


Making Unconventional Resources Less So

Stephen Rassenfoss, *JPT* Emerging Technology Editor

The label unconventional resources, for shale or other nontraditional oil and gas formations, has its detractors.

Bruce Vincent, president of Swift Energy, said in a speech in August that "it is not unconventional any more." The problem, he explained, was that "unconventional sounds unreliable," despite the large and growing volumes produced by companies like Swift, an independent whose operations include the Eagle Ford Shale.

But those on the technology-development side of the industry describe unconventional development as a precocious newcomer that has achieved much, with the US predicted to be the world's largest producer by the end of the decade, but it is far from mature.

When SPE's six technical directors were asked to talk about some of their priorities for technology development in unconventional reservoirs, they pointed to the areas where change is needed to realize the potential for resources. On the list are improved reserve estimates, adding flexibility to standardized drilling and completion methods, and a greater focus on what it will take to maximize long-term production.

A word used over and over by Vincent and the tech directors was optimizing.

The business whose methods have evolved based on experience will have the opportunity to improve its results based on increasing data from testing.

"We will know so much more in a year to two years from now," said Shauna Noonan, SPE technical director for Production and Operations. "We are in uncharted territory. We are learning something new every day."

The growing body of information will raise more questions, and make demands on operations. The "cookie cutter" methods developed to economically deliver the thousands of wells needed for development in shale and coal-seam methane deposits need to be adjusted to allow changes and tradeoffs between spending and performance.

Adjusting where a formation is fractured is likely to add cost, but could pay off in greater production if the system allows well-to-well adjustments.

There is also a push and pull between the long term and the short term.

The standard systems used to drill wells in an assembly line fashion need to build wells in a way that allows later efforts to extend the life of the field. A small cost saving now may cost more in the future.

Long-term decisions are based on only short-term data from recently developed fields. There is a need for statistics-driven methods to mine the data in search of ways of predicting what will happen over the long term and what changes are likely to enhance that outlook.

Future production declines are predicted based on old models developed for conventional reservoirs, which perform quite differently. More resources need to be committed to developing better methods to measure the productive reservoir volume—the area where natural and manmade fractures allow oil and gas to flow—and the amount it will ultimately yield.

As the industry works to shave the cost off of drilling wells by doing it faster, it needs to build in standards that ensure each of them is built to last.

With the success of unconventional development comes heightened expectations and scrutiny.

Predictions that the US is headed toward energy self-sufficiency depend on delivering reserve estimates from formations that still are not well understood.

"We are doing a lot more in communities and right in people's backyards. People see what we are doing that is impacting them," said Roland Moreau, SPE technical director for Health, Safety, Security, Environment, and Social Responsibility.

They will judge the industry on how well it manages and lives up to its potential.

Drillers need to ensure that water supplies are protected when a well is built. There are techniques available to dampen the noise and camouflage, but there is no getting away from the scrutiny of those trying to figure out whether to trust in unconventional production.

As Moreau said, "If you paint a rig blue, the same color as the sky, it will not go away."

ROLAND MOREAU

SPE Technical Director, Health, Safety, Security, Environment, and Social Responsibility

Living in an Unconventional Community

The impact of shale gas development goes well beyond the company fence line. It is something we need to be ever mindful of when considering health, safety, security, the environment, and certainly social responsibility.

The high-volume drilling that is a given for shale development has raised the public awareness of unconventional oil and gas development, often to an uncomfortable degree. There is a large community affairs component here, and we cannot avoid it.

People hear about contaminating groundwater, with negative opinions often confused with the facts, but they also worry about what they see. They see increased truck traffic, trees cut down for well pads, and more people going to bars on weekends. And they do pay close attention to the crime report.

Corporate social responsibility is an issue long associated with the role of international oil company operations in developing economies. But the shale boom has raised its profile in the US and Canada, and it will be critical in unconventional exploration frontiers such as China and Europe.

With unconventionals, the relationship is more prominent than when drilling offshore, or in onshore fields where only a few wells are needed and they can be located in the middle of a ranch where few people can see them.

There are case studies of companies that have done a good job of building long-term community relationships—starting this year social responsibility programs will be one of the topics in an online SPE health, safety, and environment publication—but the rules for managing these relationships are not the sort of thing that can be boiled down to a spreadsheet of standard responses.

Integrating successfully into the communities where we are working includes a large education component. These are often emotional issues.

When questions are raised we need to explain how the industry operates and respond to what people observe. It is important to report on the positive impact it has on the economy locally and even globally. Building long-term relationships requires managing expectations.

Past experience shows drilling booms do not last forever. Operators need to be realistic about how long the good times are likely to last. You do not want them to build a brand-new multimillion dollar school and when drilling slows, the community will be left holding the bag.

Social responsibility is a test of how well a company is run long term, from the way it manages drilling and completions to the way it plugs and abandons old wells.

Companies need to recognize their impact on the communities where they operate and consider the long-term questions: Is there going to be a ghost town or are we developing a program that is sustainable?

JOSEPH AYOUB

SPE Technical Director, Drilling & Completions

Conventional Technology for Unconventional Resources

The need to drill and complete many horizontal wells with multiple hydraulic-fracturing treatments has led to a standardized approach to lower costs of shale oil and gas development.

This carbon-copy geometric placement of wells and hydraulic-fracturing treatments cost less than custom designs. The latter requires an increase in upfront expenses to better optimize the well placement as well as the number, locations, and size of the hydraulic-fracture treatments.

Our industry has been very successful at developing shale resources, particularly in the US, reversing scarcity to abundance. Advances in formation-evaluation techniques for shale reservoirs and hydraulic-fracturing placement models continue to progress, improving the expected value of acquiring additional data needed for custom designs.

Whatever design is chosen, operational efficiency and reduction of footprint are important considerations. Pad sites with multiple wells are used to reduce the cost and land use for shale oil and gas operations. Work is ongoing to reduce the consumption of fresh water by qualifying fluid systems that can recycle or use brackish water. Sound proofing and rig camouflage are available when drilling needs to be done in urban/sensitive locations.

While focusing on improving the well and completion plans and increasing operating efficiency and recoveries, we cannot be complacent about the risk of well failures. Many of the issues that arise during the drilling and completion phase are related to well-integrity failures.

The technology exists today to ensure that shale oil and gas wells are designed and built to perform reliably until they are plugged and abandoned. Our industry has developed technology and practices that, when consistently applied, have been proven successful in safely drilling and completing wells in over 5,000 ft of water, remote arctic environment, as well as urban areas.

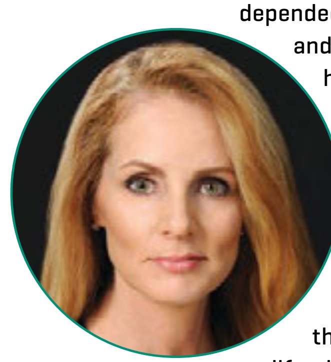
Good isolation of freshwater aquifers is required, even when drilling water wells that may encounter shallow coalbed methane formations. In oil or natural-gas wells, all sections of the well with rock capable of producing need to be properly isolated. The design must ensure hydrocarbons from high-pressure lower formations do not reach shallower, lower-pressure formations through an open annulus behind the casing.

Ensuring integrity is an activity that is best performed by considering it from the very start during the well-design phase and deploying proven engineering practices throughout the life of the well, including abandonment. Each player in our industry is faced with a choice of shouldering some additional cost upfront to apply proven technologies to ensure well integrity, or run the risk of dealing with the consequences of failure, which could cost an order of magnitude more than any upfront saving, and result in a compromised reputation.

SHAUNA NOONAN

SPE Technical Director, Production and Operations

Planning for Life After Completions



The boom in oil and gas production from shale has depended on mass-produced drilling and completion methods that have been a marvel of mass-produced efficiency. But it is time to retool the assembly line with an eye toward ensuring the long-term productivity of these wells.

The focus has been on the first 6 months of a well's life, the drilling, completion, and fracturing. The fact that a lot of wells reach breakeven in 8 months is an argument for the success of this focus, but some of the decisions early on can significantly reduce future returns.

The money saved upfront in reducing the size of casing from 5.5 in. to 4.5 in. is relatively small compared with the added cost and difficulty of installing an artificial-lift system in a narrower passage, or the production lost if that is not done because of the cost or technical issues.

The need for closer cooperation between drilling and completions and production is likely to grow as more studies are released on what affects longer-term performance in this young business.

The research is considering traditional production data and new sources of information, such as permanent fiber-optic monitoring systems in wells. These have provided a detailed look at what goes on during fracturing—possibly explaining significant production differences from fracture to fracture—and over time it could offer a detailed look at why production declines in a well, which could suggest ways to alter that trend.

Answering the questions will require improved well-intervention tools. The long horizontal sections in these wells make conventional intervention methods, such as wireline and coiled tubing, extremely difficult. Permanent monitoring systems are costly to install and the reliability of these systems in this application is questionable.

As more of these wells age and production declines, the need to develop the tools and techniques to extend their life becomes more apparent. This will require a well-planning system that leaves the door for later work to improve the output, which can mean paying more on the expectation of something better coming along.

OLIVIER HOUZÈ

SPE Technical Director, Reservoir Description and Dynamics

It's Time to Get Serious About Unconventional Reserve Estimates

Development of unconventional resources is based on the drill-and-frac paradigm. When companies estimate reserves, they often act as if this is a mining business, where production is largely a function of the force applied.

Companies are spending billions to drill and fracture wells, but asset managers are investing little money or time in properly measuring, and understanding what is happening in these plays. Smart, young engineers are expected to rapidly process hundreds of well documents. The main, if not the only technical issue considered in the decline-curve analysis is determining the value of the b-decline exponent that determines the rate of future production decreases. But is that the right question today?

In too many companies, production forecasts and reserves booking are based on matching terminal decline curves on 2 to 3 years of production data. Yet we know that during that timeframe these very low-permeability systems are still in transient phase. Such an exercise, even using additional fiddle factors that were mainly developed to explain the ever drifting calculations, is technically flawed.

Companies need to replace this process with an improved engineering methodology.

Even when we try to properly model our systems, we generally assume that fluids are produced from the stimulated reservoir volume (SRV), which is the volume of rock defined by the fractures created. It is like building with Lego blocks with neatly defined geometric boundaries within each well, a process we believe we may repeat over the whole formation.

This assumes we are "creating" neatly defined reservoirs by effectively mining them. That convenient assumption may be overoptimistic because these naturally fractured reservoirs may be draining a far larger volume than our SRV calculations would lead us to believe.

The evidence of this includes wells with unwelcome drops in production, likely because of interference from wells nearby.

The jury is still out as to whether the industry will be in for unwelcome surprises when there is infill drilling to tap what our models indicate are undeveloped reserves. We cannot wait another 10 years to find out if the process is flawed.

Reservoir engineers need to sit down now with those who write the rules for reserve calculations and address the issue. We have a moral duty to warn our stakeholders about what we do and do not yet know, and push the industry to expand its knowledge to narrow the uncertainties by expanding our knowledge. It is probably the most exciting reservoir engineering challenge out there now.

Using empirical curves developed 50 years ago for totally different formations is certainly not a good way to start. We are again in the frustrating situation of the 1970s when we had to sell the long-term value of information and science.

CINDY REECE

SPE Technical Director, Management and Information

Groundbreaking Opportunities Available: Unconventional Thinking Required

Unconventional development is becoming a job-changing event in exploration and production, creating some new job titles, and changing the skill sets required for many others.

The scale, pace, complexity, and unknowns of producing oil and gas from source rocks put a premium on the value of data. Shale plays are capital-intensive investments with major spending decisions made early on that have long-term consequences.

The management and information challenge is to compress the time required to determine how to optimize performance for the short and long run. The goal is to optimize complex operations with competing interests by analyzing more data from a larger number of sources to improve results.

One indication of the change is the creation of jobs with titles such as data scientist or optimization specialist. The newcomers will include more operational and technical experts to offer broader perspectives on optimization.

The data-centric trend led to the launch of the SPE technical section for Petroleum Data Driven Analytics at the 2012 Annual Technical Conference and Exhibition. There were 200 members as of late November.

There is also a push to expand the analytical skills required to earn an engineering degree leading to a job in the oil business. That will be on the agenda when SPE holds a forum later this year on the future of engineering education.

Still, the value of the new people and techniques will depend on the willingness of management to bring in new methods into an operation, even when it requires uncommon levels of cooperation.

The techniques can be of value throughout exploration and production, for different reasons. Unconventional developments raise so many questions, such as: Where are the best locations to drill? Why do so many fractures fail to perform? Will gas supplies justify construction of a processing plant? What is the best way to reduce the water produced over many wells?

Data can offer opportunities to learn how to do better. Doing so requires an industry shift toward greater use of statistical methods, to mine the data and seek patterns or relationships that might otherwise be missed.

Statistical methods do not offer the reassuring certitude of physics. But these methods can offer insights now in areas where production histories are limited, the properties of the rock are not well understood, and traditional processing for the large amounts of data could take a long time.

Those who are adept at using these new tools to rapidly optimize operations will have a world of opportunities available. Globally, production from difficult rocks holds the potential to remake the world supply map.

Countries from China to Eastern Europe want to follow the lead of the US, which has used its shale wealth to make a surprising move toward energy self-sufficiency.

But the pace, and degree of change, will depend on the ability of operators to quickly analyze and adapt in locales where the resource, the landscape, and the culture are altogether different.

JOHN WALSH

SPE Technical Director, Projects, Facilities, and Construction

Bigger, Faster, and More Costly

When considering the challenges posed by unconventional resources development, the required infrastructure needed is enormous. The technology required is rather straightforward, but delivering these projects on time and on budget will be a challenge.

The total cost will be tens of billions of dollars across the industry over several years. Hydraulic fracturing has been likened to an assembly line manufacturing process. In the best outcome, facilities and infrastructure expansion will be likewise.

Gathering, transport, compression, dehydration, fractionation, refrigeration, liquefaction, and dehydration technologies are well known. There are exceptions, such as large scale economic removal of nitrogen, and carbon dioxide. But those challenges are not major factors in the US, due to the high quality of the gas. There is also a need for new technology in water management.

But the critical need is for new approaches to management for the large scale projects that are likely, particularly the major facilities needed to liquefy natural gas to move it to markets where it will command a higher price.

Most of the processing technologies required have been in use for decades. A possible area where new technology may be needed is in the reduction of gas flaring and venting. However, application of common sense field development can reduce most gas leakage.

Water management remains a major technical challenge in the facilities discipline. This will be an active area of discussion in SPE's *Oil and Gas Facilities* magazine, and there will be a Water Handling Applied Technology Workshop in Dallas-Fort Worth in March. For various reasons, the cost of treating water associated with unconventional production can be 10 to 20 times higher than for conventional production. This is a well-known issue, even if the solutions are not so well known at this time.

At the opposite end of the spectrum of scale and complexity are the facilities needed for LNG export. With the recent US Department of Energy report, it appears that the US will export at least some LNG. No surprise. LNG is on an inevitable course to become a global commodity. Creating an export market will require resolving issues around trade routes, security, markets, prices, and other issues.

The challenge for the projects and facilities community is in project management and construction of these quintessential mega projects. As pointed out in Ed Murrow's book, *Industrial Mega Projects,* management for large projects is in dire need of new thinking.

Cost overruns of USD 5 to 9 billion have been reported for various LNG projects currently under development in the Pacific. Even if most US LNG export facilities are developed from conversion of idle import facilities, these are still major projects and now there will be schedule pressure since contract prices for the LNG will likely be highest for the early market entrants. **JPT**