E&P Technology: From Idea to Widespread Adoption in the U.S.

by E. Lance Cole
Operations Manager
Petroleum Technology Transfer Council

Jim Blankenship
Geoscience Director
American Association of Petroleum Geologists

Tom Williams
PTTC Board Member
and Retired Vice President, Technology Services
Noble Corporation

Ken Oglesby
Managing Partner
Impact Technologies LLC

Many factors influence the degree to which a new exploration and production (E&P) technology is accepted by industry and grows to realize its full market potential. These include the introduction of a good idea that is needed by industry, intellectual property protection, capitalization at each level of development, field testing, the business model, technology transfer and the "strength of the industry pull." Many believe that any good idea will naturally find its way to success, but there are many obstacles to overcome to achieve this. For example, strong "industry pull" – referring to an industry need plus a willingness to search for solutions – accelerates timing and broadens the spread of a technology, but even strong pulls may not be felt early on. One unique organization, the Petroleum Technology Transfer Council (PTTC), employs a broad network of connections to accelerate the progression of technologies from idea to reality. Widespread application subsequently benefits producers, the service sector, consultants, federal and state governments and the public at large.

It is widely known that the E&P industry does not exhibit short technology development cycles. It can take more than 15 years to move from idea to widespread technology adoption. This is influenced by "not developed here" and "not tested in my backyard" thinking as well as the cost and risk of testing and proving new technologies. Considering the energy supply crisis, shorter cycles are essential.

Clearly understanding the needs of industry gets the process off on a solid footing. Input must be gathered from multiple sources and consensus reached regarding the research and development (R&D) needs. Industry interaction helps potential developers understand the strength of the industry pull and identify instances where cooperative research efforts make sense. Industry pull exerts a strong influence on capital inflow and the ease with which field testing sites become available. Thorough field testing, which is done only after technologies have been sufficiently developed in the lab, measures performance and often leads to technology modifications that had not originally been expected. Insights gained from field testing refine application guidelines. Networking, connections and technology transfer occur throughout the cycle. Major companies, and to some extent super-large independents, have networks for technology development and collaboration. Independents, which produce most of the United States' oil and gas and drill the vast majority of wells, lack such networks.

Industry Pull and Consensus

New or improved technologies come into being when there is industry pull to fill a void or meet a critical need. Pushing products or creating markets where nothing new is needed fails. Nonetheless, in some instances end-users may not realize they even have a need. When game-changing technologies are needed, the pull is extremely strong. Take, for example, current high activity in shale gas plays. For the economics to work, the geology must be there and the resource must be effectively accessed, which largely means horizontal completions stimulated with multistage hydraulic fractures tailored to each shale's unique characteristics. This extremely strong pull has greatly accelerated technology development in horizontal drilling and hydraulic fracture stimulation. Another example of where there has been strong industry pull is drilling in environmentally sensitive areas. Minimal surface disturbance in areas requiring many completions is critical for retaining access privileges. Access has been a strong driving force for many of the pad drilling operations now prevalent in many areas. In this instance, industry has found that pad drilling also provides economic advantages.

Even the strongest of pulls benefits from industry consensus-building among the stakeholders (producers, the service sector, government and academia) and across disciplines and diverse geographic regions. Consensus clarifies research focus. With its third-party objectivity and connections to all groups, PTTC serves a valuable purpose in helping industry move to consensus. When there is not a strong industry pull or where needs are not recognized, technologies can still develop, but it generally takes longer because there is not a crisis or a consensus driving end-users toward change.

Capitalization

Put simply, it takes a lot of money to move technology along rapidly. Capital is most needed in the precommercial stage where risk is greatest. This funding can come from the inventor/developer, outside industry investors, industry-specific investors, industry operators in need of a technology (industry pull) or government (federal or state). The risk of undercapitalization is most serious for individuals or small companies and for the early, precommercial stage of development (called the "valley of death" of new technologies). How strong the industry pull is for a technology affects how rapidly the required money finds the opportunity. Of course, if the industry pull is extremely strong, such as in deepwater or horizontal hydraulic fracturing, capital will find the idea wherever it is. PTTC itself is not directly involved in capitalization, but it does work to develop the personal networks with organizations that are potential funding sources.

One private/university venue for helping capital find ideas is the annual Energy Technology Venture Forum organized by the Rice Alliance for Technology and Entrepreneurship. This forum allows emerging technology companies to showcase their new ventures in front of investors, venture capitalists, industry representatives and service providers. Past forum participants confirm that the forum is satisfying a matchmaking demand. Recent forums have focused on alternative energy, such as biofuels and solar, more so than oil and gas.

New or improved technologies come into being when there is industry pull to fill a void or meet a critical need.

In the public realm, for smaller-scale technology ideas focused on marginal wells, the Stripper Well Consortium (SWC), supported by the Department of Energy (DOE), can be a good capital source for product development and field testing. Each year the SWC seeks short-term, relatively low-capital proposals. Industry is represented within an executive council that determines the winning awards. The short duration of project awards stimulates rapid movement toward application. Typically, 10 or more awards are made each year. The next cycle for which awards will be made is spring 2009.

There are also public funds available through the DOE. Section 999 of the Energy Policy Act of 2005 provides $50 million per year for oil and gas R&D separate from the annual federal appropriations process. A total of $37.5 million annually flows through the Research Partnership to Secure Energy for America, a consortium that manages research in "ultra" deepwater, unconventional gas and small-producer areas. The remaining $12.5 million flows through the DOE's National Energy Technology Laboratory for complementary R&D programs and overall management.

Several states have funding groups for new technologies, many of them funding oil and gas technologies. Examples include the Oklahoma Center for the Advancement of Science and Technology, the Technology Business Finance Program and the Oklahoma Seed Capital Fund.

There is also an unofficial process at work. If PTTC knows that one member has a great need and that another is making great strides on a technology that would address that need, PTTC simply introduces them

Technology developers have an obligation to test their technology's limits and establish its durability.

and the parties proceed from there at their own risk. Matchmaking works in the technology realm as well as the personal realm.

Field Testing

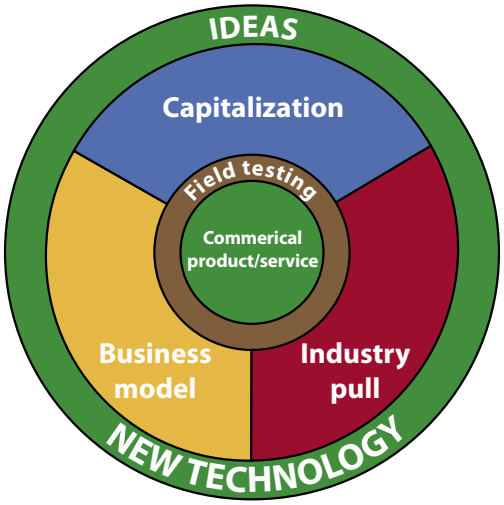
Everyone has heard the phrase "not in my backyard." When it comes to spreading a proven technology from a geographic area where it is working to another geographic area with similar characteristics, the phrase should be modified to "must be demonstrated in my backyard." Some individuals or companies are willing to try early-stage ideas, but the vast majority are slow acceptors. This is surprising since most independents readily take risk every day in exploration, yet they are risk-averse when it comes to drilling, stimulation and production operations technologies.

What does this mean for those with a new product? First it must be recognized that operators (end-users) will only support ideas that have progressed from idea through successful lab or bench tests and through successful shop manufacturing and field testing: Those are the ideas that are ready for commercialization. Developers must think through the markets where their technology is applicable; identify companies working in areas that have good candidate wells or reservoirs and will try new technologies; and then work to get early field results in several different environments. This is reminiscent of experimental design one learns in college: Know the variables that will influence results; select the first few field tests in environments where one can determine performance under a variety of conditions; and then predict performance in other conditions. It can be called the science of intelligent field design.

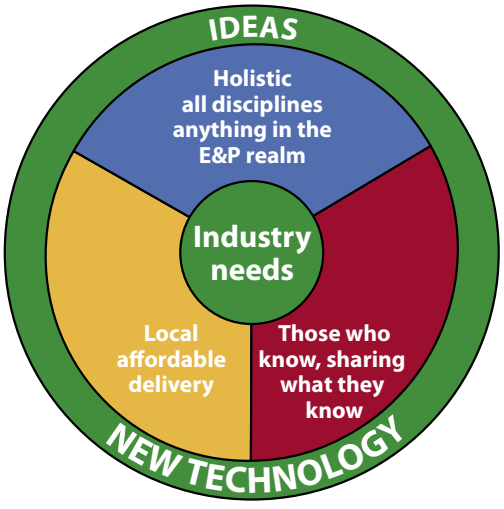
Technology developers are well aware of operator reticence to try new equipment in wells due to actual and perceived risks. The downhole environment is an especially expensive place to test equipment, and if one must go downhole, shallow is cheaper. Also, early failures can set a technology's adoption back several years. There are steps that developers can take to mitigate the necessary risks. Half-baked ideas or equipment have no business being in field tests. Technology developers have an obligation to test their technology's limits and establish its durability. If there are still valid concerns, developers should seriously consider using testing sites before going into a client's field.

One field-testing option is the Rocky Mountain Oilfield Testing Center (RMOTC) in Casper, Wyoming. Sites such as RMOTC are ideal for working out the bugs in proprietary testing. In some cases, if the developer is willing to share results publicly, RMOTC can fund part of the cost of the field test. Testing new technology in similar but less-critical industries can also help. Examples are new drilling technologies applied first in trenchless drilling for installing pipelines and cables under roads and rivers or in shallow earth-source geothermal wells in hard-rock country.

Risk sharing through joint industry projects is another



Factors affecting technology development and spread.



Leveraging PTTC's connections to spread technology across the United States.

way to mitigate risk. One example is the Drilling Engineering Association (DEA). The DEA has encouraged service companies to trot out "lingering, yet promising" R&D projects for operator funding or field tests. At any one time, leading universities typically will have several consortia that are open for participation. One prime example is the Global Petroleum Research Institute at Texas A&M University. Other universities where consortia are prevalent include the University of Tulsa, the University of Texas and the Colorado School of Mines, among many others.

The Business Model

Most venture capital fund managers do not pay attention to anything past the executive summary of early-stage ideas, since business plans change so much from original inception. They rely instead on the capabilities of the company managers to get to the next level. Producers do not care about a developer's business plan; they just want reliable, affordable services that address their specific needs. Once commercialization begins, the business model does make a difference as it then directs efforts. It affects how rapidly technology is funded, develops through each stage and spreads into the market in the later stage. There are many models that could work. However, most new technology companies try to prove the technology, get into the commercial market as rapidly as possible and then sell to a larger service company that has the contacts and marketing to expand the application of the new technology. Those developing business models must know the culture of their segment if their strategy is to succeed. As with reservoir-development decisions, looking through analogs from recent history can provide technology developers with worlds of insight regarding how to match their strategy to their market.

Technology Transfer

Optimum technology transfer occurs when PTTC and other technology-transfer efforts are involved from the very beginning. This begins with understanding the industry pull. Pull comes from forward-thinking operators that have an existing need, have capital budgeted for new technologies and have a champion in their organization for that technology. Who are the current players, and which players are appropriate to nurture? Certain major companies are known for their thorough investigations of new technologies (Shell E&P, for one). Those involved in technology transfer are, properly so, the ideal groups to stimulate producers to express their needs and work toward developing consensus on those needs. PTTC gathers informal feedback from workshop attendees, booth interactions at trade shows and conversations with recognized experts to help assess needs. These are supplemented with periodic formal "needs identification" efforts. Multiple communication channels are used to convey consensus back to all stakeholders.

Communicating the general thrust of the research that is under way has value, but there is a caution about "talking too early" about new technology. It does increase interest, but since that interest may not be able to be satisfied in a timely manner, frustration can arise. Only when a new technology idea has been designed, modeled, bench- or lab-tested and then tested in a limited field should technology transfer begin in earnest. Part of technology transfer is marketing (saying what is available) to operators, the end-users; another part is crystallizing and stimulating industry pull; another part (for a small development company) is interesting an eventual buyer A new technology can be an incremental improvement – which is more easily accepted and adopted – or it can be a game-changer. There is the potential that game-changer technologies will encounter resistance from other service companies and operating personnel, who may consider the improvement to be too big a change with too many unknowns.

PTTC: Connections That Lead to Application

PTTC is a nonprofit organization formed in 1994 to transfer E&P-related technology information to the U.S. oil and natural gas E&P industry. The Independent Petroleum Association of America, the DOE's oil and gas R&D program and selected universities with a solid reputation for transferring technology to producers worked together to create PTTC. The organization serves all disciplines, maintaining a strong business focus that addresses this basic question: Where are technologies applicable, and what does one need to know to make an application decision? Although PTTC's services are available to all, its primary audience is independent producers. The audience also includes the service sector and consultants. PTTC's goal is simple: to provide enough technology information so that when producers face problems or opportunities, they can make faster and better technology-application decisions with confidence.

PTTC takes a holistic approach, covering any area involved in the E&P realm, including drilling, completions, exploration, exploitation and production operations. Industry pull brings PTTC's network to life. Volunteer advisors and those participating in PTTC activities express what they would like to learn more about and

what their problems or opportunities are. Then PTTC puts its network to work to find those with the appropriate knowledge, working to get them to share what they know in workshops and other media. The focus is on technologies that can be applied immediately, not years down the road. Working through six regions led by prominent universities or organizations, PTTC then delivers workshops on these topics across the country. Speakers and attendees alike learn from each other in the informal workshop environments. Information and insights are then shared nationally and globally through PTTC's Web site (www.pttc.org), using a variety of tools. These tools include a national newsletter, e-mail Tech Alerts, an active exhibit program and word of mouth. PTTC proactively assesses where proven technologies might be moved within the United States, then works to get them there.

PTTC has built a strong network of connections that it applies to helping to move technology from idea to widespread application. The continued strength of this system depends on input from active volunteers, both regionally and nationally. The stability provided by the American Association of Petroleum Geologists stepping forward as a managing organization for PTTC gives the organization a base from which to work. The DOE's oil and gas R&D program remains a faithful partner. New partners and sponsors are being sought. As they come to fruition, PTTC will be able to expand its services.

As the organization grows, more producers will be able to take advantage of PTTC's network to make decisions that will positively impact production and reserves. Participating consultants will increase their capabilities and business networks, which will reap benefits for them and the producers they serve. The service sector will realize expanding or new markets. What's not to like about the results? ■