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Sea Change

Exxon Mobil Bets On New Technology In the Hunt for Oil

Trained at NASA, Dr. Srnka Uses Electromagnetics To Locate Fields Offshore

Race Against Norway's Statoil

By Susan Warren

Afloat in a research vessel off the coast of West Africa in early 2002, Exxon Mobil Corp. geophysicist Len Srnka took his laptop, locked himself inside his cabin and peered into oil's future.

Since the 1970s when he'd studied the moon for NASA, Dr. Srnka had been fascinated by the prospect of using the electromagnetic properties of earth, water and rock to decipher underground terrain. He was hired by Exxon in the 1980s to apply the method to finding oil but was stymied for years by technological and funding hurdles. Finally, on this January day, Dr. Srnka got a chance to test his theory in a proven offshore oil field.

Len Srnka

Exxon Mobil had drilled off the coast of Angola since 1997 and knew exactly where the oil was. So, could Dr. Srnka's electromagnetic contraption show what Exxon already knew?

It could, mapping the oil with unerring precision.

Two years later, Exxon is making a multimillion-dollar bet that Dr. Srnka's technology, which he calls R3M, will work in offshore oil and natural-gas fields around the world. If Exxon is right, it could give the world's largest publicly traded oil company a competitive advantage over its rivals.

The stakes are higher than one company's profits. The global economy needs more technological home runs to slake its growing thirst for oil. Current world consumption of 80 million barrels a day may hit 120 million daily by 2030, according to the International Energy Agency. If there weren't enough oil to meet such demand, global growth would be hobbled.

The price of crude oil has rocketed in recent months to $46 a barrel amid terrorism fears, Iraqi instability, China's growing demand and the legal imbroglio ensnaring Russian oil giant OAO Yukos. High oil prices are weighing on the U.S. economy, apparently contributing to disappointing job growth and prompting consumers to curtail their spending.

Easy-to-find, easy-to-get oil is a thing of the past, maintains one school of industry experts. When big new fields are discovered, they're often in hostile environments—icy Arctic frontiers or far underwater—where getting the oil out is an exercise in human ingenuity. The problem has cast a shadow over the major oil companies.

Better technology has helped them improve their exploration odds in the past. But many companies, under pressure to deliver short-term profit growth, are spending less on research and development today than they were 10 years ago. As a result, it's been decades since the industry has hit upon the kind of breakthrough technologies—such as three-dimensional seismic surveys or horizontal drilling—that can unlock major new supplies.

If Exxon Mobil can use electromagnetic technology to better identify deposits, says Anne Reeckmann, vice president of geophysics research, "we'll reduce our risks and we'll be able to drill things that today we look at and say, 'Oh, I'm not sure if I want to spend the money drilling—that's too risky.' " But electromagnetics is not a silver bullet. It will never be a replacement for seismic, just a supplement, says Steven Constable, a researcher at Scripps Institution of Oceanography.

Kurt Strack, a geophysicist at the University of Houston who has long studied electromagnetics in the oilfield, says that while "it's a very useful information supplement to understand where the the reservoir is ... I have my reservations that you are going to find huge additional re-

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serves with this."

Dr. Srnka's project is part of an effort hatched in the mid-1990s by Executive Vice President Harry Longwell to improve R&D. Mr. Longwell wanted Exxon to take more risks on ideas with bigger potential payoffs. In doing so, the company moved in the opposite direction of most peers, who were cutting their R&D budgets and shifting the burden of finding new technologies to oilfield-service companies.

Rather than sink money into risky research that might never pay off, most oil companies adopted a policy of "fast follower," picking up technology as quickly as it became available from someone else. But the service companies don't have the financial clout to tackle the ambitious research that could really boost oil supply, says Ali Daneshy, a director of the Society of Petroleum Engineers.

Mr. Longwell saw an opportunity for Exxon Mobil. He modeled its program on cancer research at M.D. Anderson Cancer Center in Houston, where he serves on the board of advisers. In search of the next big leap in cancer treatment, M.D. Anderson encourages researchers to propose their most far-out theories. The best are seeded with research money, allowing the scientists to try to prove them.

Exxon Mobil launched its new research program with a three-day workshop at Princeton University in the fall of 1996. Under the cloak of confidentiality agreements, it gathered its own researchers and top scientists from universities and industry groups to brainstorm. Among those there was Dr. Srnka, who is 58 years old and has a Ph.D. in physics. As they batted around ideas, his ears perked up at the mention of electromagnetics.

This was hardly a breakthrough concept in the industry. Oil is a "resistive" material—a poor conductor of electricity. So when electromagnetic energy waves are sent into the earth, oil-soaked rocks show up as a resistive layer that contrasts with more conductive substances like water-soaked rocks. Schlumberger Ltd. pioneered electromagnetics as the standard for "well logging," the process of mapping the layers of oil in a newly drilled well.

Scientists have nurtured the notion that the same technology could be used to explore for oil from the surface. While seismic surveys could reveal a lot about rocks and where oil might be, electromagnetics had the alluring potential of seeing the oil itself. But the idea had been discredited by a succession of failures, including efforts long ago by entrepreneurs who claimed they could find oil by walking around with special earphones to listen to the earth's magnetic reflections, or by flying planes loaded with sensors.

When Exxon hired Dr. Srnka away from the National Aeronautics and Space Administration in 1981, it was with the idea that he would use his expertise to finally find a way of making electromagnetics work for oil exploration. There was one big problem: Electromagnetic "noise" in the atmosphere wreaked havoc on measurements, muddying the picture scientists tried to get from deep in the earth.

Dr. Srnka realized that salt water would be the perfect insulator from atmospheric noise. After two years of work, he developed a process that used sensors placed on the sea floor in very deep water. A high-power transmitter would blast electromagnetic energy waves into the sea floor, and the sensors would record the response. The data would then be processed into an image. Oil would light up as a resistive layer.

All the computer models looked good, but Dr. Srnka told his bosses the project would take years, cost millions, and be very risky. "In theory, it should work beautifully, but we can't guarantee it," he remembers saying.

Executives decided to pass. At that time, 3D seismic technology was all the rage. And companies weren't yet able to work in the deep waters suited to Dr. Srnka's method. He filed a patent for his idea—granted in 1986—set it aside, and focused on improving seismic surveys.

By the time electromagnetics bubbled up a decade later at the Princeton workshop, the industry had changed. Seismic testing had been stretched about as far as it could go, and deep-water drilling was the new frontier. Lured by big deposits off the coasts of Africa and Russia and in the Gulf of Mexico, companies had developed ways to drill in waters up to 5,000 feet deep.

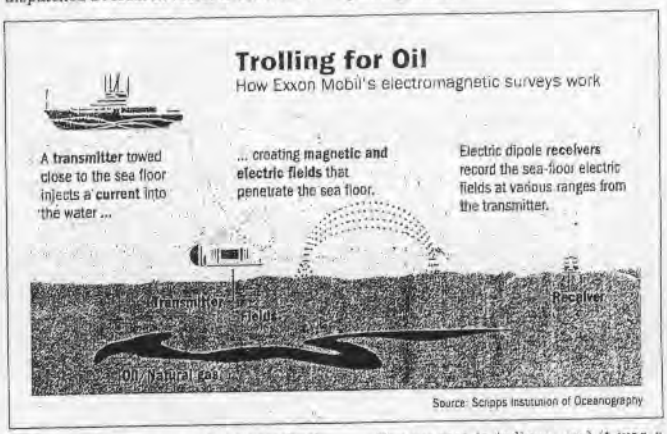
But the huge cost of wells in such waters greatly increased the risks, since oil companies still had no way of being sure there was oil where they bored. In the old days of drilling in West Texas, if you missed with a $250,000 well, the attitude was, "So what? Just drill another one," says George Lock, the recently retired vice president of Exxon Mobil's engineering research. These days, deep wells off the coast of Africa cost up to $70 million, and "the consequence of being wrong is huge," he says.

At the Princeton workshop, Dr. Srnka and his colleagues sketched out their idea in a one-page memo that went into the workshop suggestion box and quickly yielded a request for more information from the brass. Dr. Srnka was grilled on potential pitfalls. His project finally got the green light in the summer of 1998 as Exxon's first hoped-for "breakthrough" project.

He didn't get carte blanche. Every research project must pass through several "gates." At each gate, it is reviewed for progress before funding is continued. Exxon Mobil spends about $600 million a year on R&D, a number that has shrunk 18% over the past six years even as the company grew through its 1999 merger with Mobil Corp. There are many more ideas than dollars available to pursue them. Some projects are shelved after making it through one or two gates. Some make it all the way to expensive field tests before getting axed. A committee of top research executives called the "blue team" has the final say.

Dr. Srnka's project sailed through the first couple of gates. The science looked sound, computer models were promising, and a collaboration with the Scripps Institution and Britain's Southampton Oceanography Center was bringing together the equipment needed.

But in the summer of 2000, Dr. Srnka was jolted when he learned that Statoil AG, a much smaller Norwegian oil company, had dispatched a research vessel to the coast of Africa to field test a new exploration technology that also used electromagnetics.



Dr. Srnka and his team frantically fished for more information about what Statoil was up to. They combed public permits and checked shipping records to find out where Statoil's boat was going, looking for clues such as the depth of the water where it was drilling and the type of terrain there. Dr. Srnka concluded Statoil was working on something very similar. "So then, of course, you have the feeling the race is on," he says.

There was only one way to keep his project alive: Crash the gates. Dr. Srnka went to the Blue Team and asked to take the technology straight to field trials. It was a major leap, requiring tens of millions of dollars to contract a research vessel and crew and to manufacture the needed equipment. The request went all the way to Exxon Mobil's Irving, Texas, headquarters. To Dr. Srnka's surprise, it was approved.

Still, it wasn't until the fall of 2001 that he was aboard the research ship heading for the coastal waters of Angola. It was the ideal place for the field trials: relatively simple geology, 3,000-foot-deep water and a huge known reservoir of oil. "It's got to work here," Dr. Srnka says he figured, or "there's something really wrong with the whole damn thing."

Raising the pressure, there was word Statoil's field tests had been successful. Statoil researchers had quietly been working on electromagnetics since the late 1980s and were aware of Dr. Srnka's 1986 patent, says Terje Eidesmo, president of ElectroMagnetic GeoServices AS, a Statoil spinoff. They had no idea they had roiled mighty Exxon Mobil. The U.S. company has been so secretive that even today Mr. Eidesmo says he's "not aware of what they're doing."

Dr. Srnka had designed a series of test cases for his technique, dubbed Remote Reservoir Resistivity Mapping, or R3M. His research team would run their survey over an already-explored oil field, scrutinizing an area where a well had successfully tapped into oil and another where a well had come up dry.

As with seismic technology, the ship would crisscross the field, gathering data to process into images later. But unlike seismic technology, where sensors are trailed along behind the boat on long cables, Dr. Srnka's method required sinking dozens of shopping-cart-size sensors to the bottom of the sea.

There, four spider-like arms reach out 30 feet and a vertical arm rises 10 feet, to pick up electromagnetic signals returning from the rock below. A computer attached to the sensors stores the data, which are later retrieved aboard ship. Computers must sort the important data from the "noise." Electromagnetic energy is everywhere, generated even by a passing shark.

The process is tedious, and it was a month before Dr. Srnka had collected enough data to draw a conclusion. He had prepared a computer model of what R3M should show if it spotted oil where Exxon Mobil knew there was some and if it detected nothing where Exxon Mobil had hit a dry hole. Sitting alone in his cabin, he nervously loaded the data onto his laptop and was soon relieved. "The two matches were extraordinary," he says.

R3M's potential was confirmed a year later, when Dr. Srnka returned to Africa to survey an area Exxon had pinpointed for drilling with conventional seismic surveys. R3M had to predict what Exxon would find before it drilled the well. It succeeded.

Since then, Exxon Mobil has charged ahead with the technology, leasing and equipping its own dedicated research vessel, the Polar Jorn, and dispatching it around the world to test R3M's limits. The company needs to evaluate the effectiveness in different geological conditions. For instance, salt formations or volcanic rock may be confused with oil on a scan. Dr. Srnka also hopes to make R3M work in shallower waters.

If all goes well, it will become an integral part of Exxon Mobil's exploration toolbox. Competition in the technology has grown. Statoil commercialized its own process in 2002, culminating in its recent spinoff of ElectroMagnetic GeoServices. Other oil companies are making progress on their own versions, too.

Exxon Mobil began drilling its first wells with R3M this summer. It hopes to use the technology to reduce costly cases where it drills underwater and finds nothing. It also hopes R3M will enable it to spot oil where others might miss it, allowing it to lock up permits and perhaps negotiate better contracts with countries where the oil is found.