Seeing in the dark

Matt Fueston discusses how new technology could put an end to drilling blind.

When does a technological achievement in a particular industry deserve the adjectives ‘game-changing’ or ‘revolutionary?’

Few would argue that those words should not be used in regard to the 25 September, 1929 flight of Jimmy Doolittle of the US Army Air Corps. In that pioneering flight, from takeoff to landing, Doolittle used only instruments. In fact, he flew the test aircraft from beneath a hood that completely covered his cockpit. The safety pilot, Lt. Ben Kelsey, sitting in the front cockpit with a clear view, did not have to intervene during the 15 minute flight.

Doolittle’s contribution went beyond being a fearless test pilot. He was also the co-developer of the artificial horizon, precursor of the modern attitude indicator, which made ‘blind flying’ possible. Today we call it ‘instrument flight’; defined as flying by reference to instruments in the flight deck, and navigating by reference to electronic signals.

As for being a game-changer, newspapers heralded the flight with banner headlines such as ‘Fog Peril Overcome.’ Commercial aviation began to implement the lessons learned immediately to make air travel safer, and therefore more profitable, in inclement weather conditions. It was revolutionary. And even though he would go on to win the Medal of Honour in World War II, it is the flight in 1929 that earned him lifelong recognition as an aviation pioneer.

Blind flying ‘down the hole’

Doolittle’s accomplishment might be over-simplified as ‘being able to know where you are, even when you can’t see where you are.’ Is there an application of this principal in the drilling industry today, one that promises to be as revolutionary as Doolittle’s flight was to commercial aviation in 1929?

Atlas Copco Secoroc™ thinks that the answer is ‘yes.’ Secoroc, the Rock Drilling Tools division of Atlas Copco, began looking for a way to give drillers ‘eyes down the hole’ almost three years ago, along with its partner, SPC Technology AB, of Stockholm. It calls its solution EDGE.

Atlas Copco’s research and development teams began exploring technology that would take the guesswork out of deep hole drilling. Technology that speeded up a new driller’s learning curve and brought relief to experienced drillers.
Even the best drillers have to tolerate the stress of long shifts continually guessing what is about to happen to the bit, or drill string, or hole, worrying over whether they could react in time to gauges and the inherent lag of reading cuttings coming up from hundreds, even thousands of feet from the bottom.

The development team started with the premise that each strike of a hammer on the bottom of the hole sends a vibration back up the drill string. They thought of it as a kind of sonar, with unique signatures reporting the characteristics of that particular hole at that particular moment in the drilling. These signatures

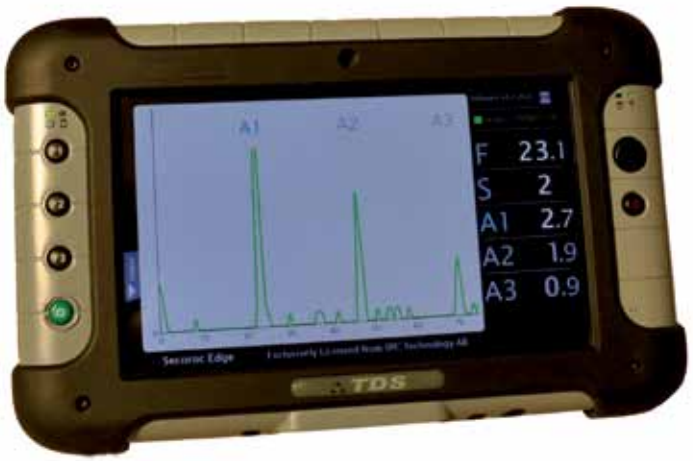

Figure 1. *EDGE detailed display.*

were travelling at the speed of sound through the steel; for all intents and purposes, almost instantaneously.

The questions that the development team had to answer were 'Can we capture it? Can we interpret it?' The company's partner in this endeavor, SPC Technology AB, brought some special capabilities to the table. SPC touts itself as specialising in software development and vibration analysis.

The Atlas Copco development team further defined the need for something like EDGE by pointing to the challenges facing deep hole drillers every day, especially that of predicting changes that take place in holes at depths of 100 m or more. When the bit encounters a new type of rock formation that threatens to 'shank' the bit, the driller must make adjustments before this catastrophic failure. Or perhaps the problem is that the hole is not being flushed properly and the drill string is in danger of jamming. Again, intervention by the driller is necessary to avoid expensive downtime. Maybe the problem is a slight vibration caused by movement inside the chuck due to insufficient feed force, which gradually reduces cutting capacity.

When can drillers realise the problem, and when do they correct it? Any delay in the proper response can have expensive consequences. It is true that a veteran driller can make assumptions regarding what is happening at the bottom of the hole, based on experience. And some drillers do seem to possess a sixth sense that puts them in a class all of their own. But at best, these assumptions are educated guesses. They parallel the history of the great 'seat of the pants' aviators of Doolittle's day. Doolittle himself was such an aviator, yet he was always looking for ways to be more accurate, to make flight safer, more precise, more productive. He looked for ways for technology to give him 'eyes' when he was blind.

A closer look

The EDGE Drill Monitor consists of a sensor, a data capturing and processing unit, and a ruggedised PC with an 18 cm display screen. It can be fitted to all types of deep hole drill rigs that use Secoroc DTH (down-the-hole) hammers.

The sensor is mounted on the drill head or rotation unit, which is connected by a cable to the data capturing unit mounted on the rig. The display PC is mounted next to the drill controls at eye level. The process starts immediately when the piston in the DTH hammer strikes the bit, creating vibration. The vibration is captured, processed and interpreted, and data is transmitted to the PC where it is displayed on-screen graphically and numerically.

The spikes showing on the display can then be interpreted as representing different in-hole scenarios: for example, the sudden presence of a new type of rock or geological zone. This immediate and continuous feedback enables the driller to optimise the drilling process from moment to moment.

EDGE in the oilfield

EDGE is aimed primarily at the oil and gas industries, where the majority of drilling is beyond sensory feedback from the surface. It also aims to make DTH hammer drilling feasible for more oil and gas drilling companies.

Percussion drilling typically provides improved penetration rates (from two to five times higher than rotary drilling) and can be used all the way to total depth. The bits are less expensive, and DTH drilling produces straighter holes. Since there is less weight in the drill-string, it is possible to drill deeper with smaller rigs.

Traditionally, however, only a few companies use DTH hammer drilling, because rotary drilling is easier to master, costs less in tooling and offers fewer formation complications for drillers at the bottom of the hole. Too, hammers and bits are more expensive than tricone bits, and are easier to damage. Training is also an issue. The benefits of percussion drilling have been reserved for those companies who could get and keep drillers expert in hammer skills.

But according to Atlas Copco Secoroc, EDGE has changed all that. Like the instruments in Jimmy Doolittle's hooded cockpit, the EDGE sensor package makes it possible to monitor conditions at the bottom of the hole and react almost immediately, thus saving downtime as well as excess wastage of consumables.

Additionally, the combination of correct Weight on Bit (WOB) and Revolutions per Minute (RPM) allows the bit to cut efficiently for every blow of the hammer piston.

Fuel economy is improved by knowing that the hammer is always running correctly for the given conditions. Efficient operation optimises the use of air. The engine to run the hydraulics works less, as does the engine running the secondary compressors or boosters.

Improved training

Today's computer literate trainees are comfortable receiving performance information on a PC display, basing their adjustments on it, and immediately seeing the result of their inputs. It's not a matter of accumulating years of experience and slowly developing the intuition to finally reach drilling standards. Teacher to student or driller to driller, the performance log is a clear, objective communication of what constitutes optimal performance.

For example, in Sweden, it normally takes six to eight months to train a driller up to standard proficiency. Using the EDGE system, Swedish customers who were part of the

test group for EDGE cut this training time dramatically. The geothermal well drilling company SYDAB recently trained a former truck driver to the standard for drilling proficiency in just a few weeks.

Veteran drillers can enhance their skills as well. Even drillers with years of experience can get back to an optimum penetration rate quicker after making a connection because they can see the 'sweet spot' on the monitor rather than waiting for cuttings or circulation indicators. Drillers will not be counting on intuition but on a visual near-real-time display.

Is it a game-changer?

Testing in Sweden and the USA was finished by the end of last year and early this year. The product is now commercially available, and the first few customers are using the new drill monitor.

In the eastern USA, EDGE has been used in shale and limestone to depths of approximately 1130 m, and in the middle of the country in shale and sandstone to depths of approximately 1000 m. In tests, the EDGE data capture unit was able to receive a signal from its sensor from a depth of over 1800 m.

Technicians in the field say that the system gives them feedback on exactly what the hammer is doing at depth, and enables them to adjust WOB, RPM, and other variables to get the best penetration and to save needless wear on bit and hammer.

The EDGE Drill Monitor will have to prove itself over time to justify the labels 'game-changer' and 'revolutionary,' but it is clear that the ability to 'see' via sensors thousands of feet down a hole being actively drilled has the potential to change the way deep hole drilling is done.

Like the pilots of Doolittle's day, today's drillers seem perfectly willing to take advantage of the extra capabilities that these sensors provide them. But one lesson being learned is that company drilling procedures that ignore some or all of the benefits of new technology will not benefit as greatly as they would otherwise. Just as giving a pilot instrumentation on the flight deck, while keeping the same old policies would result in a 1930 airline falling behind the times, so too in 2012 with drill monitoring technology and the oil industry. OT