A bigger toybox
Incremental changes revolutionize downhole systems and tools
To gauge the success of the shale gale, one needs to look no farther than natural gas prices in North America. Areas like the Marcellus have been so successful that the market has been flooded, pushing prices down and operators into oilier plays. But success does not always equal maximized production or cost effectiveness.

“When we look at unconventional reservoir development, one of the key aspects is maximizing the contact of the well bore with the reservoir. This is enabled by horizontal wells with multistage hydraulic fracturing. But first you need to know where the best production will come from in that reservoir,” said Keith Tushingham, unconventional and microseismic director for Schlumberger Information Solutions.

Tushingham added that in addition to maximizing reservoir contact, it is also about minimizing development costs because the economics are very tight in these reservoirs. So there also has to be a strong spotlight on cost. This means making certain the completions are optimally planned and that there is an appropriate focus on supply chain management.

Research done at Schlumberger reveals that 70% of the production of a standard shale well comes from 30% of the perforations. “That means that 70% of the perforations aren’t performing,” said Tushingham. “That tells you something, such as some perforation clusters are in the wrong place. Stimulating nonproductive rock is...
expensive and doesn’t contribute to production. “If you use the science to thoroughly characterize the reservoir quality and preferentially complete a well to hit the sweet spots, does it make a difference over drilling as many wells as possible, fracing the entire horizontal section, and checking the production after the fact? It is impossible to say whether a more scientific approach would have been more cost-effective in plays where operators used a statistical approach. However, we do know that fractures often close immediately after they’ve been stimulated and that a large amount of proppant is wasted.”

**Modeling**

The first part of the scientific approach comes before a well is drilled. Reservoir modeling is nothing new to the industry, but it has not been used widely in shale plays because operators know where the source rock is.

“It’s no surprise that shales present significant exploitation challenges. Production is variable, fracture effectiveness is impacted by geomechanics, and a high well count is required to make these plays work,” Tushingham said. “Taking advantage of the data allows us to measure reservoir quality to define the sweet spots.”

He added that in shale exploration it is important to establish kerogen types and hydrocarbon maturity to acquire and drill the optimal acreage. For development and production, geomechanically based analyses support understanding the natural and induced fracture patterns. Combining shale qualities, kerogen distribution, and fracture character allows the asset team to plan the well trajectory, steer wells accurately, engineer the completion program, and optimally hydraulically fracture and stimulate the rock.

“You geosteer into the sweet spots and stay in that zone as long as you can,” Tushingham said. Tushingham illustrated with examples from the Bakken, where well bores snaked in and out of the reservoir zone throughout the entire lateral section. MWD technology can help operators stay in zone, he said.

In shale wells, 50% of the cost and effort goes into the completions. For example, a recent frac job in the Marcellus had eight frac stages and used more than 4 million pounds of sand and 3 million gallons of water. This required 165 frac tanks and 623 truckloads of water for one well. “Fracturing selectively can significantly reduce the amount of sand and water required as well as related materials management costs,” Tushingham said.

**Production logging**

Production logs measure fluids in or around the borehole during production or injection. They are used to...
analyze dynamic well performance and the productivity or injectivity of different zones, diagnose problem wells, or monitor the results of a stimulation or completion.

Tushingham said that production logging can go a long way toward validating a science-based approach to shale development since operators can clearly see which perforations are contributing to production. However, operators need to be able to evaluate the trade-off between spending the extra time and money up front against performing unnecessary completions.

The other method of validation is microseismic, which can illustrate immediate changes to the stimulation and completion program or changes in orientation on the next well, he added.

Some companies will not be convinced until they can prove that these methods will increase efficiency. “It’s all about economics,” Tushingham said. “Everybody’s trying to drive down costs and increase production. Going forward, the right combination of science and execution management will win the day. Because of the high well count and complexity of shale operations, there is massive scope to increase efficiency.”

Supply chain management
There are huge opportunities in shale plays to reduce the cost of operations by leveraging materials management, logistics, and execution management.

“Maintaining and managing large inventories of well equipment isn’t a core business for operators,” Tushingham said. One potential strategy could be partnering with service providers to take on inventory risk and guarantee on-time supply of equipment that oil companies have traditionally held in inventory such as proppant, cement, or acid. A related approach that borrows from other industries would be using warehouses with sophisticated systems and tracking capabilities.

Another significant opportunity lies in improving the efficiency of trucking logistics from suppliers to the field and for infield water hauling and equipment delivery. Expert practices developed and implemented by logistics companies could make a big difference in the oil field.

Further, most companies use Excel-based tools to manage planning and scheduling of development and production activities – planning, permitting, drilling, completions, and putting wells into production. With thousands of wells to manage through the various stages of planning and execution at any given time, there is a real need for an integrated software solution to provide metrics for cost, time, and inventory at every stage in the process.

Best of both worlds
At the end of the day, it makes sense to understand the reservoir to target drilling and completions and to plan wells and completions as judiciously as possible. Spending money to get the right data and conducting thorough analyses supports cost-effective well placement and selective fracturing. Combining science with smart logistics and execution can go a long way toward maximizing production and ensuring better economics.

However, getting the balance right between upfront planning and execution excellence also is important. Recent discussions with various operators have convinced Tushingham that more of them are becoming convinced that a scientific approach provides the most cost-effective results.

One operator noted that the great majority of the value is in the earth model and well evaluation and, to a lesser extent, in well execution. If digital models are not being built, the company ends up wasting capital and will not achieve optimal production. In other words, excellence in execution will not make up for a lack of upfront analysis to understand where to drill and complete wells.

Summarizing comments from this and other operators, Tushingham said he is hearing more and more that consistent production performance is related to highly integrated subsurface teams performing thorough earth modeling and using consistent and rigorous well design processes. Further, this upfront planning must then be combined with well-informed wellsite teams with excellent remote support. Finally, costs above the authorization for expenditure are usually caused by lack of early integrated evaluation and a less-than-consistent well planning process.

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