagged other industries in the acquisition of data and the processing and interpretation of data, using machine algorithms. According to SPE's Rogers, the drilling side of the E&P has until now generally been a manual operation. Sensors acquire information and that is assessed before a decision is made, which is then manually implemented.

Part of this comes back to the fragmented structure of their drilling industry, which involves a variety of stakeholders -- operators, rig owners, service companies, original equipment manufacturers (OEMs), regulators – many of whom have competing interests.

This state of affairs may be changing. In a lower oil price climate, OEMs and others are more willing to share data across company lines. However, data integration remains the greatest challenge to faster deployment of data-driven drilling solutions.

A lack of synchronicity is one issue holding the industry back. The SPE's Laing highlights that much data is coming from downhole subsurface and communicated to the surface through mud pulse telemetry. The discrepancy between the downhole and the surface clocks makes it difficult to pool data together effectively. There is no uniform way of doing that at the moment.

This point is taken up by SPE's Rogers, who identifies a lack of coordination in the system. "Who decides how much mud flow goes down hole, what the drilling speed is going to be and other drilling parameters like that? Is that decided by the rig at the surface, or does the downhole tool have some say in those parameters? That's where were we are in industry right now; figuring out the appropriate coordination between the two."

The dilemma of data sharing: a case of adversarial collaboration?

One of the biggest bugbears confronting the US drilling sector is data ownership. Data tends to be highly protected, with the 'he who pays for it, owns it' principle dominating. This often prevents smaller companies from entering with concepts they want to trial, as they are restricted from access to data.

The SPE's DSATS committee has sought to highlight some of the issues surrounding data ownership and the barriers it places in front of innovators.

If service providers at the rig site bring their own systems, and operate off their own data, this can lead to a duplicate data, with the same sensor readings. This boils down to a matter of trust, says Rogers. "Which data do you trust as it is different for the same process value because there are multiple sensors for the same process value collected at different time periods. And there is usually not a master set of data."

Rogers points out that a change in mind is necessary. "You need to end up collaborating with your adversaries because it is necessary for both of your survival. You and your competitor work together because you need to lower your cost of doing business.

Some improvements are underway. Says Laing: "What has happened until now between rig contractors and service companies is that the two groups at the rigsite that typically would have had their own acquisition systems and ne'er the twain shall meet. Now there' serious efforts going on with rig contractors and service companies, creating connectivity between their systems with an understanding that, OK, you are controlling the rig and we are controlling what is happening sub-surface. Now let's put the two together and realise some efficiencies here. I'd say in last year that has gone from a few isolated instances, to becoming more commonplace."

SPE's DSATS meetings are one forum for discussions over the need for collaboration between adversaries. An operator's data quality group has US operators involved in coming up with calibration of data standards that should move the industry in the right direction. An SPE sub-team, called Drillstand, has attempted to identify rig information models that allow the easier discovering

of metadata data around equipment, so that consensus could be made between data standards.

Says Rogers: "These are known difficulties and DSATS has made efforts to try and navigate through these difficulties and come up with workable commercial solutions. One example was the Drill-A-Stand project which sought to create a defined set of use cases describing all of the decision points involved in drilling a stand. It's not hopeless – there is progress being made and are some commercial solutions are in marketplace."

Conclusion

The potential for digital methods and technologies to transform the performance of the US oil and gas sector is substantial. Predictive analytics are already being deployed to strong effect to enable drilling operations to become far more efficient and better adapted to a "lower for longer" oil price climate.

But there are clear obstacles preventing US oil and gas stakeholders making more rapid use of these technologies. The lack of an agreed system covering data ownership, means operators, rig owners, service providers and others are still working on different playing fields. Coordination is necessary, but industry risk aversion is an issue.

Efforts are underway to evolve a new modus vivendi that will ensure the US oil and gas sector is leading the pack, in terms of data-driven drilling solutions. The path is clear. Now oil and gas stakeholders in the US can make a start in showing other industries how the barriers to change can be overcome.