As seen in the November 2008 issue of E&P

Innovation crosses over

The myriad of challenges associated with developing petroleum reserves in the Arctic and in ultra-deepwater regions will require both new technologies and novel implementations of existing technologies to lower costs and to address environmental conditions unique to many frontier areas.

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Given the rapid pace at which the petroleum industry is pursuing hydrocarbons in frontier provinces and the long lead times associated with seeding internal research and development (R&D), it is unlikely the upstream industry will meet its technology requirements without adopting promising innovations from outside of the petroleum industry.

There are many compelling technologies under development for other industries that have potential applicability in the upstream petroleum sector. Much of this innovation is occurring in smaller companies, which tend to be entrepreneurial. They are willing to embrace new challenges and are surprisingly receptive to potential collaborations with upstream oil and gas companies.

A host of mid-sized and larger companies are also developing technologies of comparable significance for the upstream petroleum industry. While these companies are certainly worthy of further attention, these more established enterprises do not always display the same willingness to engage the oil and gas industry if they are not already selling products and services to upstream companies — unlike their smaller counterparts.

Collaborating with smaller technology companies requires a concerted effort. Many of the most promising technology companies are geographically removed from oil industry hubs. In the US, primary centers of innovation are in areas like San Jose, Calif., (Silicon Valley) and Los Angeles, Calif., Chicago, Ill., Boston, Mass., upstate New York, and the "Research Triangle" in North Carolina; all of the preceding locations are several hours by airplane from Houston.

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Many early stage technology companies have fewer than 25 employees. Corporate Web sites are often incomplete and reflect a minimal focus on marketing. In short, these companies are easy to overlook. Finding them involves establishing connections with their sources of funding such as regional angel investor groups, venture capital funds, and government agencies.

The technologies developed by these small companies frequently began in a university or a national lab. It is important however to differentiate a smaller company from its R&D beginnings. Companies with technologies originating from a university or national lab established themselves outside of that setting, which requires standalone office space, a full time staff, control over intellectual property, and access to external funding. Companies lacking these attributes are unlikely to deliver commercial solutions to the upstream petroleum industry in a timely manner.

Applying the preceding screening criteria yields a very robust collection of companies not currently involved in the upstream industry but having, in some cases, quite remarkable innovations able to address upstream technology challenges. These companies can be evaluated by creating a number of technology categories such as the following:

1. coatings and materials;
2. communications, electronics, and power;
3. environment, health, and safety; and
4. inspection and monitoring.

A focused effort, designed to unearth the most promising companies in each of these categories, reveals many innovative technologies that have potential to address real challenges in the upstream industry.

There are many small companies working in the coatings and materials arena. The technologies they are developing include coatings which are ultra-hydrophobic, as well as oxidation and corrosion resistant, while also exhibiting self-healing characteristics. There may be a number of potential subsea flow assurance applications for these materials. Other companies are developing ice-phobic and thermal barrier coatings which are non-toxic.

One small company in the Chicago area is emerging as a leading developer of thin film diamond coatings. Unlike previous attempts at diamond coatings, this technology yields uniform, nanometer-sized diamond particles requiring no further processing. Early applications include for seal faces, particularly poorly lubricated seals or those exposed to high temperatures and corrosive fluids.

A small materials company in Colorado is at the forefront of developing micro electro-mechanical sensor (MEMS) packaging deployable in high temperature, high pressure and highly corrosive environments. The technology can already protect MEMS sensors in 660 to 750°F (350 to 400°C) environments and is steadily progressing toward packaging for 1,830°F (1,000°C) applications. As MEMS sensors achieve broader acceptance in deep wellbore and reservoir applications there should be numerous opportunities for this type of packaging technology.

Communications, electronics, and power providers are also providing applicable innovations. A promising company, having fewer than 20 employees, is developing a new class of electronic devices merging solid state electronics with thermionic vacuum electronics. The result is an enabling technology for extremely high temperature applications up to 1,290°F (700°C). The electrical performance of these electronic devices is temperature insensitive implying potential uses in logging while drilling, measurement while drilling, and formation evaluation tools deployed in deep, high-temperature wells.

In this same category a young company has developed a breakthrough lithium-seawater battery, which encapsulates lithium in a conductive glass membrane. Protected in this manner, the lithium becomes completely stable and discharges uniformly — for years. The company is already building cells having energy densities of 1,000 to 3,000 Watts/kilogram; the theoretical capability exceeds 10,000 Watts/kilogram.

The resulting lithium-seawater battery promises significant weight reductions over all comparable marine power sources because it requires no pressure housing even at extreme depths. One can readily envision applications for this technology as a power source for long-life seabed sensors deployable in ultra-deepwater regions. Likewise, this technology could significantly reduce the size, weight, and handling requirements for seabed seismic nodes and underwater unmanned vehicles.

Inspection and monitoring is another fruitful area to seek out innovations residing within smaller companies. In one instance, a small but well established company in the Boston area has developed a new technology for nondestructive inspection. The technology uses compact, rugged sensors able to tolerate -14 to +355°F (-25 to +180°C) temperatures and pressures up to 10,000 psi. These sensors are small enough to be incorporated in probes able to inspect the internal surfaces of piping substantially less than 1-in. in diameter. The entire system has the potential to offer superior spatial resolution, higher contrast, better penetration, and faster inspections than eddy current testing, ultrasonic inspection or X-ray imaging. In addition, this technology works on steel as well as other metals such as titanium and aluminum alloys.

An innovative small company located in California's Silicon Valley is commercializing a structural health monitoring technology incorporating miniature piezoelectric transducers embedded in thin flexible, printed circuit films. The latter are attached to structures to provide real-time condition based monitoring to detect corrosion, fatigue cracks, and impact damage. The technology is able to identify very small cracks, determine which direction they are spreading and how rapidly.

It is possible to cite many other examples of technological innovations, developed for other industries, but having applicability in the upstream petroleum industry. If these technologies can be successfully transferred into the oil and gas industry, they may facilitate the development of hydrocarbons in some of today's most challenging environments. This type of dual usage benefits innovative companies, the petroleum industry as a whole, and the entire consumer base. **E&P**

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Environmental Innovations

Even in the environment, health, and safety category small companies are innovating and developing technologies relevant for the upstream petroleum industry. On the East Coast of the US, one of these companies has developed an important new technology for tracking marine mammals. The technology uses passive sensors and is able to operate in concert with active acoustic surveys. With a 95%+ accuracy, this system is able to discriminate between manmade acoustic sources and marine mammals. It is able to detect marine mammals at substantial distances and even track individual animals. This important new technology holds substantial promise in the Arctic and other areas where seismic surveys and drilling operations must comply with the Marine Mammal Protection Act.