Seabed Rig is a small company named after its audacious vision: creating a device able to drill a well on the bottom of the ocean. The company, 20% owned by Statoil, is using what it learned from a prototype to build a rig capable of drilling on land, or an offshore platform, with no workers on site.

“You command it, you don’t control it,” said Kenneth Søndervik, vice president of sales and marketing at Seabed. Rather than a person controlling machines putting together pipes, an automated system will respond to a command, such as “pick up 3,000 meters of pipe,” from the computer program controlling drilling. The ability of these machines to work together on their own is essential for Seabed because Statoil needs a rig capable of drilling in the Arctic, and other environments that would put workers in harm’s way.

This semantic distinction points to a fundamental change in the drilling business, and the people who work on the rigs. Seabed is building a rig like no other, using environments that would put workers in harm’s way.

This semantic distinction points to a fundamental change in the drilling business, and the people who work on the rigs. Seabed is building a rig like no other, using environments that would put workers in harm’s way.

Seabed Rig is a small company named after its audacious vision: creating a device able to drill a well on the bottom of the ocean. The company, 20% owned by Statoil, is using what it learned from a prototype to build a rig capable of drilling on land, or an offshore platform, with no workers on site.

“You command it, you don’t control it,” said Kenneth Søndervik, vice president of sales and marketing at Seabed. Rather than a person controlling machines putting together pipes, an automated system will respond to a command, such as “pick up 3,000 meters of pipe,” from the computer program controlling drilling. The ability of these machines to work together on their own is essential for Seabed because Statoil needs a rig capable of drilling in the Arctic, and other environments that would put workers in harm’s way.

This semantic distinction points to a fundamental change in the drilling business, and the people who work on the rigs. Seabed is building a rig like no other, using environments that would put workers in harm’s way.

Seabed is working on creating a confined rig floor—the footprint is 9 m by 9 m—with robots programmed using software developed for NASA by Energid Technologies. The US company’s software is also being used to control the next generation of lunar rovers. For the drilling, Seabed will be choosing from a growing number of major oil and service companies developing software that does the job.

Statoil, ExxonMobil, Petrobras, Schlumberger, National Oilwell Varco (NOV), and Baker Hughes, represent a sample of the technology leaders seeking ways to program all or parts of the drilling process.

Shell appears to have taken it the furthest, with an automated program that has drilled multilateral wells. “It is not science fiction, it is what we have done,” said Peter Sharpe, executive vice president of wells at Shell. Its SCADAdrill System has been demonstrated in Canada and the Netherlands, with testing in progress in two US shale plays, the Marcellus and Haynesville.

Shell has shown its confidence in this work in progress that it has created a joint venture with the China National Petroleum Corporation (CNPC) to create and operate a new generation of automated drilling rigs designed to efficiently develop unconventional fields requiring thousands of wells. That has been the biggest step toward taking a technology that has been gradually changing the state of the art in drilling, and shoving it into the mainstream.

Drilling contractor Helmerich & Payne (H&P) was one of the first to equip rigs with automatic drilling programs that can take control of drilling, and competitors such as Nabors Canrig have followed suit. Others are embracing computer controls as a way to create systems that show what they have learned about drilling.

Useful knowledge, such as how to reduce the vibrations that can slow drilling and prematurely wear out drill bits, is converted into mathematical formulas. For example, if there is an increase on the weight on the drill bit, an algorithm determines if the change will mean more or less, efficient rock cutting. If the result is positive, the algorithm determines at what point the change will no longer improve performance and then it says, stop doing that. Such algorithms are the basis for programs to control drilling functions that also take advantage of the stream of downhole data.
“The number of companies with significant automation efforts under way is growing rapidly,” wrote Fred Dupriest, chief drilling engineer at ExxonMobil Development, in an email. He did not offer details, but said the company is working on an automation update expected in March.

With so many companies working to turn their knowledge into working programs, NOV is redesigning its rig control system. The goal is to create an open system that will facilitate deploying new drilling programs, said Andrew Bruce, vice president of controls at NOV. The approach is similar to the way iPhones runs a growing number of applications, better known as apps.

The Unconventional Case for Automation
Computerized control systems, which have been used for decades in factories and airplanes, are emerging as a way to manage a costly challenge: developing unconventional oil and gas reserves that will require enormous numbers of wells.

For Shell, the added drilling will push its spending for drilling and completing wells from 30% of its exploration and production budget—about $9 billion in 2011—to about 50% in 2020, Sharpe said. With natural gas prices relatively low and drilling costs on the rise, there is pressure to do things differently.

“If you are drilling 5,000 or 6,000 wells next year, there is a need for serious cost control in every aspect of the drilling program,” said Fred Florence, product champion of automation and drilling optimization at NOV.

Adding to the interest is the limited supply of skilled drillers. The rapid expansion of drilling in certain US shale plays has resulted in local shortages in directional drillers. And many of the best ones are reaching retirement age. In many other countries with large shale potential, people with directional drilling skills are a rarity.

And there is the promise that automation technology will reduce the risk of injuries by reducing the number of workers on site, and ensuring safe procedures are followed consistently.

In Search of Savings
The early work suggests automation can reduce costs by drilling wells faster. But the available results are based on limited experience. In the interviews for this story, a commonly cited estimate was automation can reduce the time needed to drill a well by around 25% compared with a driller.

In a presentation, Shell showed an example where its automated system reduced the drilling time by 25% and the cost of the well by 17%. The total cost included fixed costs not affected by faster drilling.

H&P offered an example showing how the efficiency of its rigs more than make up the higher day rates it charges to drill. However, it had not done a study to separate the benefit of its automated driller from the value of other features that increase productivity.

One study of offshore drilling found that over the past decade, advances in rig designs, which promised cost reductions, failed to deliver.

The study by Michael Behounek, senior drilling adviser for worldwide drilling at Apache, found that industrywide there were little or no gains in productivity during the period. The presentation delivered at the International Association of Drilling Contractors technical meeting in April was based on a variety of cost measures gathered by Rushmore Reviews.

“We had some great technology developed. It has allowed us to drill wells we couldn’t do in the early 1990s. But on the cost curve, we didn’t bend it,” Behounek said. His prescription: radical technological change.

A worker monitors the progress of a well drilled by Shell’s automated drilling system.
The Path to Automation

SPE paper 119884 cited Professor Thomas B. Sheridan’s 10 degrees of automation, which range from all decisions made by a human with no machine assistance to decision making by the control system.

1. Offers no assistance: driller must take all decision and action.
2. Offers a complete set of decision/action alternatives.
3. Offers a set of alternative and narrows the selection down.
4. Suggests a single course of action.
5. Selects and executes that suggestion if the driller approves.
6. Allows the drill a restricted time to veto before automatic execution.
7. Executes automatically, then necessarily informs the driller.
8. Executes automatically and informs the driller only if asked.
9. Executives automatically and informs the driller only if it, the computer, decides to.
10. Decides everything and actions autonomously, ignoring the driller.

Cooperation vs. Competition

For H&P and Shell, making a change required going it alone.

In the late 1990s, when the US drilling business was in a slump, H&P began designing and building new rigs. Its rigs represent more than 40 percent of all the US rigs wired to handle drilling automation and are among the most active.

The decision by Shell to move forward with commercialization may serve as a catalyst in an industry where most companies seek to be “close followers.” Adding to the challenge is the complex structure of the drilling business.

Sharpe said it also shows how the splintered, competitive oilwell services business can impede development of a technology with far-reaching consequences. To explain, he drew a diamond-shaped diagram of the drilling business. At the four corners were equipment makers, drilling contractors, large service companies, and E&P companies.

As he explained the role each plays in drilling a well, Sharpe drew lines with arrows highlighting the symbiotic relationships with lines that crossed in the middle of the diamond. Then he drew an X at that intersection, as he pointed out how those competing interests make it harder to change. Sharpe said the barriers to automated drilling begin in the control room. “Who wants this change on the rig?” he asked. “A directional driller will do everything he can to make sure it doesn’t work, and the driller isn’t keen on this working.”

The rush to create drilling programs challenges the normal relationship between a driller and the companies that hire them. A program from the oil company that manages drilling by controlling the weight on the drill bit and the revolutions per minute goes beyond the company man setting parameters for the well.

Shell’s plan to create a joint venture with CNPC that will build and run rigs drilling in a select group of extremely large fields does not avoid the issue altogether. For the many fields where less drilling is required, including Shell’s US shale plays, Sharpe said Shell will look for ways to use its drilling control system in situations where it hires a driller. He recognizes that may require an unusual agreement, where Shell would exercise control over the drilling and the equipment needed to make its automated system work.

For a rig owner it is a significant change. When the customer takes control of equipment of a business built on selling a valuable service, there is the risk that a drilling business will become more like an industrial equipment rental company.

Bridging Gaps

The technical and business challenges presented by drilling automation have spawned a pair of professional groups seeking to bridge the gaps. SPE’s Drilling Systems Automation Systems Automation Technical Section (DSATS) has worked to identify and overcome barriers that limited the use of downhole automation, as has the IADC’s Advanced Rig Technology Committee.

One indication of the rising interest has been the swelling attendance at DSATS events. An overflow crowd filled a ballroom at the IADC/SPE Drilling Conference in Amsterdam in March, said Florence, who is the chairman of DSATS.

The discussions have covered what standards should be used for data communication and commands, how will automation change the driller’s job, and whether there are ways to resolve the business issues raised in this competitive business.

When DSATS held an automation workshop in Galveston in March, participants were encouraged to offer solutions to the technical and business issues raised by drilling automation. Florence said the business issues generated the fewest responses.

Based on a survey at that gathering, there is time to work out these issues: 46% of respondents said the day when a rig can be operated without people is 20 years off, if ever.

“Some folks say it will never happen. Some say it has to happen. Some people see autonomous drilling machines,” Florence said, adding: “Some level of autonomy will be there.”
software development. Modern rigs, with control systems wired to communicate and respond to a digital system, are needed. These are most often variable frequency drives (VFD), or alternating current (AC) systems.

Only 25% of the active rigs working on land in the US are AC equipped, according to H&P data. Its chart, drawn from H&P and industry data, showed 72% of the existing US onshore drilling rigs were built between 1942 and 1982.

“Retrofitting 30-year-old land rigs isn’t likely to make economic sense,” said Clinton Chapman, drilling automation program architect at Schlumberger. “It will cost less to scrap them and do new ones.”

Automation also requires rigs with compatible equipment that is consistent from job to job. To drill a well, Schlumberger had to develop algorithms to control drilling, and the interfaces needed to ensure its instructions are delivered and executed properly by the equipment on the rig.

Writing algorithms for every possible rig and equipment setup would be prohibitively costly and time consuming. One example of the differences: a command setting the drill bit revolutions per minute rate would need to go through the control system on one rig, while another would require setting up a system to control the throttle on the top drive.

There is no standard for communication and commands among drilling devices. To fill that gap, DSATS recommended a communication protocol widely used in industrial automation—OPC UA—based on the consensus among its members with expertise in the area.

Creating drilling equipment that works flawlessly with a computerized control system also raised questions for DSATS. The fear was the standards needed to ensure uniform performance could prevent equipment makers from adding value with unique new features. Equipment makers do not want to be trapped in a business making something that is selling a low-cost commodity.

“We have to find a way to deal with all these limits in a way that makes technical sense and business sense and is secure and reliable,” Florence said. “I hope you see more of it five years, it may take more like 10 years.”

For further reading:


**SPE/IADC 140114** • “Interoperability: An Enabler for Drilling Automation and a Driver for Innovation” by Andreas Sadlier and Moray Laing, Baker Hughes

**SPE 134580** • “Borehole-Quality Design and Practices To Maximize Drill-Rate Performance” by Fred Dupriest, ExxonMobil Upstream Research Company, et al

**SPE 143899** • “Drilling Automation: An Automatic Trajectory Control System” by Dimitrios Pirovolou, Clinton D. Chapman, Schlumberger, et al

**SPE/IADC 139897** • “Increased Rate of Penetration Through Automation” by J. Dunlop, Schlumberger, et al