UPSTREAM

Streamlining future drilling operations

Exciting new technology is set to impact drilling operations, reducing non-productive time and other contingencies while driving innovation, reports *Brian Davis*.

Faced with low oil prices and tight rig counts, oil and gas operators are restructuring and streamlining operations, with a focus on improving drilling efficiency significantly. Innovation is key, with many new technology start-up companies targeting reduction of non-productive time (NPT) and other operational challenges.

Colleen Kennedy, Lead Research Analyst at Lux Research, has been examining the latest developments and performance of some of the key start-up players intent on reducing drilling budgets in the low oil price environment, from robotic drilling to new well data transmission systems and oilfield magnetics.

Reducing drilling days is a priority, says Kennedy. 'Operators are trying to cut drilling days from 12 to five both onshore and offshore. The industry is focused on increasing automation on the rig floor, using robotics and other technology to replace some human chores.' Companies are also seeking to improve data transmission, optimise operational efficiency and completions, reduce waste and recycle.

Contingency planning and cost conscious

'Reducing contingencies is key,' continues Kennedy. Contingencies are the cost in the drilling programme for any unexpected failure that causes NPT on site. Regardless of the target formation, every drilling budget has costs and technical challenges attached to the drill rig, drill string, fluid system, casing, cement and completions. Much of the oil and gas technology is very long established. Safety and efficiency are priorities and improved performance can have a significant impact on the bottom line. However, the industry is very risk averse, so 'start-ups' often have an uphill struggle convincing operators to try new technology.

Lux Research has a strong take on new technology players in this sector, comparing 'technical value' with 'business execution' to identify start-ups with high potential against long shots. Of course, this is just a professional opinion and things change.

Kennedy points out: 'One of the largest costs associated with drilling wells is the cost of the rig, which can range from hundreds of thousands of dollars to millions, depending on the formation being targeted. With daily rates so high, any failures on site that cause drilling delays can cost operators millions of dollars. Operators try to account for the cost of NPT in well budgets as "contingencies". This cost usually represents 10–15% of the budget for any given well, but can be up to 30% of the budget in some cases, such as deep offshore drilling.' Today, the new low-price and cost conscious environment is driving innovation for reducing the NPT during drilling operations.

Typically drilling projects are divided between 'tangible' costs and 'intangibles'. Tangible drilling programme costs include the casing, cement and completions that remain after the well is completed. Intangible costs include the drilling rig, drillstring and fluid system, which do not remain on site once the well is completed.

RDS' newly installed drill floor robot at the IRIS Ullrigg Well Test Centre, Stavanger, Norway

Source: Robotic Drilling Systems

For purposes of analysis, Lux Research looked at the costs of a 12,500-ft well drilled onshore in New Mexico in autumn 2014 which totalled $3.28mn. Contingencies accounted for about $119,000 for the drilling phase and about $264,000 for the total project, including completions. These costs represented 12% of the total cost of the well.

Modern drilling rigs are complex systems which look set to be revolutionised in coming years.

Robots are coming

Start-ups like Robotic Drilling Systems (RDS) have developed robotic technology for fully unmanned drill floor operations onshore and offshore. An RDS drill floor robot was installed at the IRIS Ullrigg Well Centre in Stavanger, Norway, last September. The capacity of the robot is 1,500 kg and is claimed to be the world's strongest electrical manipulator arm. A fully robotic drill floor is also due to start up in January 2016 at the RDS workshop in Sandnes, Norway. The test rig features a drill floor robot, robotic pipe handler, electric roughneck and multi-size elevator together with a rack and pinion hoist and dynamic control system.

What's more, autonomous underwater vehicles (AUVs) will increasingly be used from exploration to pipe monitoring, and most of the larger remote operated vehicle (ROV) suppliers have AUV developments underway.

Some novel concepts are under development and some have more commercial potential than others.

5D Oilfield Magnetics has developed a novel way of catching hold of metal objects that fall into the wellbore, to prevent them affecting operations. The Open Hole Net has been tested on a range of dropped objects from wrenches to pipes, and can also catch metal, such as worn pipe casing in circulating drill mud, more effectively than using conventional ditch magnets. '5D offers an elegant solution to mitigate a costly incident that may (and does) occur occasionally,' remarks Kennedy.

The drill string – which is composed of the drill pipe and bottom hole assembly (BHA) – is a marked focus for invention. Advanced logging while drilling (LWD) and measuring while drilling (MWD) tools and mud motors can increase the ability of drillers to drill longer horizontal laterals more accurately, as delays can be costly. Start-ups such as Cold Bore Technology and XACT Downhole Telemetry aim to improve MWD and LWD operations by increasing data transmission speeds.

Axial Ventures' Cold Bore Technology uses sonic telemetry for downhole communications in directional drilling. Cold Bore's tool relays information to the surface by converting electrical energy to mechanical energy to send sonic signals up the drill string – effectively turning the drill pipe into a big antenna – where the data can be interpreted. The tool is undergoing onsite testing in wells across Saskatchewan and Alberta.

The Xact Network utilises proprietary acoustic telemetry to transmit drilling or completion data to the surface from multiple, distributed measurement nodes in real-time, regardless of flow conditions. The Xact network is claimed to reduce risk and improve efficiency in almost any drilling or completion environment. Houston-based Xact Downhole Telemetry in conjunction with BP recently completed the first operational field trial of the SandSentry acoustic telemetry network in deepwater in the Gulf of Mexico, where little or no real-time downhole data was previously available.

Meanwhile, PetroDE's cloud-based platform for collaborative decision making is used to gather, maintain and analyse data used in evaluating oil and gas projects. The company's technology is to be used by Anadarko's Unconventional Resource Best Practice's team to rapidly mine, visualise, analyse and share multiple data resources for time-sensitive decisions on where to direct resources.

Another start-up, Stavanger-based Reelwell, is attempting to give the whole drill string a 'facelift' by changing the design of tubulars, comments Kennedy. The Reelwell drilling method uses a dual drill string, with a separate inner pipe for the return fluid from the well, to optimise hole cleaning and drilling and mitigate stuck pipe issues. A joint industry project on extended reach drilling is underway, and a trial well is to be completed in North America in 1Q2016.

Tackling fluid issues

Fluid is a huge cost to operators but innovation is underway. The drilling fluid serves three main functions – to carry rock cuttings to the surface; to provide hydrostatic pressure to the wellbore; and for lubrication and cooling of the bit. 'Selection of the right drilling fluid can drastically influence the drill rate and success of the project,' notes Kennedy. Companies like Evodos and FPUSA offer add-on equipment that can increase recovery of drilling fluid for re-use. The Evodos dynamic settler offers significant reduction in ultra-fines, lower mud weight, improved oil/water ratio and viscosity, and reduces the chance of stuck pipe. FPUSA provides a solution for the shaker stream that allows better solids control. 'People are increasingly looking at how to clean cuttings and produced water for re-use,' says Kennedy.

Pipe casings keep the formation from collapsing and create a barrier between the wellbore and the rock formation. Operators install casings as the well is drilled, and cement keeps the casing in place. 'Failure to execute the cement job properly can cost millions,' notes Kennedy. Once the operator has drilled, cemented and cased the wellbore, it is ready for fracturing or final installation of pumping and flow equipment that will remain onsite for the life of the well.

Dynamic Tubular has developed an extending field casing to eliminate the 'telescoping' effect of casing using expanding steel technology to directly line wells, maintaining well diameter and to create high pressure seals. The technology is capable of providing monobore expansion levels and high collapse and burst resistance in excess of 10,000 psi, and is suitable for deep-hole, deepwater, salt and hydraulically fractured shales.

Completion options

There are a variety of options for well completion depending on the resources available. Costs, however, can vary considerably. 'In a horizontal well, fracturing can account for upwards of 50% of the total budget. Whereas in a conventional well, completion may only account for 20% of the budget,' says Kennedy. Day-work rigs are also less costly than typical drilling rigs. New technologies for transverse drilling from the likes of 5D Oilfield Magnetics, Sub-One Technology and XACT Downhole Telemetry, can have a significant impact on the bottom line in a low oil price market.

Kennedy emphasises: 'With rig day rates being the lion's share of drilling operations, reducing the days required to reach a target zone is the easiest way to reduce overall project cost. Ultimately, this means reducing risk of failure and increasing efficiency for any aspect

DTI Drilling Systems' riser tensioner system has been developed to reduce weight and space in the moonpool

Source: DTI Drilling Systems

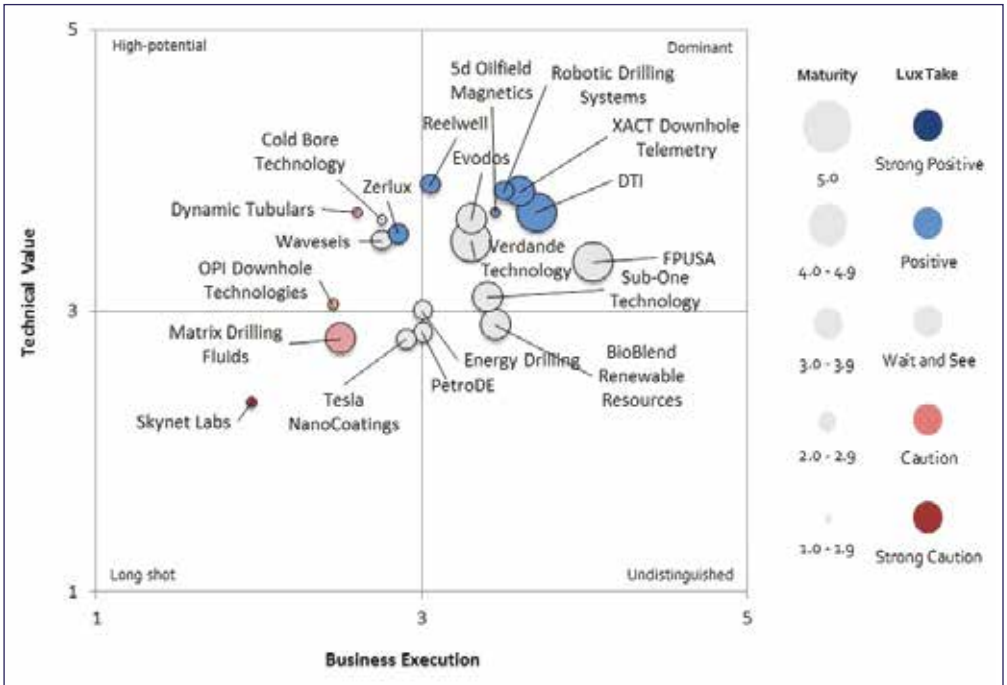

Figure 1: Lux Innovation Grid, comparing drilling cost optimising technologies
Source: Lux Research

of the drilling programme.' New technologies can address these issues in several ways: increasing directional drilling accuracy, mitigating equipment failure and ensuring wellbore stability.

Who's hot?

Lux Research analysed over 20 start-ups with technologies that target these areas, based on their technical value and business execution (see **Figure1**). Following interviews with executives, Lux plotted their potential on the Lux Innovation Grid in terms of technical value, the usefulness of products and services, ability to boost performance, lower cost and increase revenue for customers, partners and investors. The technical value score not only takes into account the performance of a solution but also how it fits with the requirements of target applications. 'Dominant' companies are considered to be proven performers. 'High potential' have attractive technologies but may struggle in business terms. 'Undistinguished' companies perform well in the market but may lack sufficient technical value in Lux's opinion, and 'Long shots' may lag in execution.

Real-time analytics software developer Verdande, for example, features in the 'Dominant' quadrant. Verdande is a spin-off from the Norwegian University of Science and Technology, and has developed DrillEdge for drilling decision support and reduction of NPT.

Another 'dominant' prospect is Evodos, which provides rapid separation technology for drilling mud and produced water. 'Production of clean mud for re-use could decrease overall project costs significantly,' explains Kennedy. Similarly, FPUSA has developed a bolt-on solution for solids control to enhance efficiency. DTI Drilling Systems and RDS can help reduce onsite personnel and positively impact health and safety. DTI has developed a single tool that operates as both a slip-joint and riser tensioner system to reduce weight and space in the moonpool.

Coatings are also a fertile area of innovation. Sub-One Technology has introduced diamond-like carbon coatings, InnerArmour, to reduce corrosion in oil and gas tubulars. InnerArmour creates a very hard surface to resist wear and abrasion and turbulent flow erosion. 'This approach may reduce corrosion in the long-term but may not be so appealing in the low-price environment,' remarks Kennedy.

Lasers to zap drilling operations

Lasers have been around since the 1970s but only recently have they reached sufficient scale (up to MW level) for drilling and mining operations. Companies with high potential in the long run include Zerlux which has developed a high-powered laser drill. Hungary-based Zerlux is developing an under-balanced laser drilling application for enhanced recovery from existing wells. The system comprises a laser generator and directional laser drilling head attached to a coiled tubing or umbilical system. The high powered laser tool melts the rock matrix and will remove the molten debris while the borehole is being drilled.

In June, Delta SubSea signed a memorandum of understanding with Zerlux for collaboration on laser-based hydrate remediation technology. The tool is based on a string of laser heads that apply thermal energy to the subsea structure, using focused warming to create a relief path for pressure equalisation and chemical flow across the hydrate plug. Zerlux claims 'productivity could be doubled using lasers compared with conventional perforations', according to research by AGR and other third parties. Furthermore, lasers could save time and the cost of replacing damaged drill bits, as well as compromised formation integrity.

Another company (not mentioned by Lux) Foro Energy, which has a research lab in Colorado and a development lab in Houston, is working with Petrobras on a three-year project to develop a high-power laser drilling system, which will mark a step change in the drilling of the pre-salt reservoir.

Further Lux Research highlighted companies include Waveseis with an advanced seismic imaging system for sub-salt structures. OPI Downhole Technology is developing low cost magnetostrictive alloys to convert the kinetic energy of drillstring vibration or hydrocarbon fluid flow into electricity – for on site energy harvesting.

Indeed, there seems to be no shortage of innovation in the oil and gas arena. While companies like Amazon and Google head for space, there's still plenty going on here on earth and subsea. 'Who knows, within a couple of decades everybody may be drilling with lasers – or not!' remarks Kennedy. ●