Digital Technologies for the Next Trillion Barrels

Ted Moon, *JPT Online* Technology Editor

Technology will continue to play a vital role in the E&P sector's quest to satisfy global energy demand, and digital technologies will no doubt make the most significant impact. The term "digital oilfield" has emerged in the last decade to describe using information technology (IT) to monitor and manage all operational activities in real time or near real time, regardless of geographical location.

Paul

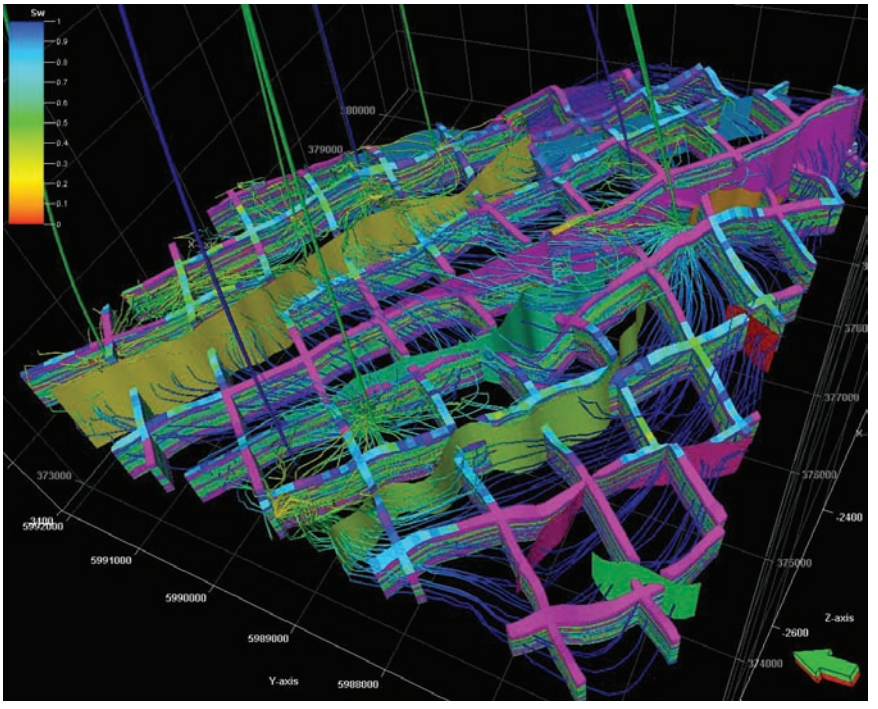
Subject matter experts representing operators, oilfield services providers, and IT developers recently described how the digital oilfield will evolve in coming decades to help find and produce the next trillion barrels of hydrocarbons. According to Don Paul, President and Managing Director of Energy and Technology Strategies, the industry has made a great deal of progress in a relatively short period of time.

"A few years ago, people were talking about the digital oilfield in a conceptual way, such as how to put more sensors in the field to gather more data and how to integrate subsurface and operating measurement. Now the industry is moving fully into implementation, and companies are redesigning their workflows and organizations around the flow of digital information. Ten years from now the situation will look radically different, because the technologies powering our processes will be much more powerful, providing more data and the opportunity for true real-time optimization of production operations."

Before postulating on the changes in 10 years and beyond, Paul put this timeframe in the proper context. "Projections for oil and gas demand and supply growth are often estimated in timeframes of decades, which is an eternity from a digital technology viewpoint. If you believe in the Moore's law effect [the 40-year old concept stating that capabilities of digital electronic devices improve at roughly exponential rates, doubling every 2 years], then in 30 years you are talking about a growth in computing power of 2 raised to the power of 15."

Furthermore, technology development and implementation follows cycles, and in Paul's experience as the former Vice President of Technology with Chevron, a new cycle starts when there is about a factor-of-10 change in the capability of the underlying technology. "That factor-of-10 jump in computing capacity is sufficiently large to enable shifts in the technical base and the work processes around the technology," Paul says. "In 30 years we are looking at five factor-of-10 changes if Moore's law holds. To put this into perspective, this is greater than all the change capacity we have had since the advent of digital computing."

This vast transformation in computing power will significantly impact and transform the energy system along several fronts.



Advances in Microsoft Windows-based high performance computing have allowed Schlumberger's Petrel software suite to simulate fluid movement in 3D reservoir models. Image courtesy of Schlumberger.

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— Don Paul, Energy and Technology Strategies

Push for the Last Trillion Barrels

The discovery and development of the last large trench of hydrocarbons is taking the industry into deeper waters, arctic environments, unconventional reservoirs, and politically sensitive regions. To be successful, the industry will increasingly rely on digital technologies to take humans out of the physical environment, allowing decision making and execution to be done remotely.

"I think that to push the edge of exploration and development in remote areas, the integration of digital technology into physical objects will grow in importance," says Paul. "Facilities will utilize robotics to a greater degree to operate remotely or autonomously. I believe that this trend will also extend to measurement devices that you can put into reservoirs."

Automation will also continue to impact traditional workhorses of the industry. "Technology developments are allowing us to use a new generation of seismic recording devices, such as permanently installed recorders that capture vastly larger sets of information," Paul says. "We are also able to include better physics in the algorithms that allow for simulation of the reservoir on through to production, with a better level of accuracy and a shortening of the cycle time. I am sure this trend will continue."

Landgren

Greater automation will only be useful if it is tied to advances in so-called real-time computing, as Ken Landgren, Marketing Manager of Production Solutions with Schlumberger Information Solutions, explains. "In a production scenario, you may need to sample and process data quickly to make appropriate decisions, and exert a control quickly enough to keep the processes working in the desired manner."

Landgren refers to the speed at which one can measure, analyze, and respond to a change as immediacy. "The immediacy of data collection has been increasing for some time already in the oilfield. Production data previously collected at a frequency of once per month are now available daily, allowing users to respond to changes in reservoir conditions in an adequate timeframe."

He is confident that this trend will continue, leading to further advances in automation. "Once data collection has become automated, you can use software that sets up an alert if a data event deviates significantly from a five-day moving average, for example," he says. "So we are really talking about automating the surveillance process. From there, you can move to automating the diagnostic process, and then the intervention process. They have done this in refineries for years, and now it is picking up in the oil field."

Squeezing Every Barrel Out

Digital technologies will also play a growing role in maximizing production from declining mature fields, which have more than 50% of recoverable hydrocarbons in place. "In mature fields, I see digital technologies enabling better measurements downhole and allowing for more advanced activities," Paul says. "Significantly complex and selective downhole completion technologies and customizable fracturing treatments will have to be developed."

Operators all over the world are already implementing digital monitoring and automation tools in their mature producing assets, and with good reason, according to Peter Roberts, BP's Subsurface Manager in Abu Dhabi. "Consider that 60% of the world's proven oil reserves, over 700 billion barrels, are in the Middle East. You can imagine what even a small increase in reserves production through the deployment of digital field technology could mean for the region's oil producers and for world markets."

BP plans to use its Advanced Collaborative Environments (ACE) strategic program for real-time production and drilling operations for most of its assets worldwide. ACE includes a range of digital technologies that enhance production and reserves through more efficient operations, drilling performance, and reservoir management. "Examples are the use of optical fiber for rapid transmission and downhole temperature and pressure monitoring; the use of time-lapse seismic with permanently installed seabed seismic arrays; and purpose-built software for well and facility surveillance, process evaluation, and production optimization," says Roberts.

Filling the Crew Gap

Perhaps digital technologies' most frequently cited role in the oil field is in the realm of virtual teams and collaboration. Instead of flying a limited number of subject matter experts around the world to contribute to projects, most operators and larger service companies use real-time operating centers (RTOCs) to facilitate a virtual meeting experience and remote field operations in many parts of the world.

Hodges

"People are the real assets for an operating company, and they must be used more efficiently to make better decisions in a shorter timeframe," says Craig Hodges, Director, Energy and Chemicals Industry for Microsoft. "How do companies effectively manage data coming in from many sources with a limited workforce that is pulled into competing projects all over the world? That is an area in which IT providers will continue to play a key role in the foreseeable future."

To use RTOCs more effectively and maximize the use of team members' time, IT companies will be expected to

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"We would like to achieve a system in which every well has wireless connectivity to easily transmit data and commands back and forth from an operating center." — Ken Landgren, Schlumberger

provide streamlined data management and transmission solutions. "These include giving users a high-definition experience, improving the richness of the devices that people use, and shifting to a more natural interface language between the user and the device," Hodges says.

For Microsoft, this translates to providing multiple ways for workers to transfer and share data such that people can find answers to questions easily. Microsoft Surface, a tabletop-designed, touch-activated presentation and collaboration tool, allows users to interact with digital content in a more natural way rather than relying on a mouse or keyboard. It also allows data to be shared and manipulated more easily among work teams separated by geographic regions.

The greater use of natural user interfaces and data centers with flexible accessibility may help solve a knowledge management challenge that Schlumberger's Landgren sees looming on the horizon. "How do you capture knowledge from people with 20-plus years of experience to automate a system? It is one thing to call someone on the phone and quickly get an answer vs. finding what you need on a database and getting the same quality of information that you could get from a conversation… that is a challenge."

Field as Factory

While digital technologies will allow for better collaboration and more efficient decision making, they will also change the decision makers' role in the producing field. According to Paul, humans will take a more strategic, decision-making role. "Because of the level of complexity of data and systems involved in the next decade, I think future production systems are going to look more like a modern refinery's control room, where the latest generation computing systems are installed to run all day-to-day operational activities. It will have to be this way, simply because the production systems are becoming so complex that you couldn't run them without extensive IT input. That is not to say that the human role will be less important, but this role will be smaller relative to the whole."

Digitization of workflows will also drive efficiency improvements in the entire operational system. "IT is the mechanism for building and managing longer and more complex supply chains," says Paul. "In the E&P sector, I think this will come to include energy efficiency and managing emissions like carbon dioxide. All that will require having a more sophisticated, almost factory-like view of the world."

Landgren says that to run fields like factories, significant communication and high-speed computing obstacles must be addressed. "We would like to achieve a system in which every well has wireless connectivity to easily transmit data and commands back and forth from an operating center. You are talking about high bandwidth and significantly increased wireless connectivity around the world, which becomes prohibitively expensive."

Greater integration will also be needed at the software level. "Companies have built software systems to run various processes, and in some cases, individual engineers have written code that they prefer. All of this needs to be integrated such that data and decisions can flow," Landgren continues. "There is an emerging standard called ProdML, which uses XML to exchange production data and commands. While in its infancy, it is something that will have to be continually developed."

To run a field as a closed-loop system, greater computer processing capacity will have to be implemented. Many technology companies are taking different approaches to boost the speed of compute-intensive simulators. Microsoft and its partners, for example, utilize cluster server technology to boost technical compute power by enabling parallel computing and are putting high performance computing into the hands of the geoscientists and engineers who need it.

Lowering Costs, Lifting Firewalls

There are several cost and security concerns around digital technologies that must also be addressed to allow more widespread implementation. "One challenge is that the industry has such a broad range of producing environments, from stripper wells to offshore platforms," says Landgren. "The economics are so different that devising a single solution is difficult."

Landgren also points to the conservative nature of asset operations as being a barrier to increased spending. "Until these digital technologies become more recognized, some asset managers will resist investing a great deal of money. When the technology becomes standard, and more SPE papers are written showing clear results and a clear return on investment, then people will take notice and start making the investment."

As more companies open up their fiber optics and telecommunications systems to allow collaborative work environments, there is a concern that they may also be opening themselves up to a security breach. "With all of these open communication lines connected to the internet, you have to worry about the data being intercepted or the system catching a virus and going down," Landgren says.

"Not only do you have to secure your data, but you have to assure it as well," he continues. "In an operation-critical location, you need someone from IT monitoring the system to ensure that it does not fail. That way, the poor production guy does not have to worry about his data disappearing. It quickly becomes a complicated process."

Hodges sees IT providers playing a more critical role to address these security concerns. "We are working on ways to ensure that confidential company

information never leaves the firewall. Of course, when it comes to collaboration, too much security can be a problem in that company firewalls may be too rigid to allow easy back-and-forth communication without significant effort."

Private internet-based file-sharing sites may be a possible solution. "We have developed a 5-GB virtual storage space on the internet called the Sky Drive," says Hodges. "I can put things in a private folder on this Sky Drive and let anyone I choose see it, manipulate it, and so on. This gets around problems with sending project data through someone's firewall."

Change Management is Key

One of the biggest hurdles to a wider integration of digital technologies in the oil field has nothing to do with technology, but rather workers' attitudes about accepting new technologies and new ways of working. "My perspective is that some companies are quicker studies than others," says Hodges. "Some companies like Schlumberger are driving this change from the top down. They have some of their senior-level managers piloting some of these new approaches to collaboration on social networking-type sites."

Other companies are slower to adopt, but Landgren believes a gradual build-up may help alleviate concerns. "You get significant benefit by putting in a surface monitoring system that allows you to execute today's processes with a little more knowledge. Better communication with remote operations would also help users do their job better. Slight improvements to field operations like this will allow people to become more comfortable and willing to try more expansive technology upgrades."

While Paul realizes that change management challenges remain, he is heartened by a recent study that shows how far the oil and gas industry has come in implementing new technologies. "I took part in a study called the High Performance Computing Initiative carried out by the United States Council on Competitiveness. This third-party comprehensive study evaluated how readily digital technologies were being implemented in four industries: oil and gas, pharmaceuticals, aerospace, and automobiles.

"The study concluded that the oil and gas industry has propagated digital technologies, altered its management and organization, and the way people connect to the data far more than any other industry," Paul says. "So, we are doing extremely well relative to these other industries, but we are still challenged to keep up with the pace of change of both the technology and the business demands. While the rate of change is challenging all organizations, we have dealt with these kinds of changes before and I am confident that we will do so again." **JPT**