EXTREME ENGINEERING'S TOOLS USED FOR FUNDAMENTAL AND HIGH-END DRILLING OPERATIONS

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on target

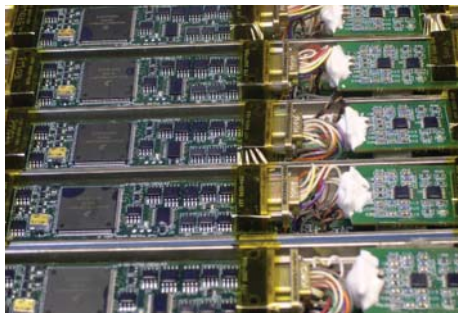
HOME-GROWN TECHNOLOGY
Left: The complete XPulse system is designed and manufactured at Extreme Engineering's facility in Calgary. Right: The rugged and compact surface kit permits minimal intrusion for the drilling crew. Automated data detection and decoding is achieved with sophisticated Digital Signal Processing (DSP) running on a standalone tablet computer.

As if drilling a well isn't risky enough, operators have to worry about actually getting to target in the first place. Deflection can be caused by any number of factors, but the combined effects can result in the drillbit wandering hundreds of metres off course. "Deviation can be a problem," says Dennis Olsen, wellsite supervisor for Apache Canada Ltd. "It's not so bad south of Calgary, but it can really be a problem in the Foothills."

Fortunately, drillers can rely on measurement-while-drilling, or MWD, to let them know when a bit is tracking off course. MWD systems sitting at the bottom of the drillstring can discern the location of the drillbit and transmit that information back to the surface in the form of pulses in the mud system. The technology suffers from several drawbacks, however; it can be costly to run, the amount of information that can be transmitted is limited and it adds time to the drilling process. Now, a Calgary-based company has come up with a suite of tools it claims not only cuts costs, but speeds up well drilling and adds oodles of information.

Extreme Engineering Ltd.'s headquarters, lab and manufacturing plant are located in an industrial park in southeast Calgary. The privately-owned company was founded five years ago by Derek Logan and other well service veterans after they spotted an opportunity in the marketplace. "Traditionally, MWD is used for directional drilling in oil wells," says the 47-year-old. "It costs $3-5,000 per day for the telemetry and $8-12,000 per day for the complete mud motor and directional package. You need two MWD operators and two directional drillers on site." Over the last few years, though, the number of oil wells has gone down, and the number of gas wells has gone up (although there is a resurgence this year in oil well licences). "…[But still] there's an awful lot of short vertical gas wells being drilled out there. We said, 'Let's build a mud pulser with shallow, vertical gas wells in mind. We'll give them high-end technology and reliability at a fraction of the cost.'"

While the goal of revolutionizing drilling tools might sound like a tall order for a tiny independent service company, Logan and his cohorts had the right pedigrees to take on the job. After graduating from Southern Alberta Institute of Technology with an electronics degree in 1980, Logan signed on with Vectel Petroleum Services, which had the idea to create a device that could communicate drillbit location information from the bottom of the well to the surface in real time.



DATA BACKBONE
Performance and reliability are achieved by incorporating the latest in surface-mount and microprocessor technology.

"Inclination and azimuth are key to positioning a tool in 3-D space," says Logan. Inclination is deflection from the vertical, measured in degrees. It is measured using a set of three axis accelerometers. Accelerometers are quartz crystal devices that are sensitive to the Earth's gravitational force, and can be used to measure the deflection from the vertical. Azimuth is the compass heading in relation to magnetic north. It is measured with a flux gate magnetometer that senses its orientation to the Earth's magnetic field. When the two data are computed, it gives an orientation of the drillbit in 3-D space.

Originally, accelerometers and magnetometers were developed for the military, but are now widely used in navigation devices and are readily available in compact form. By installing the devices behind the drillbit, they record azimuth and inclination when the bit is sitting idle. A valve then opens

and closes periodically to create a pressure increase that is detected at surface as a pulse in the mud system. By modulating the pulse, one to two bits per second of information can be transmitted as binary code data (BCD).

Logan, who was part of Vectel's team, recalls the first mud pulse MWD. "It was large, bulky, slow and unreliable — but it worked."

Vectel was eventually bought by Baker Hughes. In 1984, Logan moved on to Positec, which was formed to develop the first fully retrievable MWD tool. The first generation of devices had been mounted in a drill collar, so when the device failed, the string had to be tripped out. The company developed a retrievable probe that sat inside the drillstring and could be popped out and retrieved. Anadrill/Schlumberger bought Positec in 1989.

About this time, electromagnetic telemetry began to emerge as a competing technology. One of the principal problems with mud pulse was transmission of data to surface — one to two bits per second is very slow. In 1993, Logan co-founded Ryan Energy Technologies Inc. to create a whole suite of mud pulse and electromagnetic tools. By developing a gap sub (an insulating composite break in the drillpipe), information could be broadcast to a receiver on the surface at an order of magnitude faster. This allowed use of logging-while-drilling (LWD) and other information-rich devices in limited applications, but most information was still recorded and brought to surface for post drilling evaluation. Ryan was sold to Nabors Industries Ltd.; in 2001, Logan and three other partners formed Extreme to develop the next generation of telemetry tools.

SINGLE SCENE
The unmanned operation is mobilized and de-mobilized quickly and conveniently with one operator and a pick-up truck.

Research and development

Since its inception, Extreme has plowed several million dollars into making tools faster, cheaper and more reliable. Its first big breakthrough was XPulse, a mud pulse system that saves time and money while delivering superior data transmission.

In most jurisdictions, drillers have to take periodic inclination measurements to ensure a well hasn't drifted into someone else's lease. This can be done by traditional MWD devices, of course, but they are too expensive to run on shallow gas wells. Instead, they rely on wireline and other devices that can take up to an hour out of drilling time for each measurement.

XPulse is designed and priced so that it can be slapped on behind the drillbit of any hole and forgotten until needed. "You just put it in the drill collar and walk away," Logan says.

The device is a cylinder roughly five metres long and five centimetres in diameter. Inside, the electronic control circuit boards are sealed in silicon and surrounded by shock absorbers. The device can take 1,000 g of impact. Components susceptible to wear and corrosion are built from tungsten carbide and exotic ceramics. Parts that normally wear out in two weeks on traditional devices can last up to one year on XPulse. "It's one of the big reasons we can keep costs down," says Logan. "We charge as low as $500 per day for inclination, $1,000 per day for inclination and azimuth.

The receiver is encased in a stainless steel container the size of a large lunch pail and installed in the doghouse — it both receives information and relays it to oil company headquarters.

With earlier generation devices, measurements were taken and information transmitted while drilling was stopped. "This means that it could be 100 metres to 150 metres between measurements, and a delay of 15 to 45 minutes per survey for jointed pipe and 10 to 20 minutes for coiled tubing rigs each time a measurement is taken," says Logan. XPulse uses what Extreme is calling "Survey On Connection" — the downhole instrument detects when drilling has been stopped to add pipe (the mud pressure drops). The instrument takes inclination and azimuth readings, then, when drilling resumes, the instrument transmits the signal to surface, where it is recorded. "No time is lost due to a survey," says Logan. "A 10-day well can be brought down to seven days."

During operations, Extreme can remotely monitor tool performance, eliminating the need for an on-site technician. During a recent demonstration at Extreme's headquarters, Logan logged onto a well being drilled in southern Alberta. The screen display showed the mud pressure and coincidental transmission of data in real time. Azimuth, inclination and other data were also displayed. As observed, the drill crew shut off the mud pumps to make a connection. The downhole tool recognized that the pumps were shut off and took a measurement. When the pumps re-started a few moments later, the downhole tool sent the data in a 20-second burst. The new information was then displayed on-screen.

"With continuous directional measurements, individuals on location can perform fundamental directional drilling operations," he explains. "With coiled tubing rigs, you can pull back on the weight in order to allow the pendulum effect to correct drift." For a jointed pipe rig, he notes, the operator installs a mud motor and adjustable bent housing. The XPulse tool tells you every 10 metres the inclination and azimuth. "You can then communicate down to the XPulse system and turn on the toolfacing parameter and steer it at a

fraction of the cost. You only need to have the toolfacing turned on until the wellbore gets back on course." Logan is careful to note that this is not a full-blown steering system, but a control mechanism. "It's important to understand that the producer accepts responsibility for steering. It's a tool, use it how you see fit."

In order to test the device, Apache swapped out its normal wireline surveys on half a dozen, 2 000-metre vertical gas wells in southern Alberta with XPulse. "The biggest thing I like is that there is no survey time taken out of your drill time," says Olsen. "When we do an MWD with a directional company, there's always a survey time where you wait for the survey so you can face the tool. Over the course of one shift, you can add an hour." Olsen is also appreciative of the fact there is no technician on site. "It helps to keep costs down. All Extreme has to do is make a service call to lay the tool in and we can pick it up and use it whenever we want." Finally, it is simple to use. "Drillers don't have to interpret the data, it gives you a readout. They like it because they don't have to count blips on a graph. There's the potential for error [in that approach]."

Not all has been perfect. Certain formations within the geological column are very permeable, and will draw drilling fluid. Lost circulation material (LCM), in the form of walnut shells or sawdust, has to be sent downhole to plug up the permeability. "With the XPulse, the first time we started using it, we had a couple of incidents where it plugged with LCM," says Olsen. "But we've had it for a half-dozen holes now and we're quite happy with it. I want to keep using it."

A sound future

Extreme, with 20 customers, is beefing up its 60-member staff to handle stiff growth. "Right now, we have 86 units," says Logan. "We are ramped up to build 10 per month. By the end of 2006, we hope to have 115 systems. By the end of 2008, we hope to have 375 systems."

Much of Extreme's positive outlook rests on XAct, an entirely new set of tools that uses acoustic telemetry to transmit data to surface. Once azimuth and inclination have been surveyed, a piezo ceramic material that resembles a stack of 40 CDs gives off an acoustic signal when it is hit with 1,000 volts. This acoustic energy is transmitted up the steel drillpipe at the rate of 20 bits per second to surface, where an electro acoustic receiver (EAR), clamped to the kelly, picks it up. This rate is sufficient to transmit large amounts of geological and drilling information to surface in real time. "It allows you to make decisions faster, more accurately," says Logan. Developing the new platform has cost almost $30 million; the tools are designed specifically for high-end applications. "I see XAct as Tier 1, offshore or critical wells in the Foothills where you have faulting. You can put multiple sensors on it for fast, unlimited data."

Industry response has been positive. "The data comes up quick enough," says Olsen, whose company has run two wells using the new platform. "By the time you turn the pumps on, the survey is up to surface." The system also works better with LCM. "It has full bore circulation through it, so you can pump lost circulation material through it without clogging it up. I'd recommend it; this is a good tool." ntm

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