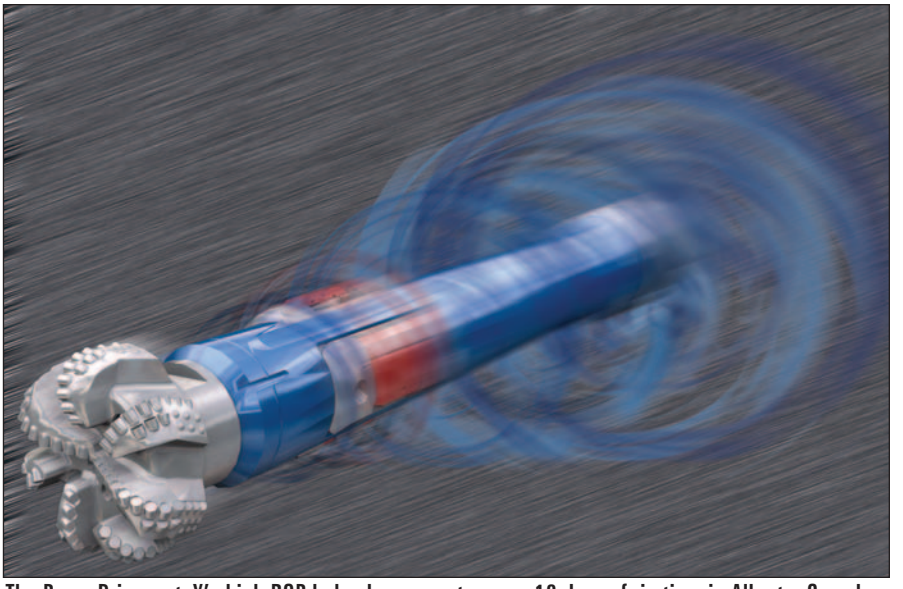
RSS ready to open new worlds of drilling

THE GROWTH OF rotary steerable applications, how fast and how wide, has been unlike few technologies in the industry. It hasn't been a decade since its first commercial introduction, but dramatic advances in its speed and reliability have helped the technology win the hearts and approval of many a drilling engineer and operator management.

From re-entry wells in the North Sea to high-tech ultra-deep wells in the Gulf of Mexico, there seem to be no limit on rotary steerables' potential applications and the savings — in both rig time and cost — it can offer. DRILLING CONTRACTOR spoke with a few rotary steerable experts on its recent advances.



The PowerDrive vorteX's high ROP helped an operator save 12 days of rig time in Alberta, Canada.

SCHLUMBERGER

Schlumberger began with a design premise that a rotary steerable should be just that — it should be rotary. While many people talk about push vs. point the bit, the experts at Schlumberger say it does not really matter.

"We are much more inclined to talk about everything rotating versus parts of the system non-rotating," said **Mike Williams**, Sales Manager for Drilling & Measurements at Schlumberger. "Our design criteria is that everything exposed to the wellbore must rotate. We believe that you drill much faster if you have an all-rotating system. The best analogy I can use is it's like sailing a yacht. If everything rotates, you're sailing away. If there are parts that don't rotate, it's like sailing with the anchor out."

Based on that concept, the company has developed its popular PowerDrive X5*, the mainstay of its rotary steerable fleet. Since Schlumberger commercially introduced RSS in the late 1990s, it has seen the technology grow tremendously in the market.

Originally very niche, high-end tools that were used only in the most difficult wells, rotary steerables have rapidly become the norm. In fact, according to Mr Williams, more than a quarter of Schlumberger's total footage drilled is now drilled with rotary steerables. That amounted to more than 7 million ft worldwide last year.

"The markets that adopted it first were the high-technology ones like the North Sea and the Gulf of Mexico. Today, we are operating in all corners of the world, from the west of China to US lands to Brazil. There really are no holds barred. Where we have operations, we have rotary steerables," he said.

The reason for the explosive growth?

Besides being able to drill 30 percent to 50 percent faster, especially in directional wells, Mr Williams said, "the leap forward in reliability has made rotary steerable almost comparable to conventional motor levels, and when this is coupled with the drilling efficiency gains, rotary steerable technology is applicable in almost all applications."

In land operations, for example, Mr Williams has noticed dramatic increases that are starting to rival offshore use. "The demand today in land work is outstripping the increase in offshore demands," he said. Offshore is still a higher percentage, but it's slowly evening out.

"Rotary steerables used to be seen as the domain of high-tiered operations where you can justify the increase in costs by savings, and drilling a couple of days faster in land wasn't such a big deal. Now, however, the risks of rotary steerable technology has gone down substantially. Additionally, the drive isn't rig cost anymore – it's to produce early oil. When people start drilling, any tool that can be used to start producing oil and gas earlier is desirable."

Since 2003, the company has also offered PowerDrive Xceed, which can serve different niche markets such as multilateral wells or deepwater – because it does not rely on interaction with the wellbore. It simply directs the bit where it wants to go.

"It's much more like using a traditional steerable motor," he said, "but you don't have to slide, which is obviously the advantage of rotary steerables. The beauty is you can have very soft formations – and by soft, I mean beach sand – and still be able to generate dogleg."

The reduced dependence of the steering principle on wellbore contact also makes the tool suitable for openhole sidetracking and steering in overgauge hole. Running with bi-center bits is another emerging opportunity for this type of RSS technology, "particularly in deepwater where we want to maximize the number of casing strings we can run," Mr Williams said. "It means that, for example, instead of drilling an 8½-in. hole from a 9⅝-in. casing, we can drill a 9⅞-in. hole from 9⅝-in. casing, which means a much larger casing can be run to provide for more casing strings to get to the end of the well."

Another advance at Schlumberger has been its integration of rotary steerable and traditional positive displacement motor technology. Its power section con-

verts the hydraulic power of circulating fluid to rotational torque, producing higher rates of penetration.

"In the past companies have experimented with just running a rotary steerable with a normal motor on top. While it worked, it didn't prove very reliable. So now we've integrated the system as one," Mr Williams said.

This system, which Schlumberger calls PowerDrive vorteX*, has helped push penetration rates up by an average of 50 percent. "But we have seen increases of as much as 300 percent," he added.

In Alberta, Canada, an operator drilled long horizontal wells to produce gas. The plan for one such well involved drilling out of the surface-casing shoe with an assembly capable of building inclination to 15 degrees at a rate of 1 degree/30 m (1 degree/100 ft) and then drilling a 2,260-m tangent section through steeply dipping formations. The high ROP of the powered RSS saved 12 days of rig time. It also produced a smoother borehole than a downhole motor and allowed casing to be run quickly and easily. Compared with experience in offset wells, this borehole required 56 fewer hours of reaming.

About 15 percent of Schlumberger's total RSS operations are now done with vorteX, which can be run with both PowerDrive X5 and Xceed configurations – "so we have the best of both worlds." Mr Williams predicts the power section of a motor will become an integral part of nearly all rotary steerables in the future.

However, ROP improvements don't help much when penetration rates need to be artificially limited because of data collection rates. To remove this bottleneck, Schlumberger has developed its PeriScope technology to allow for quicker gathering of data and real-time transmission to surface.

Removing this bottleneck is great for petrophysicists and geologists, Mr Williams said – but they're not the key. "The key is drillers can use it to maximize the potential of rotary steerables.

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>
> **Mike Williams**, Sales Manager for Drilling & Measurements at Schlumberger

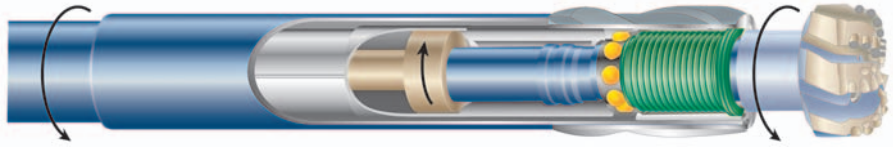
Being able to collect and transmit data at four times the industry standard makes a huge impact on our drilling speed. It's given rotary steerables a whole new lease on life."

INTEQ

At **INTEQ**, Product Line Manager **Jon Ruszka** sees a world of untapped opportunities for rotary steerable technology, and he thinks the company's AutoTrak X-treme service is poised to tap them.

Slated for commercial release in the first half of 2006, AutoTrak X-treme builds on the AutoTrak G3.0 Rotary Closed Loop System (RCLS), INTEQ's already-proven rotary steerable. It integrates the AutoTrak system with its proprietary X-treme motor technology to provide power from the performance drilling motor fully integrated with the steering capabilities of its rotary steerable system.

"Over the last two years, we've been proving it in the North Sea, gaining experience and making sure it does what we say it does before we formally launch it," Mr Ruszka said. The company has been working with a number of operators, including **Talisman**, **Maersk** and **Hydro** in proving the system across the North Sea and some intense activity offshore India with **BG**.



Schlumberger's PowerDrive Xceed does not rely on interaction with the wellbore. It simply directs the bit where it wants to go.

The most visible benefit of the AutoTrak X-treme is the improved ROP performance. Because the power is put down to the drill bit, not all the power has to be supplied from the top drive at surface. The system is rated up to a total speed of 400 rpm, compared with 200 to 250 rpm for most industry standard rotary steerables.

"Having a total of 400 rpm available means that we can put a high-power motor down there and still spin the pipe at a speed that's sufficient to clean the cuttings out of the hole. But we're not having to spin the pipe at excessive speeds just for ROP," Mr Ruszka said. "We can still spin the pipe at 150 or 180 rpm – if there's another reason to do that – but we don't have to just to get ROP."

Compare this with a conventional rotary steerable system with a standard rating of about 220 rpm. By the time the motor's driving the system, there's not much room left for rotating the pipe from surface. Thus, the pipe rotation that can be supplied from the surface for the drill string is very limited.

"Since we essentially doubled the rpm capabilities, we're not bound by those limitations of pipe rotation that most existing rotary steerables are – and since power is derived from speed, we can deliver a lot of power to the drill bit," he said. "It's the only high-speed rotary steerable system available. There's no other system that's rated to 400 rpm."

Another benefit is the reduction in wear on casing and drillpipe. A consequence of using rotary steering drilling techniques is that all the drilling is done in rotary mode. Depending on the well trajectory and especially in very complex or three-dimensional wells, this can cause a lot of casing wear, which can affect the performance of the well. This can cause issues with completions in getting sealing elements to operate correctly. Continuous rotation for long periods at high rpm also wears out the drillpipe – a major expense.

"If the operator is using rotary steerables a lot, then that cost of wear to the outside of the drillpipe itself can become quite significant," Mr Ruszka said. "Drillpipe is expensive, and there's not always a guaranteed supply of drillpipe, especially when drilling activity is high."

Although the AutoTrak X-treme technology can find uses in many different drilling operations, Mr Ruszka cited spe-

cific types of operations where it would give the most benefits.

First is extended-reach wells, where a lot of energy can be lost by trying to supply all the horsepower from the surface with the top drive. In both India and Denmark, he said, the technology has been used to drill multilateral wells further than they've been drilled before.

Second is slimhole applications. Although the system is available in all hole sizes, from 17½ down to 6-in. holes, Mr Ruszka said INTEQ has seen additional benefits specifically in the 4¾-in. version.

"The risk of rotary steerable drilling in 6-in. hole sizes, for example, is that you are using smaller-diameter pipe," he explained. "Also, in 6-in. holes, you don't really need very high rotary speeds to agitate the cuttings for hole-cleaning. So you're spinning a smaller-diameter pipe, which is mechanically weaker, at high speeds just to get ROP. And you really don't have any other reason to be spinning the pipe that fast."

This increases the risk of overloading the drill string, especially in complex wells where it might already be getting fatigue, and could cause a catastrophic twist-off. The X-treme technology helps by reducing the stress on small-diameter drillpipe.

The technology also is advantageous for re-entry wells on mature fields, such as those in the North Sea, where additional casing wear is very important because it may already be worn or damaged. "In that aspect," Mr Ruszka said, "they don't have to be spinning the pipe so fast in order to get ROP, because you're getting ROP from the motor that's driving the rotary steerable tool downhole."

There are also benefits in specific areas such as those in the Central North Sea. The Cretaceous Chalk formation in this area has always been difficult to drill, yet most of the reserves in that region are underneath it in the Jurassic Sands. Normal rotary steerable tools aren't effective in this scenario.

In the past, when these fields have been developed, wells were planned with simple well trajectories through the chalk, so directional work gets done either above or below the chalk. To do significant steering work in the chalk itself had proven to be very difficult and costly. Unfortunately, that's exactly what operators are now having to do in order to reach remaining trapped reserves in these very mature fields, some of which started producing as early as the 1970s.

INTEQ forecasts that technology such as the AutoTrak X-treme will enable operators to take on new wells that couldn't be drilled even with standard rotary steerable tools.

AutoTrak X-treme then becomes an effective solution "because it gives you the ROP of motor drilling but you get the steerability of the rotary steerable method," Mr Ruszka said. "You can drill complex trajectories for new targets that you wouldn't have been able to economically reach anymore. This maintains the financial viability of keeping these mature and declining assets alive in the North Sea."

"This is why we've focused our efforts with AutoTrak X-treme in the North Sea, and it's working out really well," he added.

The North Sea's Cretaceous Chalk also presents another type of opportunity – allowing operators to explore fields they previously found challenging. Traditional reserves in the area are in the Jurassic Sands underneath the chalk, but according to Mr Ruszka, there are believed to be significant oil reserves in the chalk itself. Especially in the UK sector, these opportunities for exploration have been largely left untapped because of the level of drilling difficulty and challenges associated with chalk reservoir development.

"This technology is going to assist the operators in reducing the risks of exploiting reserves in the chalk," he said. "This is a technology that can at least reduce the risk that people have of drilling chalk reservoirs. The uncertainty in the drilling part can be removed, and operators can focus on developing the chalk reservoirs and draining the oil in there."

Opportunities like this illustrate the vast potential of the technology behind AutoTrak X-treme, he said.

"In the decade since the original rotary steerable tools were tested and produced, the technology has become a very common way of drilling. It's all over the world, and the demand is still on a very steep growth pattern. There's no sign of that letting up," Mr Ruszka said.

"What's happening now is that instead of being a replacement technology for more conventional drilling techniques, people are planning their wells around rotary steerables. In the early days when it was just being introduced, a lot of the work it took up was pure replace-

ment work for steerable motors. But now it's grown a business of its own – of wells that can't be drilled without rotary steerables."

And INTEQ predicts a similar thing will happen with AutoTrak X-treme. "Once people get comfortable with the technology, there will be whole new wells that could not be drilled even with standard rotary steerable systems. They would only be able to be drilled with the likes of AutoTrak X-treme. … Within 5 years, we will see field development strategies being designed around the AutoTrak X-treme type technology," he said.

Of course, that doesn't mean it will ever completely replace standard RSS tools or conventional drilling techniques.

"It's just a matter of tools in the toolbox. You use the most appropriate tool for your well," Mr Ruszka said. "With this new technology, even more challenging wells will be drilled, allowing operators easier access to otherwise stranded reserves."

HALLIBURTON

At **Halliburton**, the company recognizes the rapid growth of the rotary steerable market and believes it has positioned itself well for that growth. It has found success by establishing its Geo-Pilot system as a RSS tool that can handle "the broadest range of formation types and deliver consistent build rates through the widest range of formation types, from very soft to very hard," said **Blaine Comeaux**, Global Marketing Manager for **Sperry Drilling Services**, a product service line of Halliburton.

"We utilize extended-gauge bit technology from Security DBS Drill Bits as part of the steerable system. The bit actually becomes part of our geometry that yields the curvature in the well. That has a number of benefits for us," Mr Comeaux said. "This bit style has a strong tendency to remain on course when drilling through hard streaks, interbedded formations and soft formations. It also does a wonderful job of reducing vibration levels because the bit is so well stabilized, and it consistently produces outstanding hole quality. The result is a significant reduction in trouble time throughout the entire well construction process, not just while drilling.

"The primary benefit of the Geo-Pilot system is the complete absence of downtime related to tool communication and control. We can downlink to the tool while on bottom, drilling ahead without interrupting the drilling process. We call it "stealth drilling" – it's virtually invisible to the drilling operation."

> "Any new tool, when it's first introduced, will have a certain number of things that need improvement. There's been constant refinement, but it is amazing how well the rotary steerable tool has performed from Day 1."
>
> **Blaine Comeaux**, Global Marketing Manager for Sperry Drilling Services

Mr Comeaux described the point-the-bit tool concept as elegant. The system points the bit by flexing an internal rotating drive shaft between bearings.

"Because the mechanism is inside the tool rather than outside, the tool is less susceptible to the problems presented by very soft formations or formations with strong natural directional tendencies," he said. "Both point-the-bit and push-the-bit systems work fine under most circumstances, but there are applications where the point-the-bit system has a distinct advantage."

The company has also taken its tool to a higher pressure rating. "First we took it to 22,000 psi and it's going even higher in order to address the ultra-deepwater market that is developing."

The overall growth in the deepwater market, especially in re-entry redevelopment drilling, is where Mr Comeaux sees potential for rotary steerables' further expansion. The deepwater redevelopment market and huge horizontal drilling market have driven Halliburton to develop an entire suite of RSS sizes, including a new slimhole rotary steerable system for 6-in. to 6 ¾-in. holes.

"The rotary steerable technology, on the whole, is so much more efficient than conventional steering with mud motors. In offshore drilling, where the drilling costs are so high, every form of optimization that you can employ is easy to justify, because time is worth so much in deepwater operations. Wells with fairly simple directional plans – and even straight sections of the wells – are now routinely drilled with rotary steerables," he said.

The company is also incorporating a motor into its Geo-Pilot system.

"We're using our even-walled GeoForce high-performance motors to deliver incredible amounts of torque to the bit without having to rotate the drill string at very high speeds," he explained. "We can still keep the bit spinning at very high speeds to produce the fastest rate of penetration while minimizing drillstring rotation and the associated wear on casing and reducing the amount of wear and tear on the surface equipment as well."

Another significant advance is the addition of a torsional efficiency monitor to the Geo-Pilot.

"We are monitoring the torsional efficiency of the drilling process at the drill bit," Mr Comeaux said. "The drive shaft is screwed directly to the bit, so we can monitor for any fluctuations of the bit speed. That gives us a very effective tool for detecting the onset of stick-slip and allowing us to take 'evasive action.' "

"We've had a number of projects prior to the introduction of the torsional efficiency monitor where stick-slip was severe, and after the run, when the tools were torn down, we saw signs of rotational 'chatter.' Without a downhole sensor to monitor for this type of dynamic motion, the tool can be damaged. But with this new monitor, we can detect the problem in real time. This will allow us to stay in the green zone of operating parameters and to avoid operating in destructive conditions. That allows us to keep the tool on the bottom drilling, which is what our customers want."

There will continue to be RSS improvements at Halliburton, Mr Comeaux said. "Any new tool, when it's first introduced, will have a certain number of things that need improvement. There's been constant refinement, but it is amazing how well the rotary steerable tool has performed from Day 1."

But the biggest challenge, according to Mr Comeaux, has been just keeping up with the market demand. "We definitely keep our fleet busy. It's been a challenge keeping up with the demand because the technology has caught on so quickly." ■