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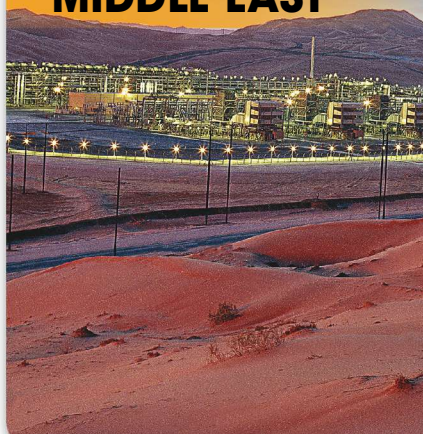
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Regional Report:  
**MIDDLE EAST**





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BETWEEN THE

BACKS

Technologies unlock tight rock's prize

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This conference recorded solid attendance growth the last four years, with strong registration from Midland-area oil and gas professionals - an audience only the EOC offers. The full-day program delivers a value-packed [agenda](#):

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- See where top industry analysts forecast 2018 commodity prices
- Get firsthand interactions with technology exhibitors
- Network with hundreds of your peers

### Water Forum addresses operators' challenges

This optional half-day program, sponsored by Peroxy-Chem as well as NuWATER Resources, Oilfield Water Logistics and PC Drilling & Service, addresses Permian Basin water supplies, water-centric midstream services, and the value of produced water.

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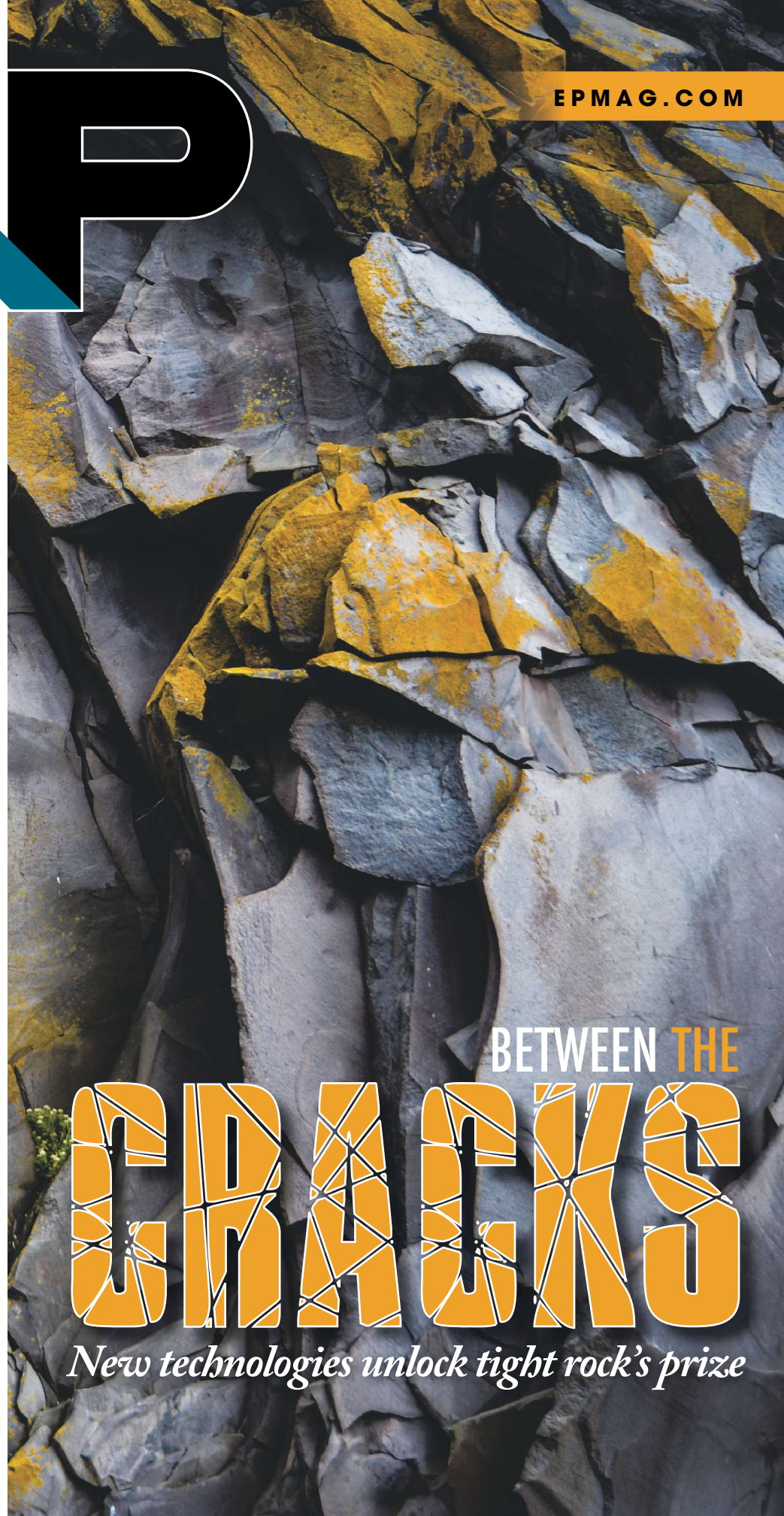
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Technology gets the credit for success

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# Deeper Verticals, Longer Laterals Drive Tubular Advances

BY **DARREN SANTELER**, darren.santeler@vallourec.com AND  
**HEATHER BYERS**, heather.byers@vallourec.com, **VALLOUREC USA CORP.**

As drilling technology advances, operators are continuing to drill deeper and further than ever thought possible. Extended reach drilling and record breaking lateral lengths have brought new challenges to the onshore market, and tubular technology has had to evolve quickly to fill the gaps. Increased depths lead to higher formation pressure that must be managed. Longer strings and tighter formations require increased pressure containment. Longer horizontals becoming the norm with severe dog legs have made ultra-high torque a necessity. As the industry leading premium connection supplier, VAM<sup>®</sup> connects operators to engineered tubular solutions for the well designs of tomorrow.

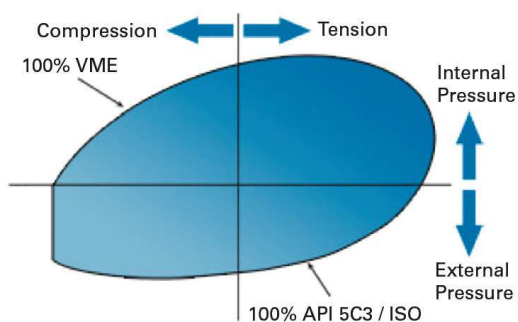
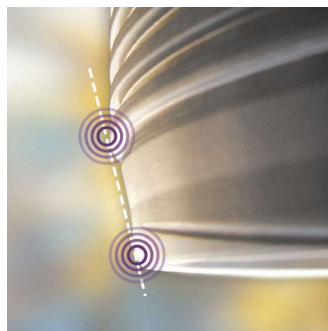
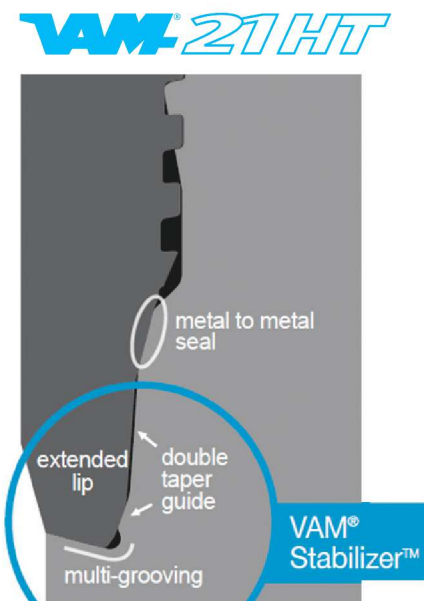
## Threaded and Coupled

VAM<sup>®</sup> 21 HT, the next generation threaded and coupled premium connection, features advanced sealing technology and maintains higher torque capability. **VAM<sup>®</sup> 21 HT** was the first connection to combine a gas tight metal-to-metal seal with 100% pipe body ratings. And with over 200 samples physically tested, it was the first connection qualified to the new ISO 13679 FDIS-2011 CAL IV protocol, and is fully API RP 5C5:2017 CAL-IV compliant within the full pipe body envelope. VAM<sup>®</sup> 21 HT is the highest performing and most reliable VAM<sup>®</sup> shouldered connection to date with excellent gas tight sealing under combined loads, extreme compression resistance (100%) and innovative VAM<sup>®</sup> Effect with the VAM<sup>®</sup> Stabilizer<sup>™</sup> ensuring full sealability. The seal and shoulder functions are separated so that torque and compression act independently under extreme

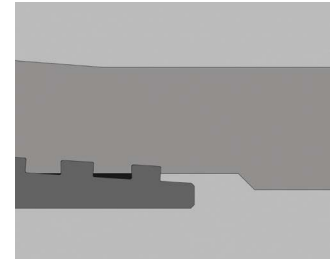
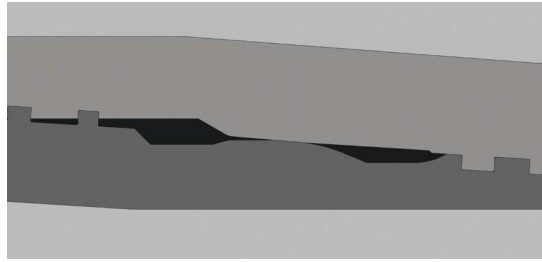
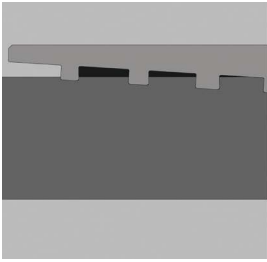
pressure requirements. This separation provides a much stiffer pin nose resulting in extra torque while maintaining full sealability throughout the life of the well. With the placement of the seal away from the pin nose, it is also protected from handling damage that conventional threaded and coupled connections suffer. VAM<sup>®</sup> 21 HT's unique multi-grooving allows for dope pressure relief to ensure good clean make up graphs. It is easy to run, extremely reliable, and the superior choice for unconventional drilling.

For extended reach and horizontal drilling with extremely long laterals, ultra-high torque capability becomes a necessity. The higher torque is required to rotate the string through the curve and across the lateral portion into position. Unlike the vertical section, torque is used to combat gravity induced friction when in the lateral. When rotating the casing during cementing, higher torque is needed to overcome the friction and drag that the cement creates on the surface of the **tubulars**.

These ultra-high torques cannot be met with slight changes to existing connection designs. A whole new concept to the conventional threaded and coupled connection was required and led to the development of **VAM<sup>®</sup> HTTC**. In a standard shouldered connection,



## VAM® EDGE SF



torque is limited by the surface contact area of the pin nose with the torque shoulder. In order to meet the ultra-high torque requirements, a change in the thread design was necessary. An innovative design with a variable width thread over the length of the connection creates a self-locking connection without a torque shoulder. This thread design allows for an increase in surface contact between the pin and box dispersing the stress concentration over a greater area. The advanced thread design combined with a metal to metal seal provides the highest torque rating of any threaded and coupled ISO qualified connection available with gas tightness. VAM® HTTC has been proven to provide excellent gas tight sealability with some of the highest torque ratings on the market and has been validated to API RP 5C5: 2017 CAL-IV. Furthermore, it has been validated to bend more than 42° per 100 ft with combined loading so it can pass through extreme dog legs in the most demanding well designs. VAM® HTTC is easy to run, with a low back-out rate and quick make up speed ensuring performance reliability.

### Integral

When geology or government regulation requires an additional intermediate string, clearance becomes a major concern. To prevent a restriction of the production casing ID (and therefore fracture and production volume) or the need for a larger surface casing (increasing weight and overall cost), an integral connection becomes a necessity. Integral connections offer OD's that are the same as the pipe OD or a few percent over pipe OD, freeing up valuable space in the well design. For the next generation of wells, VAM® has designed a complete array of products to help customers hit their target well designs.

The first connection on the market designed with Shale Gas in mind actually uses that as its name – **VAM® SG**. Designed to withstand the high fatigue from horizontal rotation, pressure cycling from repeated fracture jobs and gas sealability after this loading, VAM® SG is the perfect candidate for wells requiring a semi-flush integral connection. The hooked thread form prevents jump out, the large contact mid wall shoulder provides high

torque, and the run out thread enhances tension up to 91% in some sizes. To demonstrate the ability to be used in unconventional plays, VAM® tested this connection extensively using a dedicated testing protocol to copy the shale operational aspects provided through in-depth discussions with operators. Extreme tolerance samples go through high rotational fatigue, pressure cycling and internal gas testing before being released. This connection has proven successful in the most demanding wells in Haynesville and the Eagle Ford plays.

For extended reach horizontal wells that require slim well designs, high torque is still needed. To address that need, the **VAM® EDGE SF** was designed with the future in mind. Taking cues from the VAM® SG, it exhibits a mid-wall seal for full gas sealability with high fatigue life. A variable width dovetail thread drastically increases torque while preventing jump out at the same time. The result is a connection with double the torque of a conventional shouldered connection, and has been thoroughly tested across the product line.

A network of over 500 people is devoted to the design of innovative solutions in three R&D facilities around the globe. Our state of the art test labs prove VAM® ratings and reliability through physical testing across each product line. A full team of certified VAM® Field Service engineers is available 24 hours a day to help run VAM® connections, reduce NPT, and improve total cost of ownership.

Regardless of the projects operators have in mind, VAM® is here to engineer the right tubular solution.

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**COMING NEXT MONTH** The November issue of **E&P** will focus on production. Other features will include presalt/subsalt, land rig advances, flow assurance, and ROVs and AUVs. The regional report will focus on Malaysia. As always, while you're waiting for your next copy of **E&P**, be sure to visit **EPMag.com** for the latest news, industry updates and unique industry analysis.



**ABOUT THE COVER** Shale rock formations have provided operators a resource in which record amounts of oil and gas have been produced. Left, the Shaybah Field in Saudi Arabia is where Arabian extra light oil was discovered in 1968. (Cover photo courtesy of Koushik C, Unsplash.com; Left image courtesy Saudi Aramco; Cover design by Felicia Hammons)

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**Anadarko hits oil pay in Green Canyon Block 25**

Anadarko Petroleum Corp. released details on a discovery in Green Canyon Block 25. The #4 (ST) OCS G16783 encountered about 18 m (60 ft) of net oil pay in Miocene-aged sand.

**Parkman venture producing 2.959 Mbbbl of oil**

A Ballard Petroleum Holdings LLC well in the Powder River Basin is producing 2.959 Mbbbl of 43-degree-gravity oil, with 62 Mcm (2.184 MMcf) of gas and 1.302 Mbbbl of water per day from Parkman.

**EOG completes two more high-volume Wolfcamp wells**

According to IHS Markit, EOG Resources Inc. completed two high-volume Wolfcamp oil wells in the Delaware Basin portion of Lea County, N.M. The discoveries are in Section 11-26s-33e.

**AVAILABLE ONLY ONLINE**



**EIA predicts record for US crude production despite Harvey**  
By *Mary Holcomb, Assistant Editor, Digital News Group*

U.S. crude oil production will reach record high in 2018 despite Harvey's impact on the industry.

**Positive trends emerge for offshore sector, recovery timing unknown**

By *Velda Addison, Senior Editor, Digital News Group*

As falling breakevens and development costs for offshore projects give drillers hope, Transocean is positioning itself for ultradeep-water and harsh environment activity.



**Race is on to invigorate Argentina's Vaca Muerta Shale play**

By *Ricardo Martinez, Contributing Editor*

Independent oil companies and mid-sized players are seizing on Argentine President Mauricio Macri's commitment to drive shale developments.

**Digital era revolutionizes oil, gas industry**

By *Brunno Braga, Contributing Editor*

Executives from oil and gas, supply, and technology companies met in Rio de Janeiro to discuss the latest oil and gas technology trends.

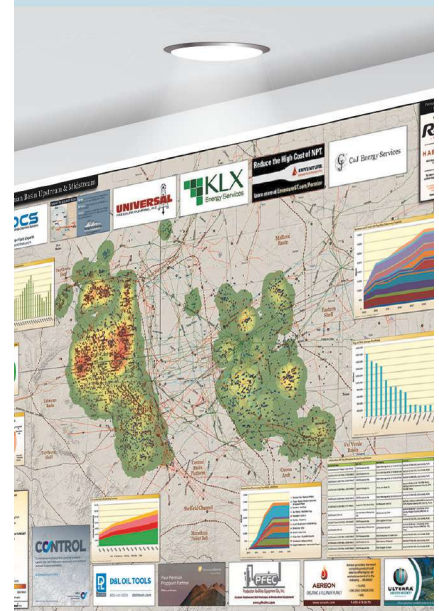
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# The ‘Game of Energy’

**Renewable energy sources continue to gain ground on fossil fuels.**

**T**here is an energy transition underway, with renewable energy sources revolutionizing the way the world uses energy. This revolution is similar to how unconventional resources revolutionized the oil and gas industry. Innovation combined with a “can-do” attitude has transformed the business models for renewable and fossil fuel-based energy companies.

Depending on how you look at it, this energy transition has moved swiftly or in a more leisurely fashion. It was just a century or so ago that the burning of animal manure for heat was an accepted practice around the world. For all of the swiftness that our technological innovations move with, water buffalo dung still gets the job done today in parts of rural India, Pakistan and elsewhere. It took decades for King Coal to lose its throne of energy supremacy to the princes known as Oil and Natural Gas.

That rivalry plays out today, with natural gas making great gains in edging out coal as the preferred feedstock for power plants. But for every king there is a young upstart itching to upend the pecking order. Clamoring for fuel equality in the Game of Energy are the houses of Wind, Solar, Geothermal and Hydro. Each is making significant strides in its own unique way, and the day will come eventually when the House of Carbon will “bend the knee” to renewables.

As to when that will happen is the question of the day. DNV GL forecasts that by 2050 the primary energy supply will be “split roughly equally between fossil and renewable sources,” according to CEO Remi Ericksen in the company’s recently released Energy Transition Outlook.

As a provider of risk management, assurance and technical advisory services to customers in more than 100 countries, DNV GL devotes about 70% of its business to energy. The Outlook drew on the company’s experience in both fossil and renewable energy industries and its network of experts to produce a forecast that presents a central case rather than multiple possible scenarios.

“Advances in energy storage and renewables will create a highly competitive clean-tech coupling that will drive energy costs downward while accelerating energy efficiency,” he said. “And that will produce a very different world in short order—one where energy decouples from carbon and where the world’s energy use decreases while the global economy and population continue to grow.”

For now, remember that the electric-powered car scooting around town on solar-charged batteries did—at some point in that battery’s life—receive its go-go juice from a fossil fuel-fed power plant. The Game of Energy truly is perpetually in motion. **ESP**

# Lending a helping hand

A nonprofit organization offers financial assistance to industry workers in need.

**Brian Walzel, Associate Editor,**  
Production Technologies

A little more than a year ago, in early July 2016, Bryce Sauser was vacationing at his house on Lake Limestone. He was swimming in the lake, enjoying the long July 4th weekend, when his life changed forever. Sauser dove into the lake but hit a shallow bottom, broke his neck and drowned. He was pulled from the lake, his brother administered CPR and, 13 minutes later, Sauser was revived—but paralyzed. At the time, Sauser worked as an account representative for Halliburton. But after his accident he was rendered immobile and confined to an electric wheelchair. His family was facing escalating medical bills in addition to needing to refit the family's home to make it more accessible for him.

A helping hand from within Sauser's own industry reached out and provided him and his family the aid they needed. Oilfield Helping Hands (OHH), a Houston-based nonprofit organization providing financial help to those working in the oil and gas industry, paid for an accessible bed and other fittings for Sauser's League City, Texas, home, where he lives with his wife, their 2-year-old daughter and his mother. Sauser said that although much of his body is still paralyzed, he is slowly regaining mobility in his arms. He said the assistance from OHH came at a time of need for him and his family and that he was grateful for the help.

"It means a lot to me that they're willing to help me and other people working in the oil field whenever they have an accident like this," Sauser said. "It's just very much appreciated."

## The start of something good

OHH was established in 2003 when a group of Halliburton employees organized a sporting clays tournament to raise money for a co-worker whose family was facing mounting financial trouble as a result of high-cost surgeries and other medical problems. OHH representative Mona Ansley said the event proved to be such a success that the organizers decided to register the organization as a 501(c)(3) nonprofit. Fourteen years later OHH has grown to six chapters in Texas, Oklahoma and Louisiana and, as of July, had donated nearly \$3.8 million to 374 recipients.



Among the events hosted by OHH's Houston chapter is an annual clay shoot. (Source: Oilfield Helping Hands)

The organization has been recognized by some of the oil and gas industry's leading charitable efforts, including the 2011 Hunting Art Prize. This year OHH earned the Distinguished Achievement Award at the Offshore Technology Conference (OTC), which came with a \$200,000 donation from OTC.

OHH's mission is to provide financial assistance to oil industry employees who are facing a financial crisis as a result of serious medical issues or other serious circumstances.

"We try to lift people up a little bit," Ansley said. "They might be in a bind for all different kinds of reasons. They may have a child with cancer and they can't work. They may need help with their child. They may be late on mortgage payments. There are so many reasons they may need help."

During the past several years, OHH has helped one family whose father was killed in a drunk-driving accident, another family whose primary financial provider was battling cancer and another who lost their young son. For someone to qualify for financial assistance from OHH, they must have worked in the oil and gas industry for at least five years, Ansley said, and 75% of their income must be derived from the E&P section of the industry.

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**Oilfield Helping Hands hosts several fundraising events throughout the year to help raise money for oil industry workers in need of assistance. (Source: Oilfield Helping Hands)**

### Eligibility and fundraising

Potential recipients also must live within one of the territories represented by an OHH chapter, though Ansley said if an employee of a corporate sponsor were to need assistance, OHH would consider that applicant regardless of where he or she lived.

Applicants also must be sponsored by an OHH representative and submit an application to the organization. Each month the organization's selection committee meets to decide its recipients and its funding amount, although Ansley said the organization has the ability to offer financial assistance on an emergency basis without the need of a committee meeting.

"If they ask us for help and we can see the need, we pretty much provide them the money," she said. "We know we can't pay exorbitant hospital bills, but maybe we can at least help pay off a car loan so that it frees up that monthly obligation. We try to be a little bit creative and put ourselves in their position to see what we can do to help."

OHH raises money primarily through its member partners and its events held throughout the year. Platinum members donate at least \$15,000 per year, gold memberships start at \$10,000 per year and silver partnerships start at \$7,000 per year.

"So it's not a whole lot to be able to give back to your community and really make a difference," Ansley said.

Its annual events vary depending on the regional chapter but typically include sporting clays tourna-

ments, fishing tournaments, golf tournaments and pistol shoots. The Rocky Mountain chapter holds OHH Night at Coors Field for a Colorado Rockies baseball game, a motorcycle rally in the spring and its Bowling and Billiard Dash in December. OHH's newest chapters are located in the Permian Basin and in South Texas, representing the Eagle Ford Shale.

Ansley said people can get involved with OHH by becoming a member, becoming a corporate sponsor or volunteering with the organization. OHH currently features more than 3,000 members. Although it's free to become an OHH member, the organization asks that its members regularly participate in fundraising events and attend at least four monthly meetings a year. Other opportunities include sponsoring an event, offering a raffle prize or purchasing raffle tickets at an OHH event, or simply making an individual donation.

Ansley said since the industry downturn, OHH has experienced a decline in both its funding and its event participation. She also said the number of requests for assistance has increased.

"People don't seem to be spending quite as much," she said. "But it is starting to come back." **ESP**

**Have a story idea for Industry Pulse?** This feature looks at big-picture trends that are likely to affect the upstream oil and gas industry. Submit your story ideas to Group Managing Editor Jo Ann Davy at [jdavy@hartenergy.com](mailto:jdavy@hartenergy.com).

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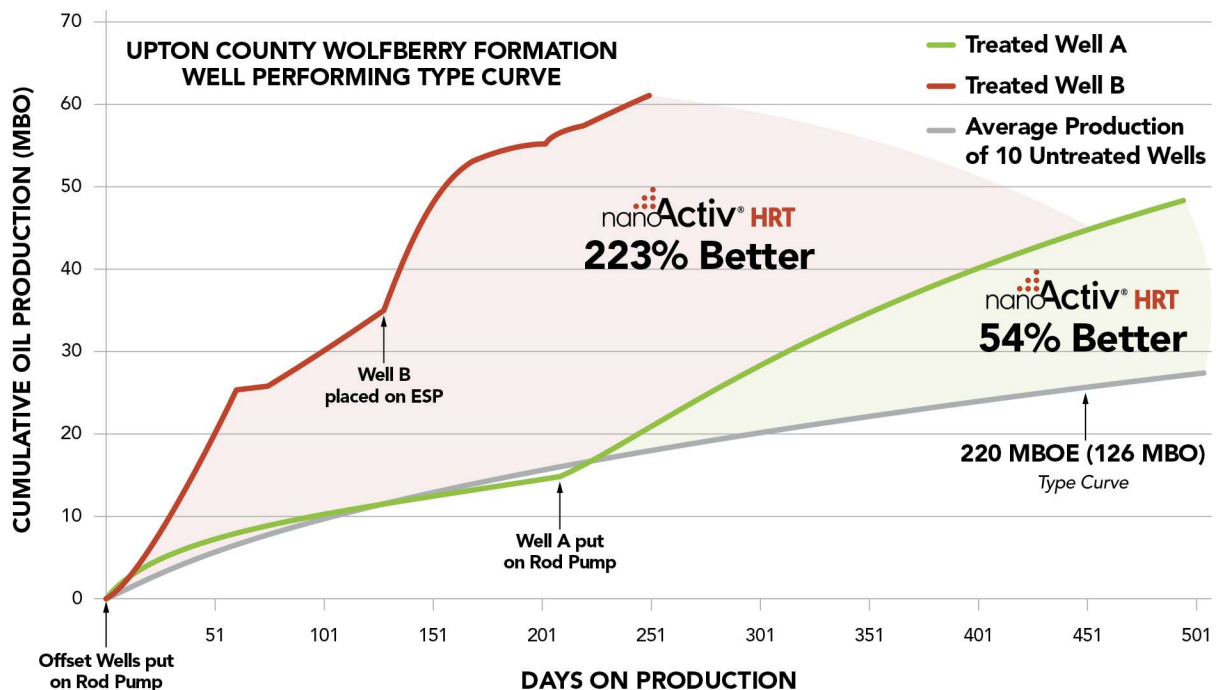
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# Practical AI lessons learned

Deep digital shifts have reached an inflection point.

**Derick Jose**, Flutura Decision Sciences and Analytics

A confluence of groundbreaking technologies bundled with next-generation business models is poised to transform the oil and gas industry. It's history in the making. This convergence of digital technologies (the Industrial Internet of Things, artificial intelligence [AI], autonomous self-healing assets, drones, etc.) is creating entirely new ways of operating a producing well and massively transforming outcomes like increasing production and decreasing nonproductive time (NPT). It's interesting to view some real-world examples of transformations that are solving real-world problems, and the takeaways are five lessons learned in the execution process.

## Predicting fracture pump failures

Flutura worked with one of the world's largest original equipment manufacturers (OEMs) of fracture pumps. Fracture pumps are used in harsh conditions, and as a manufacturer the drilling service providers and owner/operators expect the OEMs to have an intimate under-

standing of the current health of the fracture pump and the potential ways it could succumb to a fault mode. To make this transition from the electromechanical world to the digital world, the customer created a digital twin of the fracture pump, including its various sub-systems (pumps, engine, transmission, etc.), sensor signals (engine rpm, transmission oil pressure), trips, alarms and fault modes on Cerebra. Once the digital twin was created, a "digital umbilical cord" was created using Cerebra's algorithmic state assessment module providing remote digital diagnostics for the pump and predicting potential failure modes with associated confidence for the field force to automatically create tickets. This, in addition to reducing downtime of nodal assets in the field, created a new predictable recurrent revenue pool for the customer through its "digital health monitoring as a service" offering.

## AI in FLNG carriers

A major global LNG carrier approached Flutura with an operational problem to solve. Floating LNG carriers are used to ship LNG from point to point. This is a complex



A digital twin reduced downtime of nodal assets in the field and created a predictable recurrent revenue pool for the customer. (Source: Flutura Decision Sciences and Analytics)



An operator digitized sensor data and integrated physics-based models with statistical data-driven models to predict risk of failure. (Source: Flutura Decision Sciences and Analytics)

and delicate process since gas is stored at -162 C (-260 F) for ease of transport, which takes up about 1/600th the volume of natural gas in its gaseous state. There is a lot of cryogenic and leakage risk associated with this process. The global carrier wanted an “edge solution” completely self-contained on the ship to diagnose and predict risky outcomes. It created a digital twin of the LNG carrier using Cerebra modules, and the solution’s advanced deep-learning neural networks detected temperature and leakage anomalies that human eyes could not detect in an unsupervised fashion.

### AI in subsea separators

Subsea separators increase the oil recovery rate by separating a well stream into gaseous and liquid components. As oil production and recovery rates are directly correlated to separator performance and health, their importance to monitor the health in real time and proactively predict potential failure modes enter the radar. This industrial OEM was trying to solve three problems using digital platforms:

- Remotely diagnosing the digital health of subsea separators;
- Reducing NPT by having a prognosis for the failure modes; and
- Reducing high operational costs associated with expensive unwanted trips to the rig.

The operator digitized sensor data from inlet pressure, choke pressure, flow rates (gas, oil and water) and differential pressures/fluid levels. It also integrated its physics-based models with statistical data-driven models to predict risk of failure.

### What has been learned?

*Mindsets eclipse toolsets.* The race to digital transformation in operating wells is not just about digital toolsets. It’s about changing mindsets in ways that are new. The veterans of the oil and gas industry have become accustomed to tangible and reliable outcomes. Digital is intangible and iterative as the AI algorithms learn and adapt. This requires executives to think about operations differently and reimagine the way they view upstream operations.



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An LNG carrier created a digital twin to detect temperature and leakage anomalies. (Source: Flutura Decision Sciences and Analytics)

*Converting outputs to outcomes.* Digital involves executing a great deal of physics and math-based models on sensor streams. These digital outputs then need to be translated into a meaningful operational outcome, like increasing first-time resolution of upstream assets and reducing NPT, which are then mapped to dollars realized. Data need to be converted to dollars.

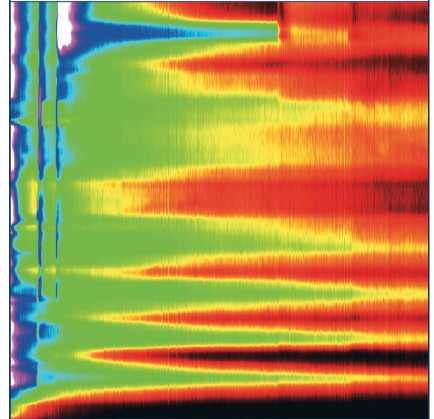
*Sensor lakes.* One of the foundational pieces for digital transformation is having a critical mass of labeled fault mode data. This creates a trail of “digital bread crumbs” and leaves a marker on the asset time line, indicating how the machine specifically failed. This information is guzzled by the deep neural network to discover weights to be attached to minimize prediction deviation. Examples of labeled fault data include electric motor failure, hydraulic leakage and stick-shift events.

*Intelligent industrial diagnostic “bot” assistance.* As the experienced workforce retires, it is important to codify that knowledge for the future workforce. Industrial bot assistants can codify frontline experience and head office intelligence into a comprehensive diagnostic template and make it accessible via “don’t make me think” voice interaction instead of complex dashboard interaction. For example, Flutura created an “Ask Cerebra” diagnostic bot for catwalks that helped a large OEM frontline team step through a diagnostic workflow to understand fault modes codified from years of experience. With the advent of natural language processing algorithms powered by deep learning, field technicians can interact with the asset diagnostic applications through voice interactions, just as bots help in customer service.

*Integrate heart and mind.* Digital transformation is a complex process requiring tact in dealing with sensitive human issues in a complex ecosystem. This has required seasoned leadership that can understand the transformative potential of digital technologies but can also provide a human-centric approach to solving problems.

These are deep digital shifts that have reached an inflection point, creating a massive transformation of oil and gas operations to move beyond “vanilla” condition-monitoring systems. The challenges are more human than technological. They require oil and gas leadership to rethink operating models, business models and economic models. And this requires them to create a blueprint to respond to these tectonic irreversible shifts and to think that the status quo is not an option as the digital wave seeps into the electromechanical world. **ESP**

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# Technology gets the credit for success

An executive shares how having a ‘front row seat’ to the progress of technology delivered a greater appreciation for the progress made by the oil and gas industry.

**Paul Hart**, Editor-in-chief, *Midstream Business*

**T**echnology “has been the common denominator” that has powered the oil and gas industry to its current status in the world’s economy and will be vital for its future, according to the president of ExxonMobil’s XTO Energy Inc. unit.

“Think about the ingenuity and tenacity that it has taken to develop technological solutions to tackle” the industry’s challenges, said Sara Ortwein at an IPAA Leaders in Industry Luncheon July 27 at the Fort Worth Petroleum Club in Texas. Oil and gas have created “innovations that have transformed our nation and the world for the better,” she said.

The industry’s technology can be credited for U.S. job growth and economic opportunities, “and it unleashed a manufacturing renaissance, particularly along the U.S. Gulf Coast,” she said. “Chemical plants are expanding due to low feedstock costs for the first time in many years.”

## ‘Extraordinary changes’

Ortwein reviewed “the extraordinary changes [and] the transformation” that she has seen over the past nearly 40 years since she began her career at Exxon Co. USA in 1980. She recalled that Exxon’s first horizontal well—al of a 152-m (500-ft) lateral—was drilled in 1983 in the Austin Chalk.

“The well was dry,” she added with a chuckle, but it was viewed as a technological marvel at the time. Compare that with horizontal laterals in North America that go out for thousands of feet, or as long as 13 km (8 miles) in one Russian test, “and when we do we can hit something the size of a pitcher’s mound,” she said. “It’s really phenomenal.”

She noted her previous assignment as president of the upstream research unit of ExxonMobil Corp. gave her “a front row seat” on technological progress.

“The innovation that has taken place in our company can rival that of any other industry, especially when you look at the scale of the projects we do,” Ortwein said, adding the oil and gas business overall is now “in a period of extraordinary transformation.”

Ortwein was named XTO’s president in November 2016.

“The shale boom brought us out of years of domestic energy insecurity into an age of what we can call energy abundance. A combination of proven technologies and new techniques has allowed us to unlock North American shales and other tight reservoirs, causing the Peak Oil theory to yield to a new reality for all of us,” Ortwein said. That success came in an industry that she said has pioneered new technology since its earliest days.

## XTO focus

XTO now operates in all of the major U.S. unconventional plays “with a leading focus on the



**R&D of new technologies and processes has created innovations that transformed the world for the better, according to Ortwein.**  
(Source: Matej Kastelic, *Shutterstock.com*)

Permian at this point.” She noted recent acquisitions have given the firm 1.8 million net acres in the Permian with 140,000 bbl/d production currently. Outside the U.S. XTO has projects underway in western Canada’s Montney and Duvernay shales as well as Argentina’s Vaca Muerta play.

Ortwein discussed what she termed the successful 2009 combination of XTO and ExxonMobil, saying she is asked frequently how it was possible for the world’s biggest publicly held energy firm “to acquire a successful independent, maintain the business and enhance value without deviating the organization from its core mission.”

Ortwein called the acquisition a win-win and said the XTO-ExxonMobil combination built on lessons learned in the 1999 merger of Exxon and Mobil.

For XTO and its new parent, “both companies brought significant strengths to the table, and we’ve been able to leverage those strengths within the two organizations,” Ortwein said. “XTO brought expertise in unconventional resource development. We’ve been transferring that knowledge throughout the broader ExxonMobil Corp., and that enables us to be more effective in safely developing and producing these unconventional resources, not only in the U.S. but around the world.”

XTO’s “unique synergy from discovery to sales” has been shared with the rest of ExxonMobil’s upstream operations. “On the flip side, ExxonMobil has brought tremendous technology prowess, financial strength and an industry-leading commitment to safety, and that has enabled XTO to flourish while several other independents, quite frankly, have struggled,” Ortwein said.

She said the pending move, to start next year, of XTO’s headquarters and much of its staff to ExxonMobil’s new campus in Spring, north of Houston, will further increase collaboration.

The company will continue to have a presence in Fort Worth. “The operating division that’s based here that supports the Barnett Shale is being expanded to support operations in the Bakken in North Dakota as well as our Appalachia operations,” Ortwein said.

“XTO, as most of you know, has a very long and storied history in Fort Worth, going back to the company’s founding in 1986 as Cross Timbers Oil Co.,” she said. “I am extremely proud of XTO and its heritage in Fort Worth. We’ve done a lot of great things, and I expect that to continue.”

Looking ahead, she said XTO is focused on the long term “because the need for energy is long-term.”

She invited the audience to download ExxonMobil’s 2017 “Outlook for Energy” report that projects worldwide energy trends through 2040. That study projects a significant growth in energy demand that will be heavily influenced by three primary forces: population growth, trade and economic development, and energy efficiency.

Government policy also will impact the future, and the business must be ready for whatever comes from regulators through continuing technological innovation. She called for close ties between the industry and the agencies that oversee it.

“We have to be able to compete in a global marketplace regardless of who may be in office and what policies they may be driving,” Ortwein said, noting that companies must protect the industry’s license to operate by operating safely and demonstrating environmental responsibility. “The companies that can do these things well will have tremendous opportunities in the U.S. as well as abroad,” she said. **ESP**

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# Digitalization comes to directional drilling

Digital directional drilling and demonstrated improvements in wellbore quality and speed is the latest disruptive technology on the well site.

**Richard Mason, Chief Technical Director**

Super-specification pad-optimal Swiss Army-style walking rigs may generate headlines when it comes to evolution in land drilling, but directional drilling is fast becoming a more accurate indicator of how the sector is evolving as tight formation development enters full field development.

Companies like Baker Hughes, a GE company, have offered sophisticated geosteering suites combining bits, motors, downhole evaluation and software control to improve ROP for some time. But quietly, and without fanfare, the largest domestic land drilling contractors and their Canadian peers are integrating digital directional drilling capabilities into rig offerings.

The trend accelerated over the last six months when land contractors began purchasing digital directional drilling providers. Acquisitions include Helmerich & Payne IDC's \$100 million purchase of Motive Drilling Technologies Inc. in May, Patterson-UTI Energy Inc.'s \$215 million cash and stock purchase of MS Energy Services and Trinidad Drilling Ltd.'s \$40 million cash and stock acquisition in August of RigMinder Inc. and its electronic data recorder and bit guidance systems, which integrate the rig and directional drilling tools.

Other drillers, including Nabors Industries Ltd. and Ensign Energy Services Inc., offer directional drilling services and supporting downhole packages that include proprietary mud motors and MWD tools integrated with software to improve directional drilling performance. Nabors, for example, is commercializing a multiple package software suite that includes its recently developed ROCKit directional steering control system.

Meanwhile, Canada's Precision Drilling aims to "de-man" the directional drilling process via a pro-

prietary directional guidance system that coordinates workflow between the rig's driller on location and a remote directional driller who oversees several directional drilling projects simultaneously. Precision is using algorithms to convert 14 process and 20 decision points in directional drilling into seven processes and 10 decisions, reducing support crew, time and cost. The system will be fully deployed across Precision's fleet in 2018.

What's going on? At the simplest level, it is an opportunity for drilling contractors to capture more revenue per rig in a flat pricing environment. Beyond that, larger drillers are bringing in-house a service that is integral to today's best practices where precise lateral landing in extended wellbores is as important for boosting hydrocarbon recovery as greater proppant loading.

Digitally enhanced directional drilling integrates software suites, sensors and downhole tools to reduce wellbore tortuosity and generate higher ROP. Digital directional drillers point to field-tested savings in time and direct costs that are measured in tens

of thousands of dollars per well.

Digitalization of directional drilling is disruptive technology. The question is whether it will supplant both personnel and the community of independent service providers.

One other factor promoting the spread of digital directional drilling is that the software is often independent of the rig, allowing smaller contractors to integrate the service into their own rig offerings via third-party access.

Like all wellsite technology, digital directional drilling may require an evolutionary step in perception at the well site that also incorporates specialized human input and flexibility as the best solution for sophisticated problem-solving in a dynamic environment. **ESP**

- **Land drillers consolidating digital directional drilling**
- **\$400 million in acquisitions in six months**
- **Standalone software is rig-independent**

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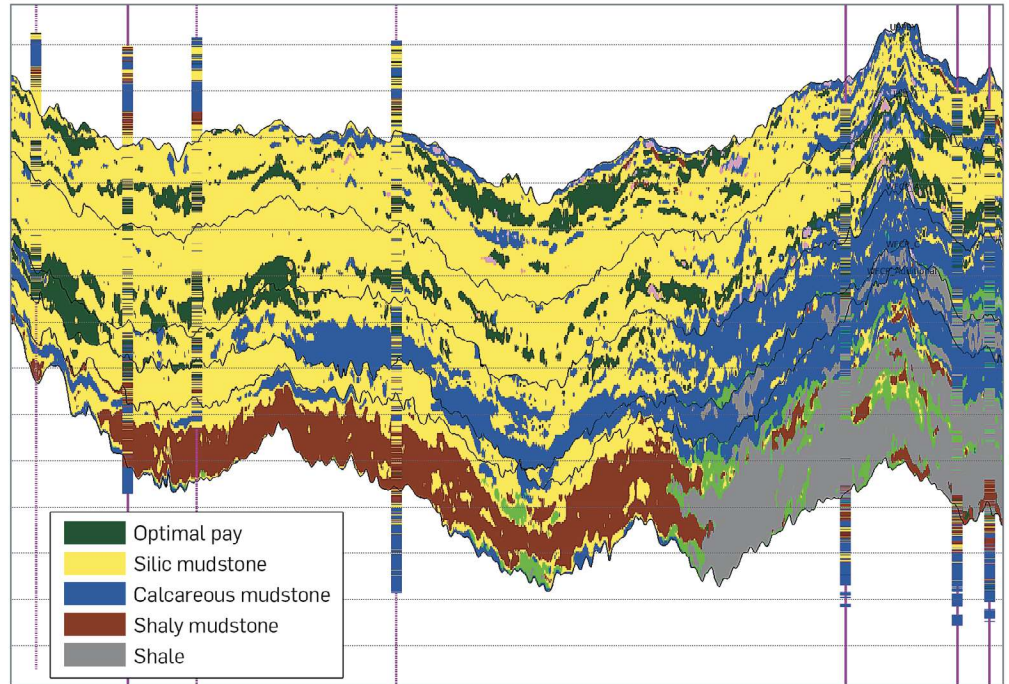
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# Once upon a time

Happy endings do exist.

Western culture fairy tales often end with, “And they all lived happily ever after.” Grownups know that this doesn’t happen in real life. People are not intended to live happily ever after. We have mortgage payments and car payments and kids who want us to put them through college.

But these stories have important elements: plot, characters, setting, point of view, theme, etc. It’s the makeup of any good narrative. This is where I think geoscience and literature meet.

A good geoscience story might not have all of these elements, although I’m sure characters are involved along the way. But good geoscience stories have the “plot” of depositional history and tectonic stresses, which in turn lead to the “themes” of source, trap, seal, compartmentalization, etc. And they end up, hopefully, with a story that has a happy ending (at least for the geoscientists—the production engineers might be telling a different tale).

So here are a few of my favorite bedtime stories. Range Resources commercialized the Marcellus Shale through large-scale slickwater fracturing and horizontal drilling. The company became interested in shows that it was finding while drilling to deeper targets.

Using the then-hot Barnett as a guide, Range put together an aggressive land position, especially in the “sweet spots” of the play in southwestern and northeastern Pennsylvania.

Unlike its conventional counterparts, Range tried fracturing patterns that were unheard of in those days. By using a Barnett-scale frack design, the company unlocked an entirely new shale play.

In another example, Erik Oswald, vice president of exploration Americas for ExxonMobil, told a story at the recent European Association of Geoscientists



**PennEnergy believes the Marcellus core extends north of Pittsburgh into Butler, Beaver and Armstrong counties in Pennsylvania. Range Resources helped kick off the play. (Source: PennEnergy Resources LLC)**



**RHONDA DUEY**

**Executive Editor**

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and Engineers conference about the company’s Liza discovery in the deep waters offshore Guyana. In the late 1990s the company’s geologists were trying to work out the plate configuration in the Caribbean Sea and developed a story that indicated that source rocks might have built up offshore Guyana. A regional seismic line led them to believe this story might be true.

The company leased a considerable amount of acreage, but its development plans were delayed because of a border dispute. But after acquiring additional seismic,

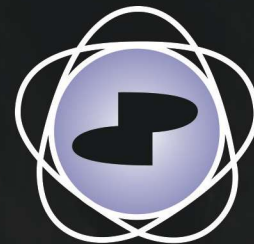
it drilled a discovery well in May 2015. Ultimately, ExxonMobil acquired 17,000 sq km (6,564 sq miles) of seismic while continuing to drill up and develop the field.

Overall, the company arrived at its final investment decision two years after the discovery, and it expects first oil within four years.

And of course there’s the classic Barnett Shale story, where George Mitchell and one of his engineers, Nicholas Steins-

berger, refused to give up on their dream of unlocking a shale play that obviously held vast reserves but wouldn’t give them up easily. Mitchell’s “story” arguably changed the energy industry forever.

I’d like to tell more of these stories. If you have a good one, please share! **ESP**



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# Drilling commences in the Bowland

Determined E&P pushes forward with its plans to develop shale in the U.K.

**W**hile controversy surrounding shale development has eased in the U.S., it is still roaring in the U.K., where operators like Cuadrilla Resources have faced stiff resistance to their efforts to develop gas resources locked in the Bowland Shale that stretches across central England.

For a country that, according to one U.K. Parliament Report from 2013, consumes about 84.9 Bcm (3 Tcf) of gas annually, the need for a reliable source of gas close to home is considerable in light of declining gas production from the North Sea and the increasing use of LNG from U.S. shale sources. The Bowland Shale may just be the answer to bridging the gap.

The estimated total shale resource of the Bowland Shale ranges from a low of 23.3 Tcm (822 Tcf) to a high of 64.6 Tcm (2,281 Tcf), according to a British Geological Survey report from 2013.

The central estimate pegged gas resources at 37.6 Tcm (1,329 Tcf).

There have been no hydraulic fracturing activities in the country since 2011, when tremors brought an end to Cuadrilla's fracturing operations of a vertical well near Blackpool. In August Cuadrilla began exploratory drilling operations at its shale gas site located in Preston New Road in Fylde, Lancashire.

Getting to August was a difficult road to travel for the company in that it saw its drilling rig vandalized while it sat in storage along with a near-constant presence of protestors at the site, where construction began in January.

Initial surface construction included the creation of a new site entrance, access road and well pad. Top soil on the pad was cleared for the installation of a protective membrane to create an impermeable barrier. The company also set up a dedicated viewing area near the site to allow interested members of the public to observe operations from a safe location.



**JENNIFER PRESLEY**  
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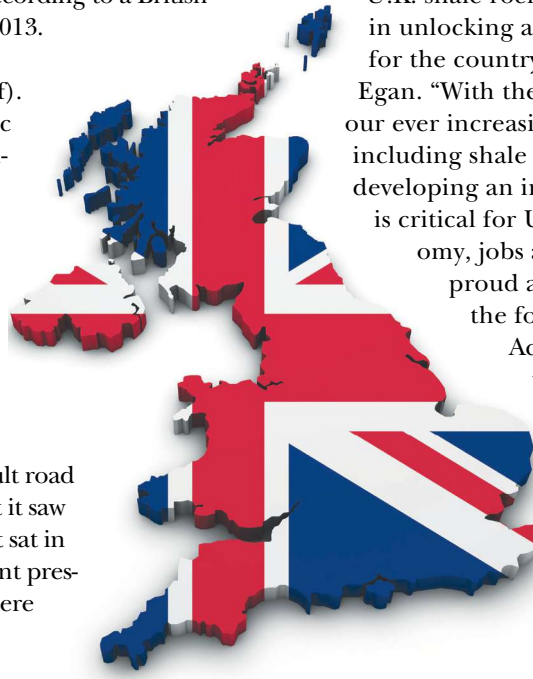
With the arrival of a drilling rig on site in late July the company took another step closer to attaining its goals.

"We are very pleased to have taken delivery of the drilling rig to our shale gas exploration site. The drilling of the first horizontal exploration wells into U.K. shale rock will be an important milestone in unlocking a vital new source of natural gas for the country," said Cuadrilla CEO Francis Egan. "With the decline of North Sea gas and our ever increasing reliance on gas imports, including shale gas imported from the U.S., developing an indigenous source of natural gas is critical for U.K. energy security, our economy, jobs and the environment. We are proud as a Lancashire company to be at the forefront of that effort."

According to Cuadrilla, the operational plan is to drill two of four planned horizontal wells that it has received permission for this year. A pilot well will be drilled to about 3,500 m (11,482 ft). Samples will be taken from the pilot well at various depths within the shale rock to determine where to best drill the laterals.

Then the first two horizontal wells will be drilled to depths between 2,000 m and 3,500 m (6,562

ft and 11,482 ft), a press release said. The company estimates the wells will be completed before year-end 2017. **ESP**



(Source: niroworld, Shutterstock.com)

*Jennifer*



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# Understanding ESPs through machine learning

A recent study reveals that predicting an artificial lift failure is possible through the use of analytics.

**E**lectric submersible pumps (ESPs) are one of the go-to mechanisms for artificial lift, with as many as 150,000 ESPs in operation around the world, according to Schlumberger. Although ESPs are remarkably efficient for pumping large volumes, they are highly susceptible to prolonged failures.

Post-mortems on ESPs reveal that produced gas and solids have proven to be their undoing. But with the advent of Big Data and machine learning, predicting when an ESP may fail well in advance of any potential mechanical problems is improving.

At the Unconventional Resources Technology Conference held in July in Austin, Texas, Devon Energy reported on its recent efforts to do just that.

For its study, Devon selected a geographic area utilizing several ESPs and a common target formation. Devon's Advanced Analytics team collected a sample dataset of 51 ESP failures that occurred from January 2015 to July 2016 across 37 wells, while the company's subject matter experts identified all of the potential factors that affect ESP functions.

Although Devon acknowledged in its study the challenges of analyzing only 51 ESP failures, its results revealed that its predictive modeling technique anticipated ESP lifespans to within about five days of the true ESP lifespans, and 90% of the model's predictive error was within +/- 30 days of the true ESP lifespan.

"The first iteration of our model identified the specific variables that affect ESP lifespan and should be continuously observed," said Jessamyn Sneed, evaluation and planning professional at Devon Energy. "We've since found ways to improve our model and overcome issues with model fit while addressing concerns discovered during the data-mining phase. We'll continue to refine our model so that we



**BRIAN WALZEL**  
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Read more commentary at  
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can leverage operational knowledge with insight from analytics and human intelligence to provide the most value to the field."

Devon's study is an example of how leveraging Big Data can help predict problems before they happen.

Jeff Dwiggin, managing director at Artificial Lift Solutions, said it's imperative for companies to be proactive with their analytics efforts rather than reactionary, such as what Devon has done with its study.

"You've got to be proactive; you cannot be in a responsive mode," he said. "You have to learn through the use of Big Data's distinct signal patterns that will warn you and allow you to respond."

However, not all companies have the resources in today's economic climate to invest in large-scale data analytic R&D projects, he said, even if the end result could be long-term cost savings.

"You see operators typically in two distinct classes," Dwiggin said. "There are those bigger operators that feel they need to apply multiple resources and subject matter experts, and then

other operators try to respond to problems. They're certainly applying technology to help them be more aware and more proactive to changing conditions that would negatively impact the ESP." **ESP**



**Operators are turning to analytics to help predict when machines such as ESPs might fail before they do. (Source: Syda Productions, Shutterstock.com)**

COVER STORY:  
SHALES

BETWEEN THE  
**CRAACKS**

*New technologies unlock tight rock's prize*

Rhonda Duey, Executive Editor

**G**eorge Mitchell spent a lot of time and certainly a lot of money trying to crack the secret of the Barnett Shale. And even after he found success, many people doubted that this whole unconventional thing would ever amount to much.

We've learned a thing or two since then. In North America alone, McKinsey Energy Insights estimates U.S. shale oil production will reach about 9 MMbbl/d by 2025. Total capex will grow at 25% per year through 2021, and drilling and completions will grow by 20% per year over that same time frame. Even as shale plays tipped the balance of supply and demand, operators found ways to do things for less, and McKinsey's "North American Shale Oil Perspective" report noted that the Permian Basin's core breakeven price is less than \$41/bbl in 2017.

The following pages contain a snapshot of just how creative operators and service companies have become in tackling these challenging plays. **EP**





Shell's operations in Canada have helped its engineers geosteer wells in Argentina's Vaca Muerte Shale. (Source: Shell)

## When is a major not a major?

Shale plays require nimbleness. But some huge companies can still play the game.

**Rhonda Duey**, Executive Editor

Over the past few years, the Unconventional Resources Technology Conference (URTeC), a joint effort between the Society of Petroleum Engineers, the American Association of Petroleum Geologists and the Society of Exploration Geophysicists, has examined the relatively new realm of shale plays and the integration they require among the disparate disciplines. At the recent URTeC conference in Austin, Texas, Greg Guidry, executive vice president of unconventional for Shell, discussed how one supermajor got in on the ground floor and duked it out with some much more nimble independents.

Noting that there were “lots of brains here in the audience,” Guidry described Shell, in the shale reference, as a “lumbering international oil company” but noted that “one of the Seven Sisters” has actually been

able to be “as nimble as an independent” while leveraging the strengths of a major oil and gas company. “And this is all while in the context of doing more with less,” he said.

He gave an overall context to shale’s importance to Shell. “Obviously, shale is a piece of our overall portfolio,” he said. But it’s not the only piece. Shell is still very invested in its deepwater interests around the world, Guidry said, including its assets in Brazil. And because of low fuel costs and plentiful methane availability, its chemicals business, particularly with its new cracker capability in Pennsylvania, is a “huge, huge commitment,” he said.

### Deep portfolio

But shales remain a major part of the company’s North American portfolio. “This is a future opportunity that we’re spending about \$2.5 billion dollars a year on,” he said. “So it’s a very, very substantial business in Shell,

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and it is meant to be even more substantial as we go forward. The strategic intent for shale is to be a very material, attractive, sustainable business for Shell for growth into the future.”

Currently the company has about 12 Bbbl on the books, he said, mostly in North America. But Shell also is dabbling in Argentina as well as other countries around the world.

### Nimble yet strong

“What do I mean when I say, ‘nimble as an independent but with the strengths of a major?’” Guidry asked. He noted that the company had to do “an incredible amount of work” to alter its standards to a more fit-for-purpose approach to enable it to be as cost-effective, quick and pragmatic as an independent. “This is absolutely required to even compete in this business,” he said. This required some dramatic changes in terms of well standards, facility standards and the way the company matures hydrocarbons, he added.

“We’ve made tremendous progress, and we are quite competitive in terms of execution costs,” he said. “About 90% of the wells we drilled last year were top producers, and this was with a very steep learning curve.”

### ‘Strengths of a major’

What can an enormous company like Shell bring to the shale table?

“One is technology,” Guidry said.

“We have to work with existing technology, but we also have to be looking at the longer term.”

He described Shell’s “Shale Field of the Future.” “We see a huge opportunity to actually adapt existing and emerging technologies to the shale business,” he said. “Some of that’s already taking place. But what we have not seen yet is a fully integrated shale field of the future that leverages a lot of the digitalization technologies that are around.

“It’s something we call ‘iShale.’ Based on our own risk assessment, we see the ability to take about 30% to 40% of the unit development and operating cost vs. 2016 over and above what would be done with conventional learning. It’s a very material opportunity for us, and our time frame is about 2020.”

Much of this work is being done with standard suppliers, but Guidry also was pleased to note that a joint

venture with the Massachusetts Institute of Technology (MIT) was helping guide the process. “We’ve got a laboratory and incubator at MIT called ‘Shell Tech Works,’” he said. “Shell Tech Works is about 50 world-class scientists and engineers that have never worked in oil and gas. They’re astrophysicists. They’re media experts. They’ve worked in automotive systems and engineering industries.

“And we just give them a problem, and they come up with an incredibly innovative solution. They’re part of iShale as well, and that provides a bit of a different lens over and above some of the basic research that we’re doing in our own R&D laboratories.”

### A matter of scale

One of Shell’s major strengths is its scale. It can be as nimble as an independent and can use its huge technology shadow to gain competitive edge, but it also has the scale to make these things count, Guidry said.

He addressed scale in several dimensions. “One is global procurement scale,” he said. “Applying some of our global scale to our needs here in North America is an opportunity we take advantage of.”

But it also helps to have that procurement advantage in places like the Vaca Muerta Shale in Argentina. While Shell has only drilled 20 wells in the play, he said the company is at the leading edge in terms of cost competitive-

ness and EUR performance. And having geosteering experience in the Duvernay in Canada has helped the company in its Argentina shale excursions.

“We’re actually geosteering the wells in Argentina from Calgary,” he said.

Overall, Guidry said the journey has been a success. Between 2013 and 2016 the company reduced its capital spend by about 60% while growing production by about 40%. Resources have grown while the footprint has shrunk. Operating costs have dropped.

But Shell is not becoming an independent. “We are an international oil company, and we certainly have a reputation to manage,” Guidry said. “We came up with one set of operating principles that controlled our framework across all regulatory regimes. And we operate by that standard regardless of what the regulations call for.” **ESP**

“Applying some of our global scale to our needs here in North America is an opportunity we take advantage of.”  
— Greg Guidry, Shell

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# Using buoyancy-assisted casing equipment to extend lateral reach

Tool allows casing string to run to total depth.

Kevin Ardoin, Halliburton

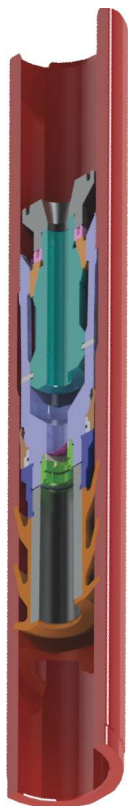
A major challenge in lengthy horizontal or highly deviated wellbores is running the casing string to depth. Drag between the casing string and the formation can often exceed the load capacity of the casing hook, preventing tools from reaching optimal setting depth. This challenge is compounded in shallow horizontal wells. Finding a way to minimize the drag is the key to extending the reach of highly deviated and horizontal wellbores.

A technique developed to “float” the casing into the wellbore using buoyancy-assisted casing equipment (BACE) allows operators to run casing to the bottom of these particularly challenging wellbores. Paired with floating equipment, the application of BACE traps lightweight fluid or air in the lower section of the casing string, thereby reducing the weight of the casing. The lighter weight reduces drag by lifting the casing string away from the formation wall and minimizes the surface area contact of friction.

This technique enables increased running depth and decreased potential for casing buckling or sticking. To simplify its application, BACE is fully integrated with the casing string, and it helps reduce risk because it has no outer shear pins posing potential leak points. Additionally, the tool doesn’t require debris barriers that can obstruct free flow in the casing. As opposed to other methods or alternatives, BACE does not leave behind any trace of rupture disc within the casing wall, which can impair fracture plug deployment during plug-and-perf operations.

Three recent jobs in unconventional shale plays involving lengthy lateral casing strings illustrate the effectiveness of the BACE technology to overcome challenges.

Halliburton’s BACE allows operators to run casing to the bottom of challenging wellbores. (Source: Halliburton)



## Reaching out in the Western Hemisphere

In the first case study an operator planned an extended lateral well of about 3,962 m (13,000 ft), anticipating challenges getting the casing to planned depth. The operator also was concerned about the compatibility of equipment throughout the casing string for cementing and future operations.

Halliburton performed analysis on the wellbore and determined that the best way to set the casing would be to use BACE along with a fullbore pressure-operated fracturing sleeve. Additional torque and drag analysis identified the need to create a buoyant chamber at the heel of the wellbore.

While the service company was executing the job, BACE ruptured at the planned applied casing pressure. After successfully removing the buoyant air chamber, technicians launched the bottom plug from the surface, landed it down on the BACE plug and released it to initiate displacement. During the cement job the plugs were successfully pumped through the RapidStart Initiator Casing Test without incident, proving compatibility and allaying concerns the operator had in the planning stage.

## Challenges in the Eastern Hemisphere

In the second case study an operator planned to run about 3,200 m (10,500 ft) of casing in a lateral wellbore and achieve both planned total depth (TD) and top-of-cement for zonal isolation. Because the job would be the operator’s longest lateral, it was extremely concerned about successfully executing to plan.

Halliburton performed torque and drag analysis using the wellbore parameters and determined BACE would be the best course of action placed at the heel of the wellbore. Additionally, cement design modeling suggested the use of an external sleeve inflatable packer collar (ESIPC) for second-stage cementing. Executing the job, the extended-reach casing was floated to planned TD using BACE, and the success of the run eliminated the contingency of running a smaller liner to achieve TD. All displacement measurements for the cement plugs and the BACE were in accord with the job design, and the ESIPC functioned properly, enabling the displacement of the second-stage cementing to achieve planned top of cement.



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### Specialty casing application with fiber optics

In the third case study an operator sought to set casing in a well with a true vertical depth of 3,246 m (10,650 ft), a measured depth of 6,390 m (20,967 ft) and a bottomhole temperature of 137.7 C (280 F). The operator also wanted to run fiber optics as it considered the well something of a “science project” to monitor *in situ* conditions and provide data for future well development in the area.

The Halliburton team proposed using BACE and, after conducting torque and drag analysis with wellbore conditions, it determined the technology would work best near the heel of the wellbore. The subsequent four months of planning and preparation for the job entailed mobilizing the necessary downhole tools, surface equipment and field personnel to the site and conducting a critical well review to ensure all elements of the operation were coordinated.

The execution phase began with the team positioning the BACE about 2,438 m (8,000 ft) from the end of the string and then successfully floating the casing and

fiber optics to TD. Next, pressure inside the casing was increased to 1,250 psi and ruptured the disc as planned, which separated the 10 parts per gallon well fluid from the air-filled chamber. Finally, the team circulated about 1,000 bbl of fluid to ensure that all of the air in the buoyancy chamber was depleted, after which the cement job was performed.

With critical data being fed back to the operator, the BACE provided a successful outcome, according to the operator. During the planning phase the operator estimated the job of running fiber optics with the casing would take three to five days at a pace of running about four joints of casing per hour. By using BACE the operator was able to run about 14 joints of casing per hour and cut three days from the operation, reducing time and costs.

As lengthy horizontal and highly deviated wellbores become increasingly common, the application of this type of technology could become a more widely used technique in more places around the world. **ESP**



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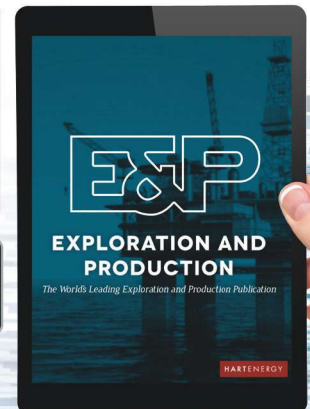
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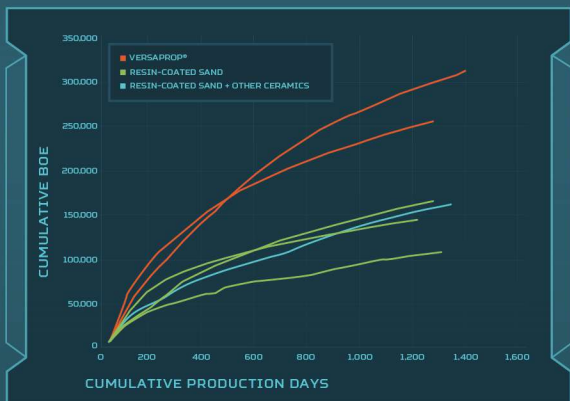
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# Increasing reliability in expandable liners

Liner hanger avoids high-setting pressure requirements.

**Frank Mullins, Seminole Services**

The first hanger designs specifically developed to run liners were true to their descriptive name. The weight of the liner set mechanical slips in a vertical well, and cement was used to seal the liner top. These were mechanical devices that lacked reliability, particularly in deviated wellbores.

As wells were drilled to greater depths, more reliability was needed and eventually obtained through the use of hydraulically set hangers. Once directional drilling and horizontal completions became more prevalent, many equipment suppliers adapted existing technology to the changes in well construction, with more focus on the running tools. Robust running tools ensured liners could be deployed in deviated wellbores that required reaming. However, the basic concept of using slips with a cone remains at the heart of all conventional systems, and options have been added to this basic offering to aid in both functionality and reliability. This has added complexity.

More robust running tools ensure liners can be deployed in deviated wellbores that require torque, washing and reaming. However, the basic concept of using slips with a cone remains at the heart of all conventional systems, and options are added to this basic offering to aid in functionality and reliability such as dual cones, liner top packers and high-strength running tools.

## Trends in liner hangers

The latest developments in running liners include metal-formed liner hangers. Expandable systems have dominated development in liner hanger technology for the past 10 years. These systems are popular because of increased setting and deployment reliability. The advances in technology are apparent through the popularity of the expandable systems and the enhanced applications in different well profiles around the world. Still, expandable systems using hydraulic pressure to set the liner top come with their own risks (e.g., high hydraulic pressure on the rig



The Powerscrew Liner System is tested at the Catoosa Testing Facility in Hallett, Okla. (Source: Seminole Services)

floor). Other limitations include continued complexity, potential leaks in connections and incompatibility with some rig operations.

To combat these challenges, Seminole Services developed the Powerscrew Liner System, a tool utilizing a metal-forming process that does not require high hydraulic pressures and eliminates the risks associated with reaming to setting depth. The Powerscrew is a torsionally set metal-formed liner hanger that works by converting torque from the top drive into linear force to set and seal a liner top.

The assembly is deployed on drillpipe and conveys the liner to total depth (TD) with a unique running

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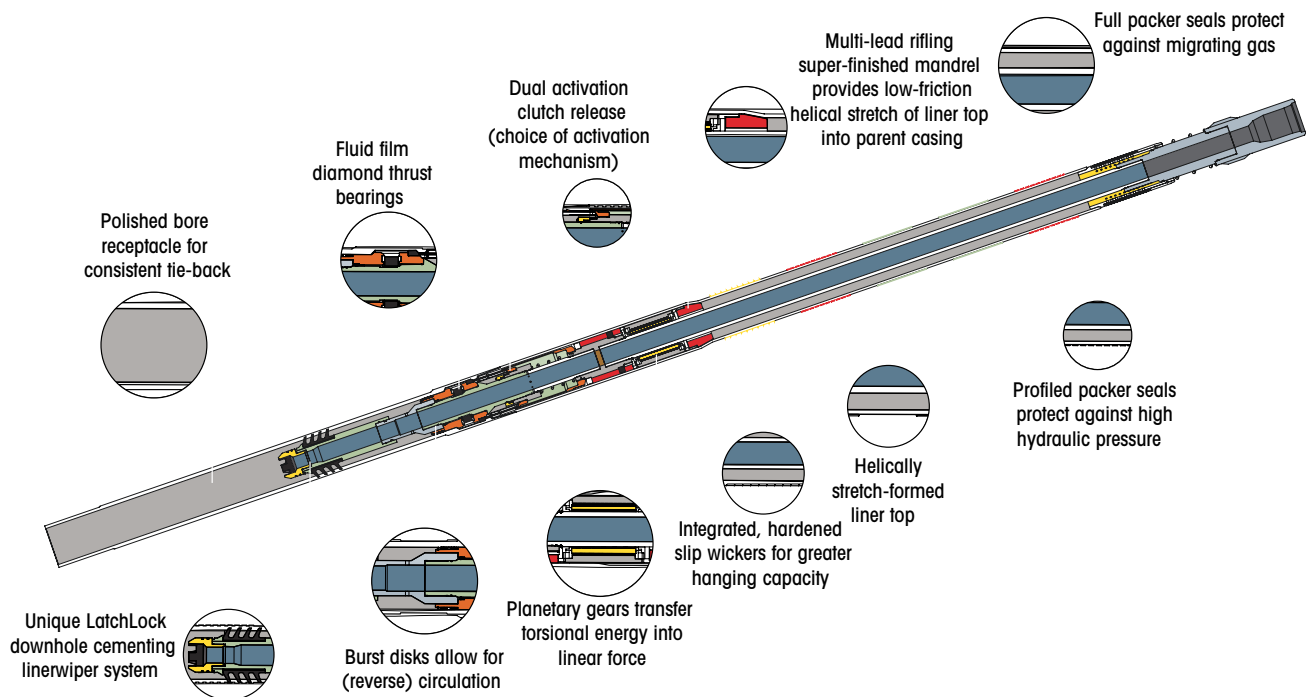


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**The Powerscrew design includes packer seals to protect against migrating gas and high hydraulic pressure. (Source: Seminole Services)**

tool. In many cases, running a liner to TD requires compression, rotation and circulation. This is especially true for longer laterals, so special design emphasis has been placed on the running tool, which can take higher compressional loads associated with reaming.

The Powerscrew's running tool is designed for both torque and compression while setting the liner top. As a result, these loads transfer more easily through the running tool during liner deployment.

The system includes a patented helical stretch method of metal-forming using a multi-lead rifling (MLR) mandrel. The MLR mandrel provides micro-upsets, increasing the post-formed collapse, and it counter-rotates to eliminate residual torque. In addition, helical stretch forming has less friction and therefore requires less force to forge a metallic tubular downhole. The tool incorporates a high-strength clutch that disengages the running tool from the liner upon reaching setting depth and initiates the metal-forming process with the application of torque. The wellsite operator monitors the torque gauge and weight indicator to ensure proper operation.

### Liner hanger market trends

A deep dive into the liner hanger market gives credence to the idea that liner size and weights matter tremendously. With the trend in U.S. drilling focused on

shale plays along with the downturn in offshore activity, there has been a shift in demand from larger tools to smaller ones. Increases in demand for liner hanger tools such as the 4½-in.-by-7-in. and the 5-in.-by-7-in. stem from the increased use of liners in horizontal sections common in U.S. shale production. The continuing increase in drilling longer lateral sections also will provide more meaningful savings to those operators choosing to run liners.

Operators drilling more complex wells have facilitated alternatives in well construction that allowed metal-formed liner systems an entry path while also providing multiple options to conventional system offerings. Liner hangers no longer, these well construction tools were built to withstand tortuous well paths and high loads, adding complexity. The tradition of hydraulic setting methodology transferred to the newer expandable systems can still suffer from difficulties sourcing hydraulic horsepower from the rig. Given that longer laterals will continue to be the trend in producing from shale, less complex tools that can withstand the rigors of deployment in horizontal wells will offer a viable solution to operators. Since rotary drilling rigs are readily available to deliver torsional power through drillpipe, the Powerscrew offers an alternative in metal-forming methodology. **ESP**

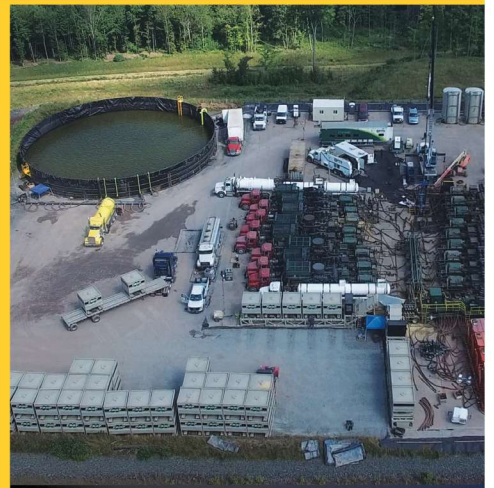
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# Delivering operational, financial benefits to Permian stimulation projects

Integrated bacterial control solutions extend the health of wells over normal life cycles and maximize cost efficiency.

**Christina Pampena**, Dow Microbial Control, and  
**Gabriel Tapia**, Halliburton

Stimulation has been on the rise in the Permian Basin, with 379 active wells as of mid-August—more than a twofold increase over the same week last year. With completions increasing in the Permian along with other regional considerations like water shortages, cost effectiveness is more important than ever. The investment is high and can be protected with an effective bacterial control program.

Although biocides make up a very small part of fracturing fluid, an effective bacterial control program can extend the health of the well and maximize the return on the investment during completion.

Low-cost oxidizing biocides like chlorine dioxide are widely used in the Permian. These quick-acting biocides offer an immediate kill topside, but they are not able to control the growth of bacteria downhole. That leaves the operation susceptible to biofouling, microbially influenced corrosion and souring of hydrocarbons. To minimize and help prevent these issues, it is recommended to design and implement an integrated solution during well completion that will provide bacterial control in all phases of the hydraulic fracturing process: preparing the water before entering the well, decontaminating the well and protecting the reservoir.

## Breeding ground for issue-causing bacteria

The warm climate, lack of abundant freshwater resources and downhole conditions such as bottomhole temperatures in the Permian Basin create ideal conditions for problematic bacterial growth.

These conditions can impact the profitability and safety of an operation. For example, the buildup of biofilm and occurrence of biofouling can cause plugging and lead to decreased hydrocarbon flow. Modeling studies have shown that uncontrolled growth of microbes and resulting plugging due to biofilm can reduce oil and gas production rates.

Also, hydrocarbon souring can negatively impact the cost per barrel of oil equivalent. It is far more cost-effec-

tive to implement an integrated bacterial control solution during well completion than it is to apply a remedial treatment for detrimental sulfides during production. Souring can also pose a potential safety hazard to workers from exposure to H<sub>2</sub>S, a corrosive, toxic and flammable gas.

Finally, microbially influenced corrosion of topside assets, including holding tanks and pipelines, not only incurs cost for expensive replacement but can potentially lead to devastating loss of hydrocarbons.

Operators in the Permian commonly rely on open-air lined water pits to store water on surface. This water is exposed to high temperatures, providing an ideal breeding ground for bacteria. Layers of biofilm at the bottom of the pits create an anaerobic environment that is conducive to sulfide production before the water has even entered the well. The Permian region also is naturally rich in sulfate, providing bacteria with an essential nutrient for growth. Even if the water source is not standing for long periods of time, it can become rich in bacterial life before it is used for well completion.

## Contamination risks

Faced with a high bioburden in the source water, many operators in the Permian use quick-acting oxidizing biocides such as chlorine dioxide for bacterial control. The promise of sterilization and the immediate results when treating water topside may look impressive, but because oxidizing biocides do not kill all of the bacteria in the water, the remaining bacteria have an opportunity to contaminate the system downhole. They also react with sulfides to produce sulfates, effectively converting bacterial waste back into a preferred food source for detrimental microbes. In some cases, the required dose levels of oxidizing biocides are corrosive to the fracturing and surface equipment.

Although oxidizing biocides can be an effective solution for bacterial control on the surface, by themselves they do not provide integrated efficacy, meaning they do not decontaminate the well or protect the reservoir. Downhole bacterial control solutions require endurance in high-temperature and high-salinity environments over an extended period of time, which oxidizers cannot provide.

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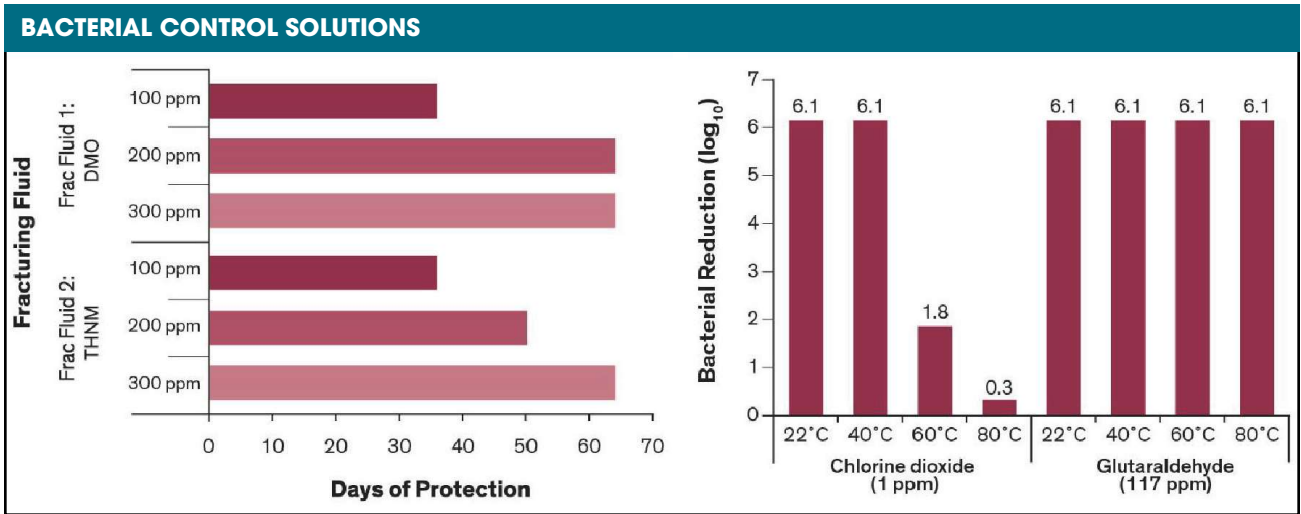
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Chlorine dioxide, widely used in the Permian for its low cost and quick kill, leaves operations susceptible to bacteria. At temperatures common to the Permian, glutaraldehyde retains killing power and can offer long-term reservoir protection in all phases of the hydraulic fracturing process when used in an integrated microbial control program. (Source: Dow Chemical)

Decontamination of the well is especially essential in the Permian due to downhole temperatures of 54 C (130 F) to 71 C (160 F) that offer an excellent breeding ground for bacteria. Chlorine dioxide, for example, is unsuitable for protecting the reservoir in the long term as it loses its ability to control the growth of downhole bacteria within two hours. Nonoxidizing biocides like glutaraldehyde, however, have shown efficacy for up to weeks at typical downhole temperatures. Preservative biocides like dimethylloxazolidine (DMO) and tris (hydroxymethyl) nitromethane (THNM) are the newest technologies available for bacterial control and offer bacterial control in the reservoir. The duration of such extended protection varies with biocide dosage, ranging from a few weeks past flowback phase to about eight to 12 weeks in production phase.

Integrated solutions provide the quick kill to prepare the water as well as the downhole heat tolerance and extended lifespan needed to decontaminate the well and protect the reservoir. As an example, glutaraldehyde or glutaraldehyde/quaternary amine (quat) blends combined with a preservative chemistry like DMO or THNM can prepare the water, decontaminate the well and protect the reservoir, offering both a quick kill on the surface and downhole protection for months.

As the graph shows, chlorine dioxide suffers steep declines in its ability to control the growth of microorganisms at downhole temperatures common in the Permian. Glutaraldehyde, on the other hand, retains its killing power at temperatures common to the region and protects the reservoir for months when used in combination with long-term bacterial inhibitors like DMO or THNM.

**Combining chemistry, application expertise**

Halliburton is bringing tailored, engineered bacterial control solutions to the Permian to combat the most common issues; extend the health of wells over normal life cycles; and maximize cost efficiency using the expertise, advanced capabilities and broadest portfolio of biocides from Dow Microbial Control.

Halliburton’s application expertise and longstanding relationships allow the company to recommend and implement solutions customized to its clients’ strategic and budgetary needs while helping maximize efficiency and minimize HSE exposure. The company can then integrate the solution into the stimulation treatment for effective application delivery. Field-testing supports the technical recommendations for a delivery of operational and financial benefits from effective microbial control in the Permian.

As stimulation activity is increasing in the Permian and large investments are made, it is important for operators to consider the impact that their biocide program has on the health and profitability of a well. With an integrated approach to bacterial control that prepares the water pre-treatment, decontaminates the well and protects the reservoir, oil and gas operators can avoid the pitfalls of unchecked bacterial growth and produce high-value hydrocarbons. **ESP**

*References available.*

**Have a story idea for Shale Solutions?** This feature highlights technologies and techniques that are helping shale players overcome their operating challenges. Submit your story ideas to Group Managing Editor Jo Ann Davy at [jdavy@hartenergy.com](mailto:jdavy@hartenergy.com).

SPONSORED CONTENT

# Boost Performance, Safety in Water Applications

## Advanced Oxidation Chemistries Improve Fracs and Produced Water Handling

The combination of hydrogen peroxide and peracetic acid or PAA has found innovative applications that surpass traditional oxidation technologies in oil & gas water treatment processes. The benefits of using PAA can enhance safety and performance while providing cost savings to pressure-pumpers, water providers and producers.

Working in partnership with oil and natural gas producers and service companies, PeroxyChem has developed performance improvements over existing chemistries (such as chlorine dioxide, 'stabilized' chlorine dioxide and ozone) for common biocide and viscosity breaker applications spanning a range from separation tanks to fracturing operations.

Peroxide–PAA is delivered in liquid form, ready for controlled meter dosing, without requiring on-site generation. It delivers results expected from oxidation chemistry for stimulation and water treatment at well sites while supporting increased efficiency, productivity, sustainability and environmental responsibility.

Peracetic acid specifically is a fast-acting, broad spectrum biocide. It can eliminate common bacteria such as: SRBs, APBs and Sessile bacterial forms and is commonly deployed for SWD (salt-water disposal) water treatment, pond and pit pretreatment and on-the-fly slickwater fracs.

### Eliminating Sources of H<sub>2</sub>S

Oxidation of reduced sulfide irreversibly eliminates the source of H<sub>2</sub>S generation. Traditional scavengers (such as triazine and acrolein) only 'bind' the source. The superior chemistry of PAA destroys it permanently via oxidation.

Better still, decomposition byproducts of PAA reactions are environmentally benign: oxygen, water and vinegar. Safety is assured with a stabilized chemistry and clean-up is simply resolved by dilution with water.

### Reducing Hydrocarbon Padlayers in SWD Tanks

Low-dose PAA additions immediately break up hydrocarbon emulsions. This allows operators to skim and recover oil with better efficiency, improving oil carry-over with up to 90% reduction in tubing head pressure.



Figure 1. Before and after reaction of high-sulfide concentration produced water treated with peracetic acid.

There is a corresponding increase in disposal volumes. Iron and solids are oxidized and separated while biofouling is eliminated – with immediate disposal improvements.

### Prevent Bacteria and Biofouling in On-the-Fly Fracs

PeroxyChem's VigorOx® PAA is a registered biocide formulated for fast-acting destruction of all bacteria in on-the-fly fracs. It delivers >180 months of excellent flowback results.

Its compatibility with anionic/ionic friction-reducers and corrosion inhibitors makes PAA a superior biocide for fresh-water fracs – and the most cost-effective biocide for produced water blends. Typical applications use Hydrogen Peroxide pre-treatment to reduce iron and H<sub>2</sub>S which improves the efficiency of the biocide and lowers the dose requirement of Friction Reducer up to 30%

### Complete operational support

New, innovative technology often requires specialized equipment and trained field service personnel to pump and meter oxidizer chemicals in remote oilfield locations. From mobile ISO containers to totes, PeroxyChem has the product, package and service required for any project. **ESP**





# Enhancing Ekofisk's water stream

Treatment system improves quality of produced water.

**Eilidh Duncan, Greg Hallahan and  
Jacek Kacperski, ProSep**

In 2007 ProSep provided the Ekofisk 2/4 J platform with a CTour produced water treatment package. CTour is proprietary technology that uses existing gas condensate combined with ProSep's high-efficiency mixers to enhance oil and water separation. The implementation of the CTour began in 2004 with a FEED study followed by pilot tests during 2004 and 2005. The results of the pilot test showed significant reductions of oil in water and polycyclic aromatic hydrocarbons (PAH).

These results led to the installation of a full-scale system in 2007 that is still in operation.

Evaluating operational data from the period after installation in 2007 until 2014, it can be seen that CTour technology reduced the oil-in-water concentration down to about 9 ppm in 2014, which is a 60% reduction from installation in fourth-quarter 2007. In CTour's first year of operation a 29% reduction of oil in water and a 39% reduction in PAH was observed compared to conventional treatment alone.

Discovered in 1969 by Phillips Petroleum Co., Ekofisk remains one of the most important oil fields in the North Sea. It was the first discovery of oil in Norway after the drilling of more than 200 exploration wells in the North Sea, when Phillips started producing directly to tankers from four subsea wells.

Oil production is planned to continue until at least 2050.

The Ekofisk Complex comprises installations connected with bridges on the central Ekofisk Field. The complex is a center for the Ekofisk Field itself as well as other fields in the Greater Ekofisk area.

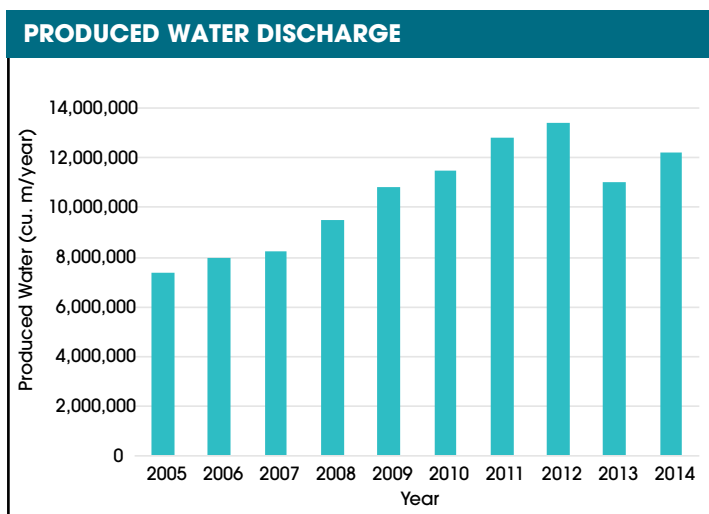
## CTour process

The CTour process removes dispersed oil and dissolved aromatic components from large volumes of produced water. Condensate (typically from the compressor knock-out drums) is injected and mixed into the produced water to extract dispersed and dissolved hydrocarbons. The condensate is then separated from the produced water using conventional separation technology such

as hydrocyclones, induced gas flotations or compact flotation units. Typically, the reject from these units is routed back upstream to the first-stage or second-stage separator, or it can be directed to the crude line from the separators.

The CTour process enhances conventional oil/water separation equipment by the addition of the condensate. Following the absorption of condensate, the oil density decreases, leading to a larger density difference between oil/condensate and produced water, and the oil droplets grow larger. With the addition of the CTour process the same conventional oil/water separation equipment will see increased efficiency because of these characteristics.

On Ekofisk 2/4 J CTour is used to clean produced water from the Ekofisk Field. The facility treats about 150 Mbbbl/d of water before discharging it to sea. From fourth-quarter 2007 until 2014 all produced water in the Ekofisk Field was discharged after treatment via CTour. Since 2014 only produced water from Ekofisk 2/4 J, Ekofisk 2/4 X and Ekofisk C wells is processed for discharge on Ekofisk 2/4 J, accounting for about 65% of all produced water from the Ekofisk Complex. CTour also has been used on Eldfisk since 2015 as well as on Aker BP's Valhall since 2013.



**FIGURE 1.** This chart displays the produced water discharged to the sea from the Ekofisk Complex from 2005 to 2014. (Source: ProSep)

### Process description and conditions

Ekofisk 2/4 J processes production in a high-pressure (HP) and a low-pressure (LP) separator. There is also a test separator for testing of Ekofisk 2/4 X and Ekofisk 2/4 C wells. The produced water from the HP and LP separator enters primary produced water treatment (de-oiling hydrocyclones) for preliminary treatment. The underflow of the hydrocyclone with oil-in-water of 70 mg/l at 950 cu. m/hr (34,000 cf/hr) is mixed with 0.3% condensate, where the high-efficiency mixer allows the oil droplets to become larger and less dense. This change in oil droplets is the main principle in the CTour process for increasing performance in the de-oiling hydrocyclone. This new mixed water stream is routed to the CTour hydrocyclones for treatment. The underflow then enters the degasser before being discharged to sea. The reject flow from the CTour hydrocyclones is collected into a CTour condensate separator and treated by a smaller CTour system.

### Operational data

Figure 1 displays the volume of produced water in cubic meters per year that the Ekofisk Field discharged to sea from 2005 to 2014. From 2008 all produced water was treated via CTour for discharge, with flow rates as high as about 210 Mbbbl/d of water. From 2014 65% of the total produced water was discharged via CTour on Ekofisk 2/4 J, which was about 150 Mbbbl/d of water.

In the Norwegian sector of the North Sea operators and the OSPAR Commission legislation must comply with specific Norwegian legislation calling for zero environmental impact from overboard discharges. The Environmental Impact Factor (EIF) is used as a tool to quantify the harmful effect of discharge to the environment.

The EIF was developed as a management tool on internationally agreed procedures for hazard and risk management. The tool models the dispersion of produced water and calculates the predicted environmental concentration vs. predicted no-effect concentration ratio, accounting for the volume and composition of oil, aromatic components and production chemicals of the produced water.

Figure 2 highlights the improved performance of the produced water treatment on Ekofisk 2/4 J since the installation of CTour in fourth-quarter 2007. CTour reduced the oil-in-water discharge by 29% in 2008, and a 55% reduction was observed in 2014 compared to 2007. During this time, the produced water volume also increased by as much as 3.9 MMcm (137.7 MMcf) from 2008 to 2012. However, it has been reported that the increase in 2010 was a result of operational problems.

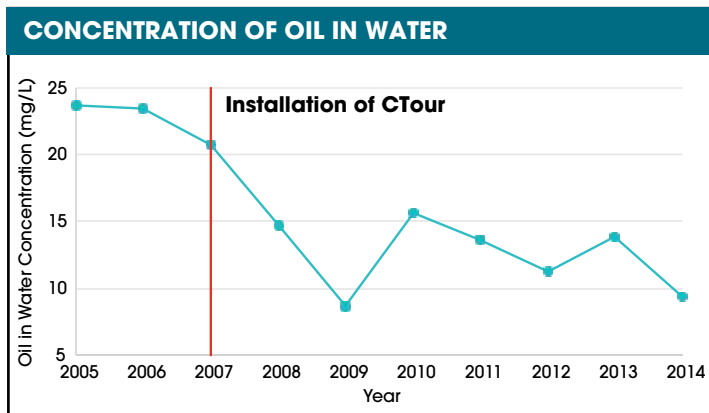


FIGURE 2. Concentration of oil in water for produced water discharged to the sea from Ekofisk 2/4 J is shown. CTour was installed fourth-quarter 2007. (Source: ProSep)

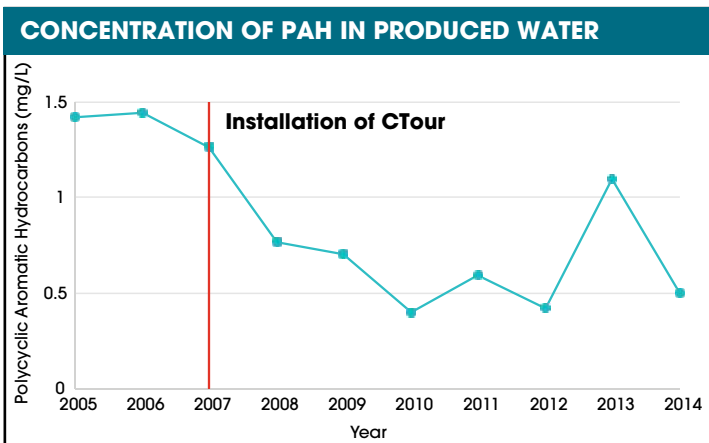


FIGURE 3. Concentration of PAH in produced water discharged to the sea from Ekofisk 2/4 J is shown. (Source: ProSep)

Figure 3 presents the concentration of PAH in the produced water discharged to the sea from 2005 to 2014. During the first year the CTour system was in operation, a reduction of 39% was observed for PAH. By 2014 the PAH concentration had dropped by more than 60% compared to 2007, the last year of operation without the CTour process.

It can be concluded that CTour contributed to about a 60% reduction of EIF value in 2014 compared to 2007. **ESP**

References available.

**Have a story idea for Offshore Solutions?** This feature highlights technologies and techniques that are helping offshore players overcome their operating challenges. Submit your story ideas to Group Managing Editor Jo Ann Davy at [jdavy@hartenergy.com](mailto:jdavy@hartenergy.com).

# Getting a boost

A workflow was designed for selecting the optimal type of artificial lift for reactivating abandoned wells.

**Katherine Escobar Patron, Paola Martinez Villarreal and Jorge Luis Villalobos Leon, Schlumberger**

Challenging oilfield economics are incentivizing producers to increase asset values by extending production in mature reservoirs, even reopening abandoned wells rather than launching new drilling campaigns. Artificial lift has a key role to play in this growing trend. The tried-and-true methods, including electric submersible pumps (ESPs) and rod pumps, continue to prove themselves as worthy workhorses in bringing old wells back to life.

Emerging with the growing trend is a strategy for selecting the most appropriate artificial lift method to reinvigorate a particular field or well. Rather than relying on guesswork, familiarity with a certain type of artificial lift or bias toward one method or another, reservoir and production engineers are recognizing the benefits of using quantifiable field data to measure a field's economic and technical potential and develop a streamlined workflow for selecting a customized lift approach for the entire life cycle of the well.

Engineering an artificial lift strategy that balances economic factors with specific well application consid-

erations can be a game changer for exploiting complex reservoirs where recoverable reserves remain by extending equipment runlife, reducing the cost per barrel of oil and boosting incremental production. A workflow designed to maximize artificial lift reliability and performance was implemented in a mature field in South America, for instance, as the centerpiece of a strategy for the reactivation of 10 abandoned wells.

Designed to simplify the process of selecting the artificial lift method that best suits operator objectives, the Schlumberger LiftSelect strategic production planning service uses available field and reservoir data to model well behavior. The service combines the vast amount of data from conventional manual workflows to streamline the decision-making process for selecting the optimum artificial lift method for a specific well.

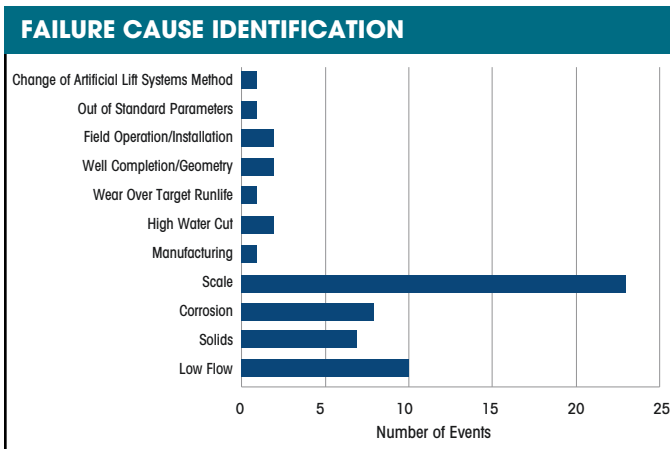
An initial screening of the field narrows the options using software that evaluates the seven major types of artificial lift against well criteria. Those include well depth and deviation, downhole temperatures and pressures, produced fluids and solids, availability of power, and surface facilities and flow assurance issues such as paraffins and solids production.

The service also has the capability to calculate results as production rates, cumulative volumes, capex, opex, net present value and pump properties. Single artificial lift evaluation simulates well performance using one method for a given period and compares methods. Scheduled lift analysis helps optimize a schedule for transitioning between lift methods. Full lift optimization determines the most appropriate lift method for each phase of well life, including natural flow if applicable.

## Reactivating 10 abandoned wells

Considerations for reopening abandoned wells include deep installations, low production rates and problems related to flow assurance, which often result in premature artificial lift equipment failures and repeated interventions that impact the field's ability to produce from an economic standpoint. To develop a strategy for extending production in these wells, it is essential to understand the issues that led to the abandonment in the first place.

Discovered in 1970, a challenging mature field in South America provided a sample group of 10 abandoned wells



**FIGURE 1.** This chart shows the failure distribution for the sample wells. Post-failure analysis identified failure cause for 58 events for the sample wells. As scale failures were seen in the same well, this was a well-specific problem rather than a field trend. (Source: Schlumberger)

with varying production characteristics and well profiles to introduce the workflow for artificial lift selection. None of the wells had the ability to flow naturally, yet if reactivated, the wells' combined production potential could deliver at least 1,000 bbl/d to the overall field production.

Nine of the wells were drilled in the last decade, and one well was drilled in 1981. Because of the field infrastructure and design, all of the wells were initially completed with conventional ESPs for artificial lift, a method that offers wide flexibility and operating range over the life of the well.

However, changing reservoir conditions, rapid production declines in the first months after the wells were brought online, scale buildup around the equipment and design input uncertainties related to reservoir properties resulted in multiple pump failures traced to 58 events, according to a post-failure analysis (Figure 1). Most of the wells averaged two interventions per year to address low flow rates, solids, corrosion and scale. The reservoir also showed a lower productivity index than was initially anticipated, meaning the artificial lift equipment was oversized for the application. As a consequence of these factors, the wells were temporarily abandoned.

After attempting different ESP configurations with various vendors, the operator decided to take a holistic approach to reactivating the wells using an engineered workflow that factors in the conditions and characteristics of the field and the wells to evaluate the applicability and likely success for the seven types of artificial lift: ESP, sucker rod pumps, gas lift, progressive cavity pumps (PCPs), rodless PCPs, plunger lift and hydraulic jet pumps.

The sample wells were designed with deviated "S" and "L" shapes and vertical geometries, and each well was analyzed using the workflow to determine the optimal artificial lift strategies. Based on the depth and deviation of these wells, with pump setting depths between 2,896 m and 3,048 m (9,500 ft and 10,000 ft), the workflow narrowed the artificial lift choices to ESP and rod pumps. Plunger lift-assisted gas lift was eliminated due to the lack of a gas source, and capital investment necessary to build a gas-lift infrastructure. PCPs are not recommended for applications deeper than 2,000 m (6,500 ft).

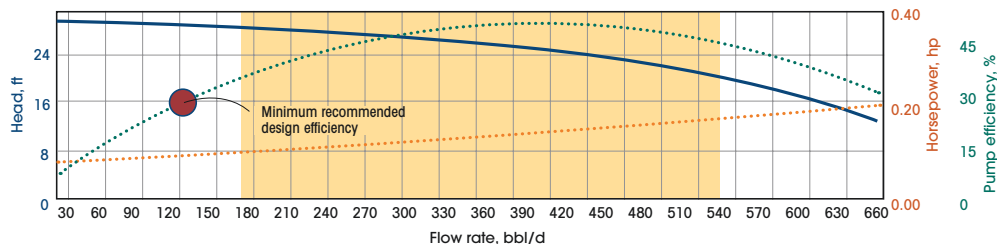
### Designed for performance

The workflow also identified equipment performance risk factors. With the methods narrowed down, the engi-

neers then focused on specific design details to reduce the risks, conducting in-depth comparisons between the two approaches. Final equipment designs would need to accommodate both long- and short-term conditions for maximizing efficiency and equipment runlife. LiftSelect created a variety of production scenarios by setting sensitivities on variables, including flow rates, gas-liquid ratio and amount of produced solids.

ESPs were selected as the best artificial lift option for four of the wells. However, based on the root cause analysis of the previous ESP failures, including radial bearing abrasion, erosion wear and low pump efficiency due to low production and mechanical wear because of operating at downthrust conditions, the engineers designed a more robust ESP tailored to overcome those challenges. The new design includes abrasion-resistant materials to increase shaft stability and toughness, compression construction to minimize mechanical wear downthrust, an optional motor with a shroud to enhance fluid velocity in low-flow conditions and a gas-handling device for nonanticipated or pump-off conditions. The designs also were engineered to achieve operating efficiencies as low as 25% to provide a wider flow rate range (Figure 2).

For the remaining six wells reduced-footprint hydraulic rod pumps, compared to conventional rod pumps, were considered the best option. Because the field had originally been designed for ESPs, only 3 m (10 ft) exists between the wells, leaving no room for a large conventional pumping unit. For these wells the equipment can reach a minimum pumping speed of 1.5 strokes per minute to enable effective pumping when production rates decline. Corrosion-resistant materials were selected to extend pump runlife, and a high-strength rod was designed to ensure performance with high rod loads in the deep wells. **ESP**



**FIGURE 2.** The most commonly recommended design or used design efficiency in ESPs is shown with operating range from 200 bbl/d to 650 bbl/d. (Source: Schlumberger)

**Have a story idea for Operator Solutions?** This feature highlights technologies and techniques that are helping upstream operators overcome their challenges. Submit your story ideas to Group Managing Editor Jo Ann Davy at [jdavy@hartenergy.com](mailto:jdavy@hartenergy.com).

# Rethinking traditional decision-making

Software enables data-driven decisions to improve certainty and efficiency.

**Brian Walzel**, Associate Editor, Production Technologies

**A** software system that has been refined over 30 years of use at Baker Hughes, a GE company (BHGE), is being made available to industry operators and coiled tubing (CT) service providers for the first time. BHGE's CIRCA CT simulation software offers operators data-backed solutions for challenges and projects that call for CT, enabling users to calculate potential outcomes prior to the onset of a job. The software system has been used extensively in a variety of wells and environments such as conventional and unconventional wells, on offshore and onshore projects, in horizontal and lateral wells and on deviated and S-shaped wells.

"CIRCA essentially models all CT jobs in the industry, anything from simple jobs to the more refined and complicated operations," said Rodrigo Micheli, CT product champion for BHGE. "Some examples of those might be concentric coiled tubing or tough cleanouts, while some of the challenges seen in North America might be milling plugs, extended-reach wells or sand cleanouts."

According to BHGE, CIRCA Pro, one of the three applications in the CIRCA suite, has been used to model, plan and execute solids transport on more than 30,000 wells to date. The software also enables CT ser-

vice providers to maximize equipment performance and improve operational efficiency in well interventions.

Micheli said BHGE realized there was a need to make the CIRCA software available to the industry after receiving feedback from operators and CT service providers. BHGE said in a release that other CT simulation software systems "lacked real-world feedback and adequate support, producing inferior models that fail to adequately identify risks, especially in complex environments."

Micheli said, "CIRCA not only offers simple CT modeling tools, but it also comes with advanced and unique calculations as well. More advanced capabilities include modeling solids transport, which predicts the behavior of solids in a well given varying fluid and gas volumes. Another is abrasive perforating and, again, concentric coiled tubing operations."

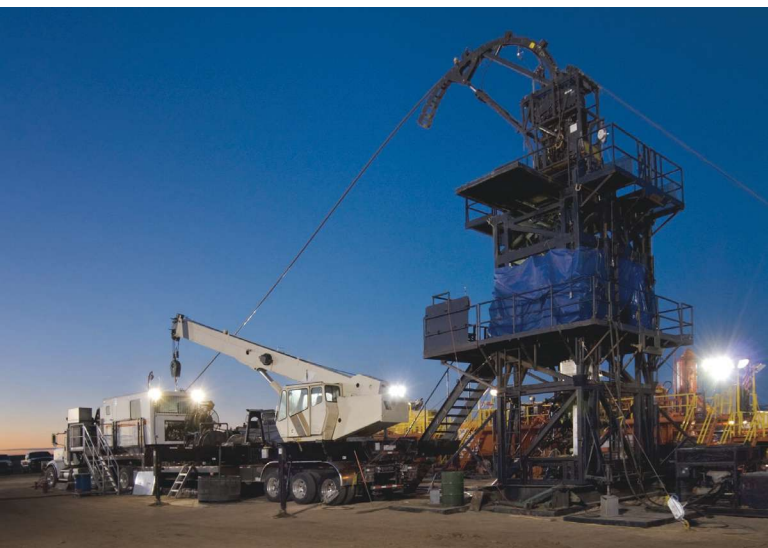
## A new way to find solutions

According to BHGE, the CIRCA system is designed to offer data-based solutions to challenges rather than companies relying on traditional methods such as experience-based decision-making. BHGE said these types of traditional decision-making methods could compromise job performance and even damage downhole equipment, particularly with the industry's more complex wells and in wells with longer laterals and multiple stages.

"An example of that would be for sand cleanouts," Micheli said. "Too often operators and consultants use rules of thumb. They use generalized pump rates, fluid weights and pull-out speeds because that worked the time before in a different well. But CIRCA offers an advanced solids transport model that is based not on rules of thumb but on thousands of tests and actual field evaluations to really understand the dynamics of solids moving in a wellbore as you're pumping fluid down."

Micheli explained that a BHGE CIRCA software client recently operating in South Texas had been using the CIRCA Pro suite modeling solids transport to model a milling and cleanout job. Rather than implementing the recommendations suggested by CIRCA, the company utilized its standard operating procedures and rules of thumb, Micheli said, to clean out the well post-fracture.

"The CT ended up getting stuck for a couple of days," Micheli said. "Once they did a post-job analysis of [the



Baker Hughes' CIRCA software models CT jobs to help maximize equipment performance. (Source: Baker Hughes)

operation], it turned out the original solids transport analysis from CIRCA was right. So essentially they were pumping too low of a pump rate and moving coil out of the hole too fast. They weren't moving solids as fast as they needed to, and they were trying to leave the well too soon."

According to Micheli, had the company utilized the CIRCA recommendations at the onset of the project, it potentially could have avoided the downtime.

According to BHGE, the unplanned downtime tripled the operational time. Once the mill had been freed from the well, the CT provider entered the well parameter data into the CIRCA Pro application.

"The result has been months of subsequent millout jobs with no instances of stuck CT. Further, the operator reduced costs by avoiding nonproductive time and the need for intervention/fishing to retrieve tools stuck downhole," BHGE stated in a press release.



**The CIRCA system offers data-based solutions to challenges rather than companies relying on traditional, experienced-based decision-making. (Source: Baker Hughes)**

## Software features

The CIRCA software suite includes CIRCA Complete, CIRCA Pro and CIRCA Real-Time, which Micheli said could all work in unison with each other or individually. CIRCA Complete provides tubing force analysis and wellbore hydraulics monitoring for common applications like milling, setting and retrieving tools and intervening in extended-reach wells. CIRCA Pro uses complex calculations to accurately model solids transport to surface without compromising downhole equipment in more challenging operations like abrasive perforating, cleanouts and multistage plug milling. CIRCA Real-Time optimizes jobs using live operations data inside the CT control cab, accommodating changing well conditions quickly and efficiently.

"The software delivers valuable insights [about] the subsurface such as downhole conditions, flow rates and safe operating envelopes, enabling operators to calculate outcomes with more certainty to improve planning and execution," BHGE stated in a release.

Micheli said large operators may, for instance, use CIRCA Complete or CIRCA Pro to simulate a CT job or a larger scale plan in advance, whereas CT service providers could leverage the entire CIRCA suite.

"CT service providers can use CIRCA Complete or CIRCA Pro modeling to plan, and then they can use CIRCA Real-Time to make adjustments on the job. CIRCA Real-Time updates the initial models in the CT cabin with live data from the well site," he said.

One of the features of the CIRCA system is its ability to replicate or even predict with a high level of accuracy key factors like surface pressures and downhole conditions.

"We've done a lot of work with CIRCA and conducted several matching exercises in the field, and a lot of times we've noticed that we've matched exactly what the field was applying," Micheli said. "For example, with pump rates and fluids we've ended up basically matching the pressure they were seeing on the surface with a high degree of accuracy." **ESP**

**Have a story idea for Operator Solutions?** This feature highlights technologies and techniques that are helping upstream operators overcome their challenges. Submit your story ideas to Group Managing Editor Jo Ann Davy at [jdavy@hartenergy.com](mailto:jdavy@hartenergy.com).

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# Executive Oil Conference Tracks Proven Stacked Play Production

Permian Economics Provide Effective Counter-Punch to OPEC



The **Executive Oil Conference** affords plenty of time for face-to-face meetings with peers, colleagues and prospects on the exhibit floor and in other venues.

**O**PEC tried to break the back of America's shale revolution, but production from the Permian Basin's multiple stacked plays provided an effective parry. Now the Permian is punching back and putting some OPEC producers on the ropes. The fight will determine who can survive and thrive with lower-for-longer commodity prices.

U.S. producers remain focused on operating efficiency to produce real earnings. Service and technology suppliers working hand-in-glove with operators' technical teams have cut finding and development costs to nearly match "Middle East economics." The resulting supply-side elasticity is redefining E&P market fundamentals worldwide.

Anyone whose business depends on oilfield activity can benefit from joining hundreds of Permian Basin producers, investors, technology providers, analysts and other professionals for Hart Energy's annual **Executive Oil Conference (EOC)** and exhibition, Nov. 6-7 at the Horseshoe Arena and Pavilion in Midland, Texas.

## Robust deal-making environment

Interlocking and overlapping resources across the Delaware and Midland basins provide the world's most active drilling environment. This is the foremost proving ground for unconventional drilling and completion technology – and the pride of the U.S. oilfield today.

Industry pundits predict a "bidding war" for prime Permian Basin assets as integrated producers compete in this resource-rich region. The trigger for that "war" could come as major players position themselves for BHP's announced divestiture of U.S. shale assets, including a 123,000-acre holding in the heart of the Delaware Basin.

Acreage prices have reached levels that make many companies wince, driving some to look to other regions, yet the economic efficiencies of proven Permian operations are difficult to match elsewhere. Sometimes money doesn't even change hands. As Darren Barbee reported in *OilandGasInvestor.com*, Parsley Energy started September by adding 5,600 premium net acres worth as much as \$200 million— and did it all through trades. "The company is not alone in doing smaller, tidying deals," he wrote. "Other companies have launched efforts to make small-scale transactions in the Permian."

## Exceptional value in a few hours' time

Whether the deals are big or small, all types of buyers, sellers and traders alike will be in the crowd when the 2017 **Executive Oil Conference** kicks off in Midland. This conference recorded solid growth in attendance for the last four years and, although many travel to attend, this event historically attracts strong registration from Midland-area oil and gas professionals.

Full-conference attendees hear candid executive-level speakers in the session room and enjoy complete access to the exhibition floor. Registrants and exhibitors alike

## Conference and expo foster connections



Gathering intelligence from field operations and networking with peers are principal reasons to attend the **Executive Oil Conference**, yet the full-day program on Day 2 offers a value-packed agenda.

- Hear directly from **active Permian producers** – and find out how they view market conditions;
- See where **top industry analysts forecast** commodity prices to be in 2018 and beyond;
- Get **firsthand interactions** with top technology companies on the exhibit floor; and
- **Network with hundreds of peers** during networking breaks.



The **Executive Oil Conference** focuses on Permian Basin activities within a global context, bringing seasoned industry professionals together for knowledge sharing and networking.

can take advantage of unique networking opportunities that only the EOC audience offers.

### **Water Forum addresses operators' challenges**

This year's pre-conference schedule also offers a Water Forum for technical professionals. Sponsored by Peroxy-Chem as well as NuWATER Resources, Oilfield Water Logistics and PC Drilling & Service, the half-day program tackles Permian Basin water supplies, the rise of water-centric midstream services, the value of produced water and an analysis of recycling v. disposal options.

### **A traditional start – with golf**

Hart Energy acquired EOC from Midland-based Petroleum Strategies, Inc. (PSI) in 2012 and, keeping a tradition that began with PSI, Day 1 of the conference offers a golf tournament with a welcome reception afterward.

Hart Energy has its own tradition of using golf events to benefit U.S. military veterans. This year the EOC tournament benefits the Folds of Honor Foundation, which provides academic scholarships to families of fallen and disabled service members.

### **Energy Executive Dinner**

Day 1 concludes with a dinner at the Midland Country Club celebrating standout players in the nation's top oil province. Conference registrants and energy professionals join **Executive Oil Conference** speakers, prominent Midland-area executives, and past Hearst Energy Award winners for this event.



Over 1,000 oil and gas executives, engineers and technicians will roam the exhibit floor at the opening reception, before sessions begin, during scheduled breaks and lunch, and throughout the event.

Since 1996, the *Midland Reporter-Telegram* has presented its Hearst Awards for exemplary work in the Permian Basin, recognizing company performance, government service or industry advocacy, environmental excellence, and technology. An especially memorable part of the evening will come as Hart Energy honors legendary Permian Basin oilman Ted Collins, Chairman and CEO of Patriot Resources Partners LLC, with its own Lifetime Achievement Award.

This event brings the entire region together. Qualified producer personnel can access the exhibition floor at no cost. Everyone walks away with new insights and valuable business connections. Solid operating results ensure interest in Hart Energy's Executive Oil Conference and exhibition remains high. **ESP**

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*The Executive Oil Conference takes place Nov. 6-7, 2017, at the Horseshoe Arena and Pavilion in Midland, Texas. To register to attend or learn more about exhibiting and sponsorship opportunities, please visit [ExecutiveOilConference.com](http://ExecutiveOilConference.com).*



# Recent advances in gravity gradiometry technology

A new system offers increased accuracy and higher spatial resolution.

**Christian Richards, Austin Bridgeporth**

**G**ravity gradiometry is a well-established geophysical technique that is often used in the search for hydrocarbons. The technology measures small differences in the Earth's gravity field associated with changes in subsurface geology.

Lockheed Martin is the only company to provide commercial moving-base gravity gradiometers and, until recently, broadly offered two types of gravity gradiometer to the exploration industry: the full-tensor gravity gradiometer (FTG) system, which is deployed in both airborne and marine modes, and the partial tensor system, typically deployed in airborne mode only. By their intrinsic design, these systems have a greatly improved resolution when compared to conventional (scalar) gravimeters and thus provide a natural advantage when used in exploration.

In addition, geoscientists can benefit from having multidirectional gravity gradients as they yield extra information on geometrical and density changes in subsurface geology that give rise to gravity anomalies. Historically, these gravity gradiometers have been widely used in a variety of geological settings to rapidly screen basins and assist with the mapping of basin architecture, basement depth, faults and intra-sedimentary structure.

## eFTG

A recent significant advance in technology means that the existing generation of gravity gradiometers has been surpassed by Lockheed Martin's next-generation instrument called the enhanced FTG (eFTG). The eFTG is the world's most advanced moving-base gravity gradiometer, possessing a noise floor about three times lower than the FTG and providing data with higher bandwidth. These improvements mean eFTG data have increased accuracy and higher spatial resolution, therefore widening the range of geological targets that can be mapped with gravity gradiometry.

Given that the eFTG incorporates similar design principles from pre-existing FTG and partial-tensor gravity gradiometers, it is worth summarizing these designs before describing the eFTG.



The eFTG system was designed and built by Lockheed Martin Corp. (Source: Austin Bridgeporth)

## FTG design

The FTG system contains three gravity gradiometry instruments (GGIs), each consisting of two opposing pairs of accelerometers arranged on a spinning disc with measurement directions tangential to the disc. The opposing accelerometers are separated by a prescribed distance, which is known as the measurement baseline. The GGIs are orientated orthogonally so that all components of the gravity gradient tensor are measured, allowing the system to fully describe the gradient field at every point in the survey. Although there are only five independent tensor components, the arrangement of the 12 accelerometers in the FTG system provides six independent and orthogonal measurements of the gravity gradient tensor.

## Partial tensor design

With a single horizontally mounted disc containing eight accelerometers, the partial tensor system measures only the two horizontal curvature components of the gravity gradient tensor. Signal power in the horizontal components is weaker (about half that of the vertical components), so to offset a reduction in the signal-to-

noise ratio (S/N), the disc measurement baseline is about double that of an FTG's GGI.

From measurements of the horizontal components, vertical tensor components are derived by mathematical transformations performed after the survey is completed. The vertical gravity gradient ( $G_{zz}$ ) is considered to be the most useful for interpretation purposes by the geoscientist, primarily since this component is a more intuitive representation of the subsurface geology. Despite the differences in design between the two systems and provided that the line spacing is not too large (relative to the target depth), the resulting derived  $G_{zz}$  component from the partial tensor system can be comparable to that from the FTG.

### Increased bandwidth and S/N

The eFTG system combines the best design elements of both gradiometers, essentially comprising three digital partial tensor discs/GGIs mounted in an FTG configuration. This means the eFTG GGIs have eight accelerometers per disc with a measurement baseline roughly double that of the FTG accelerometer separation. The increase in accelerometer count and larger baseline means the eFTG has a threefold improvement in S/N over the entire bandwidth. With 24 accelerometers the eFTG provides 12 gravity gradient outputs per measurement location (the eFTG essentially measures the full tensor twice and with double the accuracy in each case).

### eFTG benefits

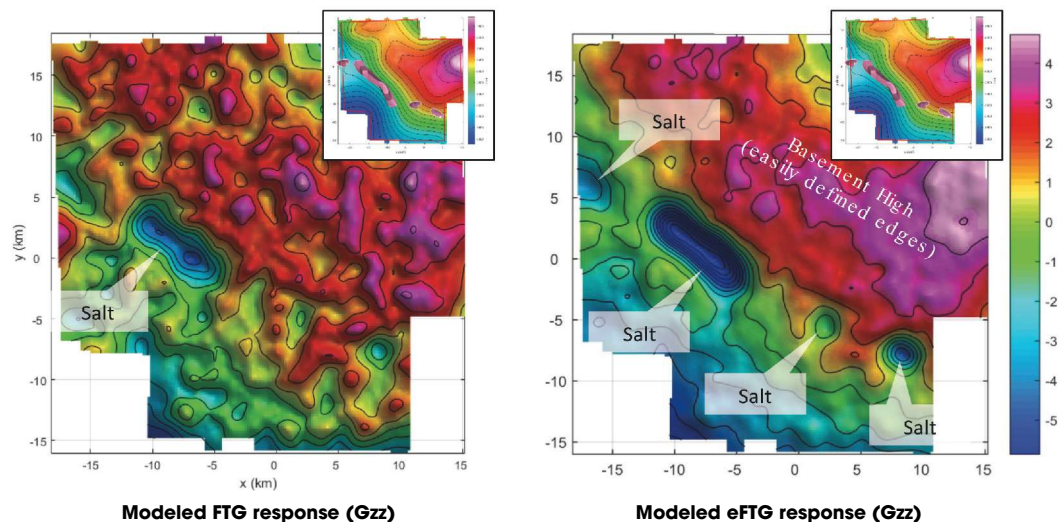
With its increased capability and performance, the eFTG benefits apply throughout the entire geological section, helping to deliver a more accurate Earth model. The greater sensitivity of the instrument allows the detection of smaller geological features with subtler density contrasts and improves the application of mapping structure in deeper basins. Surveys can be done more cost-effectively since the increased S/N means that the line spacing can be increased in some geological scenarios. The higher bandwidth and

increased spatial resolution of data means these data can be more tightly integrated with seismic data than before; applications include joint gravity-seismic inversions and the ability to quality-control and refine seismic velocities. eFTG data also can be used ahead of a seismic survey, providing a highly detailed map on which to precisely locate seismic lines in the optimal locations.

### FTG and eFTG data comparison

To visually demonstrate the differences between the FTG and eFTG instruments, a feasibility study was carried out to test the expected responses to a geological model that would generate both short and long wavelength signals. The following workflow was adopted:

- Construct a 3-D geological model;
- Assign densities to the key lithological units;
- Forward-calculate the model response;
- Add typical instrumentation noise to the model response (this simulates realistic survey conditions); and
- Analyze final filtered grids.



The FTG response shows the position of the large salt structure. The smaller salt bodies are easily confused with many 'false anomalies' brought about by the lower S/N ratio.

The eFTG response shows that all salt bodies are easily mapped. Note that few false anomalies exist due to the higher S/N of the instrument. In addition, the eFTG's greater bandwidth images the large north-northwest-trending basement high (warm colors) with better coherency than the FTG does.

**This figure shows the comparative responses between FTG (left) and eFTG technology (right). (Source: Austin Bridgeporth)**

AustinBridgeporth is offering the eFTG to the exploration industry on an exclusive basis. The system is survey-ready and can be deployed in airborne or on shipborne platforms. The eFTG will allow geoscientists to image subsurface structure and complexity in unprecedented detail, facilitating cost-effective exploration even in a "lower for longer" oil price environment. **ESP**

# Full-spectrum gravity provides new insights

Gravity data pick up dominant basement highs and anticlines in South Sumatra Basin.

David Moore, CGG

**A**irborne gravity gradiometry (AGG) maps minute density variations in the subsurface rocks by measuring the subtle changes in the Earth's gravity field. AGG has been used as a structural mapping, lithology discrimination and lead-generating tool for more than a decade, and few exploration technologies have moved as swiftly up the value chain of an explorer's toolkit, particularly in combination with 2-D seismic. Being able to map the lateral extent of structures out of the plane of 2-D seismic and by giving confidence in the orientation of key structures observed in the seismic, AGG provides a tremendous uplift in the information provided from either dataset in isolation. In essence, AGG provides an extra dimension.

For gravity gradient wavelengths shorter than about 25 km (15.5 miles), CGG's Falcon AGG precision is extremely high and sets the benchmark for airborne gravity measurements. However, as with all AGG acquisition systems, accuracy diminishes as wavelength increases, making it difficult to reconcile gravity derived by AGG systems with conventional ground or marine gravity datasets. Depending on survey size, gravity signal with wavelengths of greater than 25 km typically cannot be accurately recovered with any available airborne gradiometry system. Geological features in this long wavelength band include deep basement structures or large carbonate platforms that are not easily imaged even by long-offset seismic data.

In areas of high-quality publicly available ground gravity coverage, the gradiometry data can be conformed to the regional dataset to provide a high-resolution gravity image.



CGG Multi-Physics partnered with Airfast Indonesia and deployed its new sGrav meter with the Falcon AGG system on a modified Twin Otter aircraft to acquire its Falcon Full Spectrum Gravity survey in Sumatra. (Source: CGG Multi-Physics)

However, in regions where suitable data are not readily available, being able to measure the longer wavelength gravity data from the same aircraft becomes critical.

Global gravity data from external sources such as satellite altimetry-derived gravity provide good information in open ocean, but only at wavelengths greater than 50 km (31 miles), and its accuracy diminishes greatly near the coastline and shelf breaks, where most of the world's offshore exploration occurs. Over land satellite gravity data are inadequate for exploration purposes. Basically, there is too much of a gap in the gravity spectrum between what is recoverable with AGG and what is provided by satellite gravity data.

### Full-spectrum gravity solution

To provide a solution to this, CGG Multi-Physics has developed a new gravity meter, providing the missing link between conventional gravity and gravity gradiometry from a single airborne platform. This strap-down gravity system, known as sGrav, is a small lightweight instrument that sits alongside one of CGG's six Falcon gradiometers, providing highly accurate gravity data at wavelengths greater than 18 km (11 miles). These data are acquired simultaneously with the AGG data under the same dynamic drape flight conditions, resulting in CGG's Falcon Full Spectrum Gravity solution.

AGG and 2-D seismic (onshore or offshore) data complement each other extremely well. The high-resolution lateral information of the AGG is a perfect accompaniment to the vertical resolution of the 2-D seismic, with the combination of the two providing a pseudo-3-D depiction of the subsurface. In fact, the gravity gradiometry data can be modeled using inversion algorithms developed by CGG's Multi-Physics Imaging group that deploy the seismic data as a constraint, allowing dips observed directly from the seismic to be honored.

### South Sumatra Basin

In late 2016 CGG acquired the first commercial Falcon Full Spectrum Gravity survey in Indonesia on the island of Sumatra over two blocks covering some 11,300 sq km (4,636 sq miles) in total. This basin has had no previous systematically acquired ground gravity data that are publicly available, and the provenance, quality and resolution of what is available cannot be accurately determined. It was therefore decided that full-spectrum gravity data should be acquired to ensure the full range of gravity signal was captured.

The South Sumatra Basin is a mature area in terms of hydrocarbon exploration, with many known and producing oil and gas fields. One of the key reservoir

units in this basin is the uplifted areas of Mesozoic and Eocene fractured and weathered basement consisting of granites and quartzites. These uplifted basement blocks host a significant proportion of the discovered hydrocarbons in the basin and also provide a positive density contrast against the surrounding sediments, making them ideal targets for AGG.

The most recent deformation event in the basin was basement-involved compression, resulting in basin inversion and reversal of normal faults in the Pliocene to recent times, forming the basement highs and anticlines that are the major traps in the area. This is the dominant signal observed in the data.

More subtle but still clearly evident in the gravity data is a north-south-oriented trend reflecting the earlier extension during the late Paleocene to early Miocene forming north-trending grabens that were filled with Eocene to early Miocene deposits, providing the rich lacustrine source rocks and hydrocarbon-generating kitchens that make the basin so prolific.

By imaging both the key source grabens and the overlying reservoir/trap locations, the data can be used qualitatively to immediately prioritize and rank exploration targets, improve the interpretability of the legacy 2-D seismic datasets, and significantly reduce the geological risk inherent in any exploration program. Fast-track images can be produced within days of survey completion to allow more informed decisions to be made, and with final data available within weeks of the survey, this potentially allows multiple phases of exploration to be undertaken in one season.

More quantitative information can be derived from full-spectrum gravity data with modeling and inversion, ideally using seismic and well data as constraints. Prospects and leads can be modeled with more confidence than before, allowing better decisions to be made throughout the exploration process, from seismic positioning through integrated interpretation projects and ultimately drilling decisions, all providing tangible cost savings to any exploration project.

This survey has shown the importance of longer wavelength information in gravity gradiometry surveys by better imaging the deep and wide grabens. The survey also has demonstrated the capability to simultaneously measure gradiometry and the longer wavelength gravity information under the dynamic flight conditions of a draped airborne survey. The success of this survey has led CGG to investigate the possibility of further Falcon surveys over the wider South Sumatra Basin, possibly paving the way for a renewed phase of exploration in underexplored areas of this highly productive basin. **ESP**

# Rig automation maximizes value for contractors and operators

A process automation platform manages repetitive tasks on the rig floor.

**Benjamin Facker, Vinesh Rambally and  
Ryan Hanford, NOV**

**D**rilling a well is a complex mix of overwhelming data and tasks in need of constant attention. To address the challenge of repetitive complexities of machine and process control, the NOVOS process automation platform was launched by NOV after an extensive development period.

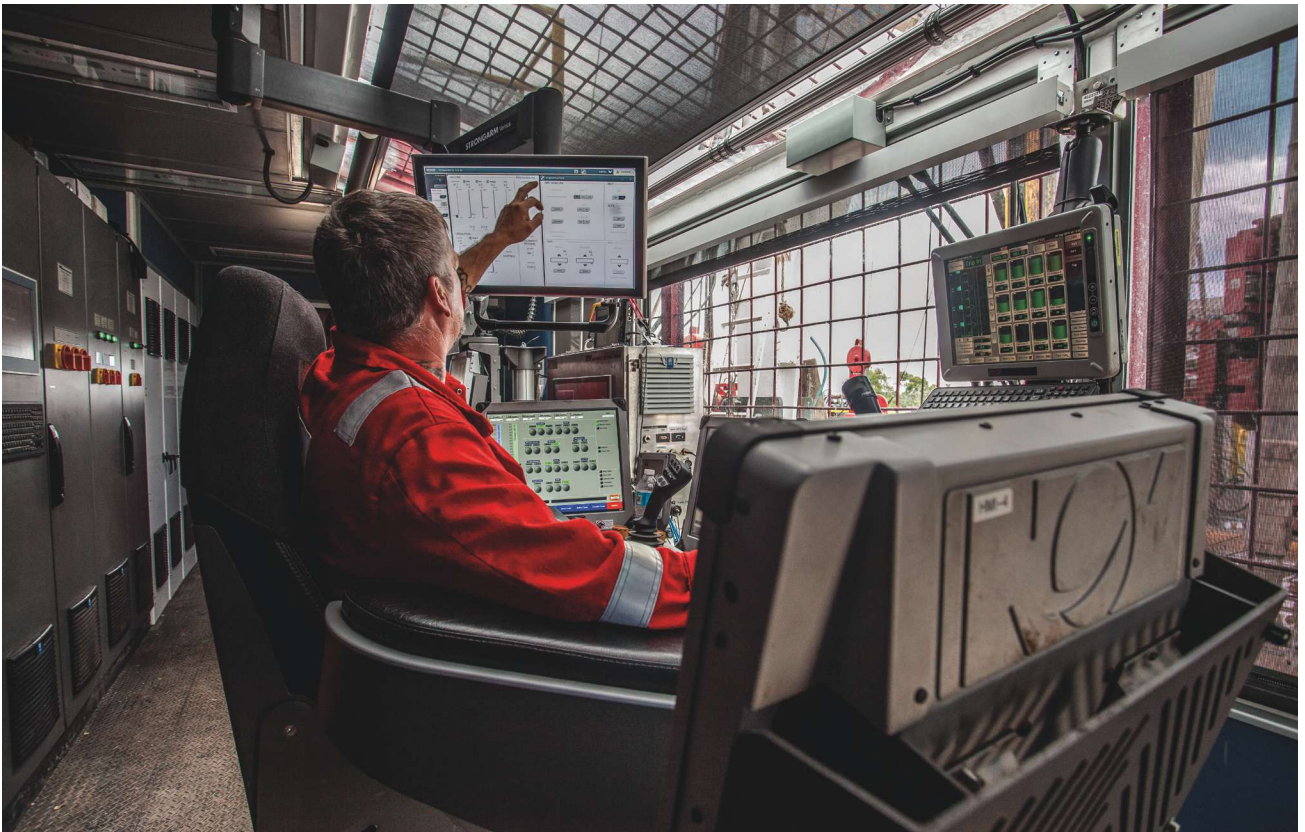
The system provides a common platform for the control, monitoring, scheduling and optimization of drilling operations. This enables drillers to focus on what is important while they consistently execute repetitive drilling activities to achieve the well program by integrating the best of human and equipment capabilities.

## Compatibility

The structuring of data and defining activities through process automation enables engineers to develop lessons learned and apply best practices across regions and rig fleets, regardless of rig specifications or location. The system is scalable, not custom-built, so it does not require extensive R&D for it to work with each new deployment.

NOVOS is simply dropped on top of the existing NOV control system, creating a quick and rapid deployment. The scalable installation enables the system to be easily placed on rig fleets, which increases overall consistency, enhances the performance of the entire fleet and gives the end user the ability to plan ahead.

The system is equipped with applications that immediately allow the rig to drill faster, safer and more



When activated, the NOVOS platform performs planned operations until total depth is reached. (Source: NOV)

effectively. It also has the capability to incorporate customized applications for specific drilling requirements.

A software development kit allows developers to create and deploy their own optimization applications that use sensor data to control rig machines. Third parties are provided with safe access to a wide variety of functions within the system and encouraged to develop applications that address their unique challenges. Those applications can then be layered, prioritized and partitioned to provide simple flexibility of control and monitoring in ways that were previously unachievable.

There are five major operators and service companies working to develop applications compatible with the platform, with development pending with nine more companies.

### The platform today

Years of development were spent to ensure NOVOS was built with a foundation of stability, flexibility and ease of scalability to be valuable in bringing practical automation to the drilling process.

In the years since its launch the platform has successfully been installed and commissioned on 19 land rigs. There are five additional installs scheduled but pending rig availability. The system is installed on rigs in Oklahoma, Pennsylvania, Texas and Canada. Precision Drilling currently has the system installed on 18 land rigs. In second-quarter 2017 a system was purchased by Beaver Drilling for installation on its Rig 15.

The NOVOS team is actively training drillers on rig location depending on rig and resource availability. During the training process drillers are easily picking up the system and becoming even more proficient over time.

### Value in the numbers

NOVOS was recently deployed during a rig move for Precision Drilling. The early results showed the company's drillers achieved consistent

bottom-to-bottom time savings—a 10% improvement bottom-to-slips, 18% faster add-stand and a 67% improvement slips-to-bottom—yielding overall time savings of 41% per connection.

To evaluate connection time improvements, NOV compared the five best consecutive bottom-to-bottom

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**Precision Drilling saw a savings in overall connection-to-connection time and delivered a consistent drilling process with its use of NOVOS. (Source: NOV)**

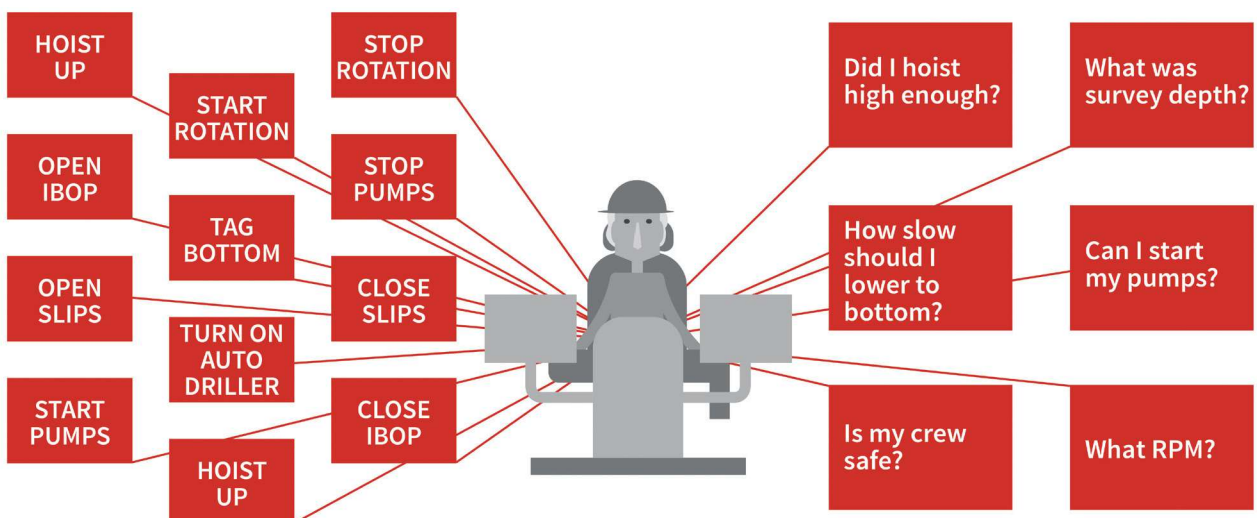
cycles for conventional drilling against five consecutive cycles of NOVOS-enabled drilling. There was a reduction in average bottom-to-bottom time from 7.91 minutes to 4.67 minutes using NOVOS, demonstrating a significant improvement in Precision's performance. The increased consistency created by automating repetitive tasks resulted in an increased awareness of safety and successful delivery of the overall drilling operation.

Assuming six wells per pad and 20 total days of drilling time per well, connection time savings translated to nine hours saved per well and 2.25 days saved per pad on average, enabling the drilling contractor to better plan service delivery, allocate resources and move quickly to the next pad. The total savings added up over time yielded higher profits and rates of return on the customer's initial investment.

### Next steps

As NOVOS begins to make its way on to several rigs, the surface is just being scratched on how the automation can be used. There are many repetitive functions that are still performed manually that can be brought into the control system. Right now, consistent and repetitive tasks are automated on the drill floor, but there are other areas on the rig where repetitive tasks could be automated.

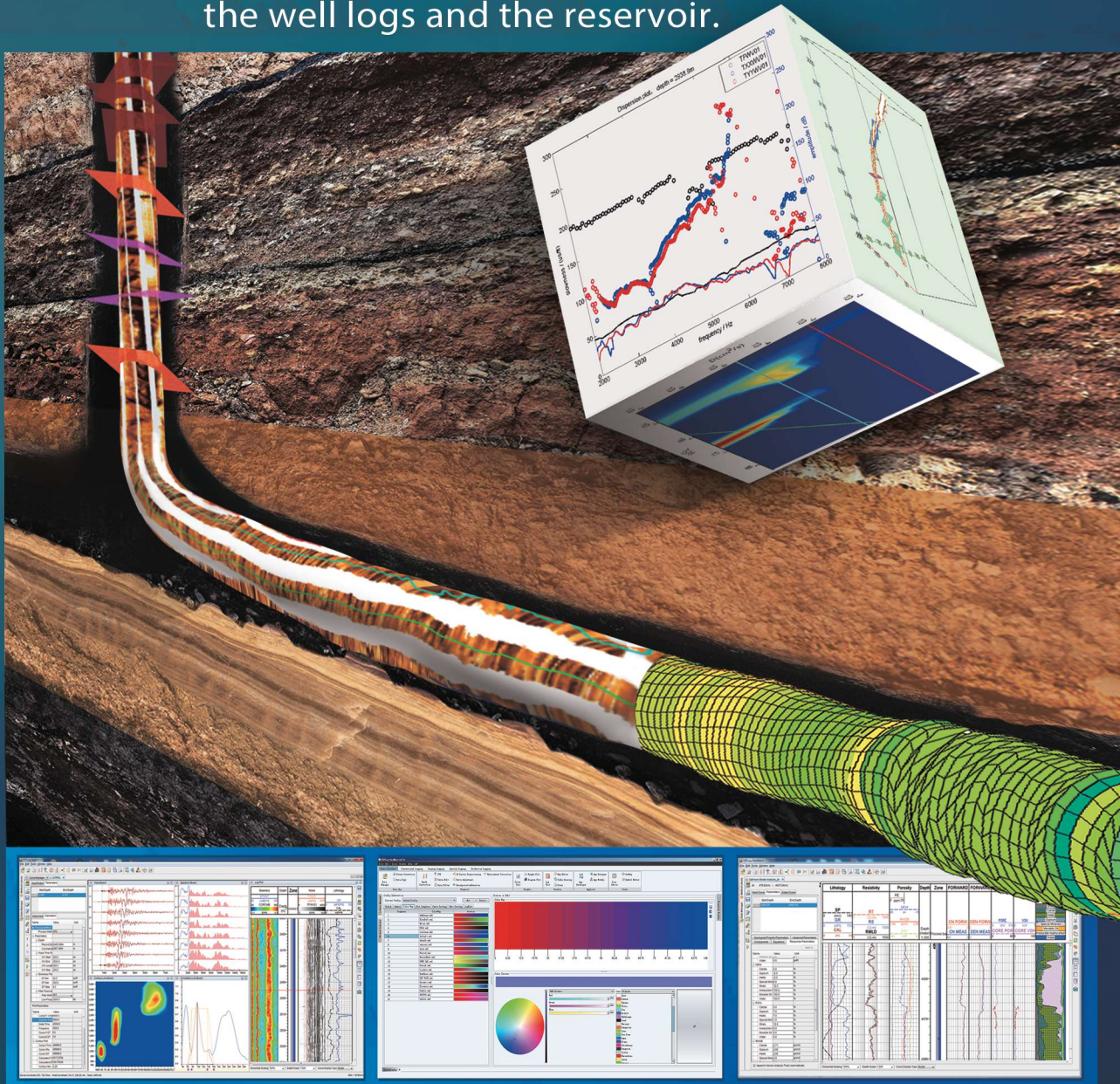
Features added since the release of NOVOS include, but are not limited to, reaming, rocking, torque and drag, and a downlinking interface. The ease of updates and enhancements further shows the flexibility of the NOVOS platform. As for next steps, an improved user interface based on driller feedback also is being developed. The additional features and new user interface are scheduled to be released in third-quarter 2017, and work toward finalizing offshore capabilities for gel breaking and envelope protection are underway. **ESP**



**The NOVOS process automation platform manages rig equipment to execute drilling programs, allowing the driller to focus on safety and process execution. (Source: NOV)**

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- ④ Rich preprocessing functions



# Delivering drilling efficiencies

New approach makes humans, not machines, smarter.

**Amit Mehta, Mobilize**

**M**achine automation has been an industry focus for more than 100 years, leading to many innovations in hardware-centric drilling optimization as companies focus on making downhole tools smarter and better. As data become more valuable than oil itself, tendencies have been to dissect and learn from data to continue optimizing drilling.

This approach, while having its merits, has not gained the engineering community's trust and is not scalable to all basins or all business units. Why? Only a few optimization experts from the central team drive it with a very heavy engineering focus. Every basin is different, so success in one area doesn't guarantee the same success in all. And complex variables are involved, like the heterogeneity of reservoirs and formations as well as the inconsistency of standardization of downhole tools.

Take as an example the ability to predict stuck pipe. Its prediction has been touted for 40-plus years, with every vendor or operator having some version of it. Yet can anyone claim that they can predict stuck pipe with 100% accuracy?

## The key is consumerization

Houston-based Mobilize took a different approach to delivering drilling efficiencies by applying analytics to enable consumerization of the oil and gas enterprise and fully unlock human intelligence. Consumerization happened in three waves. In the first wave consumers (engineers) said, "I'll work with whatever system you give me." In the second wave they said, "I'll bring a better system; just support it." In the third wave they're saying, "I expect a system that enables a better way of working. Deliver it."

So the baseline expectation has shifted, led by an increasing number of experiences in engineers' personal lives becoming easier and better. Frequently, mobile apps are becoming the most important client as users look for the convenience of "any time, any place" access, and apps take advantage of the many converged features on a smartphone (e.g., geolocation, multimodal communications, camera, applications, etc.).

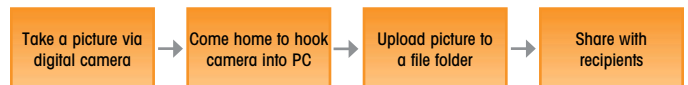
## Growth platform: the natural evolution

This approach guided the development of the ProMPT growth platform that focuses on improving the daily lives of oil and gas engineers. To guarantee success, a growth platform must:

- Eventually support a diverse set of participants and offer opportunities for creating value in many distinct areas;
- Scale up by accommodating a large user base without eventually adding unacceptable cost/issues;
- Generate increased returns as participation grows;
- Evolve continuously in functionality over time, providing incentives for participants to engage regularly and share learnings;
- Provide development leverage (investment required to build additional functionalities) and interaction leverage (effort and cost for diverse set of participants to facilitate interaction), and;
- Define practices to eventually guide the activities of a large number of participants at the enterprises.

An example of a successful growth platform is the smartphone. The result was the smartphone collapsing all previous inefficiencies in daily workflows and making users more productive to focus on things and decisions that matter.

### Past



Wait times, Idle times, Setup times, etc. = inefficiency

### Present



No Inefficiency

**The evolution of the smartphone reduced the number of steps necessary to share photos and videos. (Source: Mobilize)**

## A growth platform for drilling engineers

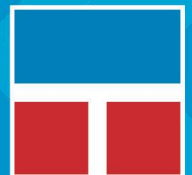
ProMPT is a cloud-based growth platform that includes ProACT for drilling engineers; ProFRAC for

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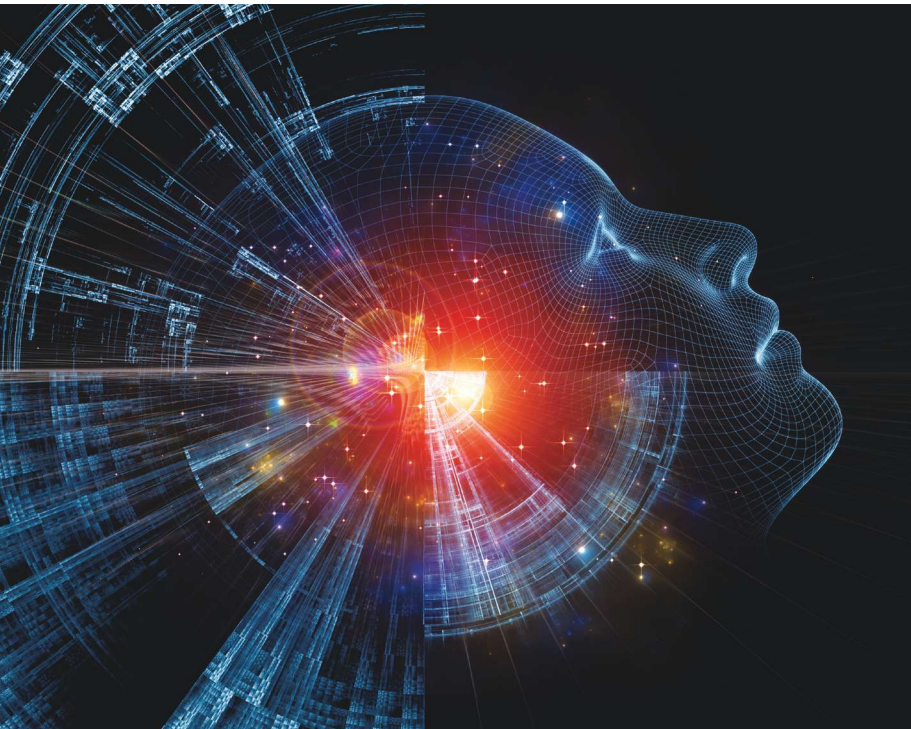
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**As data become more valuable than oil, the relationship between man and machine working together becomes more harmonious. (Source: Mobilize)**

completion engineers; and ProWISE, a private artificial intelligence knowledge platform for the entire oil and gas enterprise.

ProACT maps the entire decision universe of drilling engineers in four broad categories: planning, daily operations, post-well analysis and reporting. It's become an all-in-one analytics platform by giving drilling engineers a single source of truth in those four areas.

The typical drilling engineer is overloaded with work due to highly inefficient daily workflows. Because of time constraints decisions are often made on intuition instead of facts, which can lead to overlooking opportunities and underestimating risks. ProACT allows drilling engineers to do more with less by collapsing inefficiencies in daily workflows so they that can spend time where truly needed—engineering.

It applies machine intelligence on incoming raw data from a variety of data lakes in real time to provide actionable facts and support big judgment from Big Data. This was a paradigm shift in oil and gas since traditional wisdom states that getting a return on investment is only possible by optimizing drilling tools. Mobilize helped its clients rip up the old scripts and write new ones to fully unlock human intelligence and creativity in ways not possible before.

### Case study

A common decision dilemma is determining how to select the best rig contractor and rig for the job in real time. Prior to ProACT, this type of decision would require at least two days of analysis, which could result in lost opportunity. From a workflow perspective, client engineers would request rig metrics from multiple contractors and then compile drilling metrics from instrumentation providers. Then they would have to find time to perform analysis. This would require downloading and later uploading all metrics into spreadsheets, running calculations and comparing results.

With data provided by RT Analytics from ProACT, engineers can instantly be presented with actionable insights like drilling and tripping connection times, parameters and rig utilization by driller, and tripping rates between many rigs for multiple hole sections to determine the best performer. Further, granular analytics showcase metrics for the best well drilled in an area against active wells, revealing more contextual information around whether a driller is using the current rig to maximum ability, such as optimal block speed while tripping. In this case the data showed that the active rig was considerably slower than the best performer, suggesting that engineers analyze tripping rates.

The machine-guided facts showed the blocks were moving much slower at the beginning and end of each stand tripping in or out of the hole. Upon closer investigation, engineers found the driller was easing into and out of each stand on the joystick that controls the rig, considerably reducing the overall efficiency. All this cannot be easily interpreted unless multiple vendor reports and applications are touched, manipulated and prepared as insights—a true engineering nightmare.

The power of providing actionable insights guided by real-time machine intelligence in this example of a “data-to-decision” workflow collapsed traditional inefficiencies by 80%, as engineers could instantly share fact-based insights. This resulted in a decision to change driller behaviors allowing trip rates of eight to 10 stands per hour faster than was previously seen. Savings totaled almost six hours on each lateral trip, and the team was able to drill the well from spud to total depth faster with the old rig instead acquiring a new rig that would have cost the company an additional \$120,000 if such insights were not available. **ESP**



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# A slick solution

A rigless slickline ESP deployment proves to be a success for a Middle East operator.

**John Algeroy and Greg Nuffer, AccessESP**

It is more important than ever to reduce the frequency and extent of workover operations whenever possible. Pulling a failed electric submersible pump (ESP) requires a heavy workover, and with the ongoing challenge of rig availability, especially in the Middle East, operators are looking for ways to avoid or minimize the occasions that a rig is required. Typically, replacing an ESP involves taking a rig that is drilling and halting the drilling program to pull the broken ESP. ESP-related production downtime is a common and costly problem. Consequently, some operators are investing significant time and resources in investigating ways of reducing the revenues lost when changing out their ESPs. Some goals operators are working toward are obtaining ESPs with a 10-year life cycle and ESP replacements that can be started and completed in only one day.

AccessESP works to support operators in achieving these goals through its rigless slickline ESP deployment system. Retrievable ESPs can reduce replacement times and eliminate the need for a rig to be onsite to perform a heavy workover. The ability to replace the ESP with a slickline unit delivers a variety of benefits for the operator. Costs are reduced, complexity is eliminated and downtime is minimized.

## Development of a rigless system

The development of the rigless slickline ESP deployment system had its origins in a system that had been in use for about 20 years. This initial system featured an ESP pump, pack-off and tubing stop that could be pulled and replaced with slickline, thus providing positive improvements to well uptime in areas where pump wear is an issue. The current deployment system is a four-run retrievable system: motor, pump, pack-off and tubing stop. Instead of a rig or heavy workover unit, the AccessESP system allows an ESP to be replaced in a live well through tubing using conventional lightweight readily available slickline equipment. It is no longer necessary to consider an ESP as a part of a completion string that must be pulled whenever there is a need to intervene in the well or to replace a failed ESP component or system.

When the components are out of the well, there is a fullbore path to allow well work to be accomplished below the ESP setting depth. In several cases sand plugs have been observed below the ESP, and by pulling the ESP components the wellbore obstructions were easily removed and the well returned to production. By designing the system with simplicity at its core, the opportunity for successful retrieval and replacement is increased.



The Access 375 system was recently integrated into a Middle East operation and achieved the operator's successful criteria for the project. (Source: AccessESP)

### Middle East applications

Operators in the Middle East region are looking to produce their wells as efficiently as possible, and ESPs provide the most efficient artificial lift method.

The AccessESP system recently underwent a program in a live well application under real operating conditions.

The integration program was initiated in 2016 to qualify the technology for potential full field implementation in the operator's wells. During the initial 2016 operation a failed conventional ESP was pulled and replaced with the AccessESP "dock" (wet-mate connector). The complete retrievable system (motor, pump, pack-off and tubing stop) was installed through tubing in a conventional slickline operation. As part of the program the retrievable system was immediately pulled and reinstalled.

In February 2017, after six months of operation, the retrievable system was again retrieved and replaced in a live well using conventional slickline equipment and operations.

The key success criteria for the program, as identified by the operator, have been achieved to date. These include deployment and installation of the dock, commissioning and multiple retrievals, and re-installations of the ESP on slickline.

The equipment installed included the Access375 permanent and retrievable systems. The permanent system consisted of an orienting section and a docking station. AccessESP's proprietary dry-mate connectors were used to enable

connection to surface via a conventional ESP power cable. The dry-mate connector increases quality and reliability of the system since it is factory-installed on

Some operators are investing significant time and resources in investigating ways of reducing the revenues lost when changing out their ESPs.

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the cable. This leads to rig time reduction during installation and removes one field splice.

The retrievable system includes a 250-hp permanent magnet motor, a 19.2-m (63-ft) 400 series ESP pump, a pack-off and a tubing stop.



A rig worker runs the AccessESP tool into a well. (Source: AccessESP)

The AccessESP permanent magnet motor operates with any commercially available variable speed drive (VSD) motor. In this installation it connected to the VSD on the well with no modifications required. The 400-series pump outer diameter was turned down to 3.80 in. to allow through-tubing deployment in the 4½-in. tubing.

No changes were needed to the horizontal wellhead configuration. The program demonstrated that the ESP can be slickline-deployed without killing the well while remaining fully compliant with rigorous safety policies, well control barrier philosophy and slickline operating procedures. This is accomplished without a downhole lubricator valve or deepset safety valve using standard ESP completion designs.

The system is compatible with 7-in. casing, producing up to 6 Mbbbl/d through 4.5-in. tubing using 3.75-in. permanent magnet motors up to 400 hp. Higher flow ratings (to 20 Mbbbl/d) and power ratings (to 1,300 hp) are available in larger tubing sizes.

This deployment system delivers significantly reduced ESP operating cost, simplifies field logistics and increases production per well through reduced ESP downtime.

A slickline-deployed live well intervention system requires no changes to well control procedures. It is the only system that allows the change of only the pump while leaving the motor in the well connected to the permanent completion. As a result, further time and cost savings are delivered with significantly reduced HSE exposure and risks.

AccessESP's system is unique in that it can be deployed with slickline. When retrieved with slickline, the permanent completion has fullbore pass-through to allow well work below the ESP setting depth. The system can be integrated with any ESP pump provider and can utilize any ESP surface drive in the market. No special surface equipment is needed. It also can be deployed at high inclinations, unlike other systems.

Building on success in the Middle East, additional operators in the region are also recognizing the need for reducing the time and cost to replace a failed ESP system with the rigless method. **ESP**



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# Using kinetic energy for plunger lift safety and maintenance

New API rating system helps identify magnitude of equipment impacts.

**Mark Scantlebury**, Extreme Telematics Corp.

The plunger lift industry has mostly been unregulated to date, leading to installation of equipment that is unreliable and unsafe on plunger lift wells across the continent. Wellhead surface equipment routinely takes heavy impacts from plungers, leading to failures that can result in spills or injuries.

Because of this there has been a push from industry to come up with a common set of standards that helps to provide some regulation for plunger lift equipment.

A new specification from the American Petroleum Institute (API), 11 PL, is emerging in plunger lift that covers plunger lift lubricators and related equipment. One of the main outputs of this new standard is the requirement for manufacturers to provide a kinetic energy (KE) rating for their lubricator and spring combinations. This rating helps to identify the magnitude of the impacts their equipment can take and allows the control system to compare real-time KE measurements. KE allows measurement, tracking and the ability to react to real impacts at surface instead of relying on velocity or overengineering of equipment to ensure safe and reliable operation of a plunger lift well.

The KE of an arriving plunger can be calculated using the mass and velocity of the plunger.

The mass of the plunger already is specified by plunger manufacturers, leaving operators to measure velocity at surface in real time to calculate the KE of each plunger arrival.

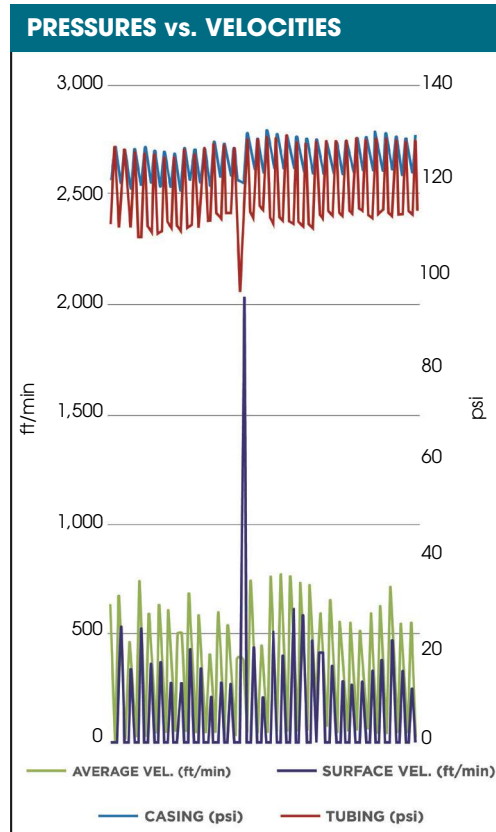
Historically, operators have been content to rely on the average velocity of a plunger, which is calculated from the well depth and the time for the plunger to rise. But this is not accurate enough to be used for the KE calculation since it does not account for acceleration or deceleration and whether the plunger started at the bottom of the well or not.

## Plunger surface velocity

The new Sasquatch plunger velocity sensor from Extreme Telematics Corp. (ETC) uses geomagnetic sensing technology to measure, store and relay the plunger arrival and surface velocity of the plunger. This gives an accurate velocity of the plunger in real time just before it strikes the anvil inside the lubricator at surface.

Geomagnetic sensing technology was first implemented in the Cyclops plunger arrival sensor. Instead of using an electromagnetic coil to sense the plunger, the Cyclops uses a magnetometer or magnetic eye that monitors the magnetic field of the earth. The movement of any ferrous object causes the magnetic field to change. These changes are compared to a threshold, which when exceeded is used to signal the arrival of the plunger. This fundamental shift in plunger detection technology eliminated missed arrivals and false detections and led to the Cyclops becoming a recognized option for plunger arrival detection.

The increased accuracy of the plunger arrival using this technology allowed the creation of the Sasquatch. The Sasquatch uses multiple sensors and interprets the



**FIGURE 1. Testing results from a well in the San Juan Basin compare the calculated average plunger velocity with the actual surface velocity of the plunger when venting. (Source: Extreme Telematics Corp.)**

changes in the magnetic field to give a measured velocity of the plunger as it passes the sensor. This velocity is logged internally and made available via Modbus to a connected control system. An external dry contact switch is closed, just as with the Cyclops, signaling that a new arrival was detected and a velocity value is available. The algorithm to measure plunger surface velocity and its use resulted in a patent, U.S. 9,587,479 B2, "Velocity sensor for a plunger lift system," granted in March.

### Plunger surface velocity, KE

Using a real-time plunger control system such as the ALiEn2 Expert plunger lift controller, operators can measure the surface velocity and mass of the plunger to calculate the KE of each plunger arrival. This can be compared to a user-defined threshold to determine if an operation should be halted. In ETC controllers the user can specify both a hard hit and dangerous hit threshold. The controller watches for a specified number of consecutive hard hits and will automatically shut down operation of the plunger well to protect equipment. If a plunger arrives that exceeds the dangerous hit threshold, the operation of the well will be stopped immediately to allow the operator to inspect the equipment before continuing.

During testing of the Sasquatch with a well-known producer in the San Juan Basin, some startling results were recorded. In one instance a well was routinely vented when the plunger did not arrive. The long wait time for the arrival led to a low velocity of 121.9 m/min (400 ft/min) being calculated. This meant that the 7.5-lb plunger appeared to be traveling with 7.02 Joules (J) of energy. The Sasquatch was able to show that the plunger was in fact arriving at a much higher velocity of 617.2 m/min (2,025 ft/min) (Figure 1). The real KE was 180 J, or 25 times more energy than expected. This was happening because the venting of the well removed the backpressure, causing the plunger to accelerate rapidly.

On another well in the same area the plunger was being optimized to an average velocity of 228.6 m/min (750 ft/min). When examining the plunger surface velocity, ETC could see the 9-lb plunger was consistently arriving closer to 365.7 m/min (1,200 ft/min, Figure 2). This meant the



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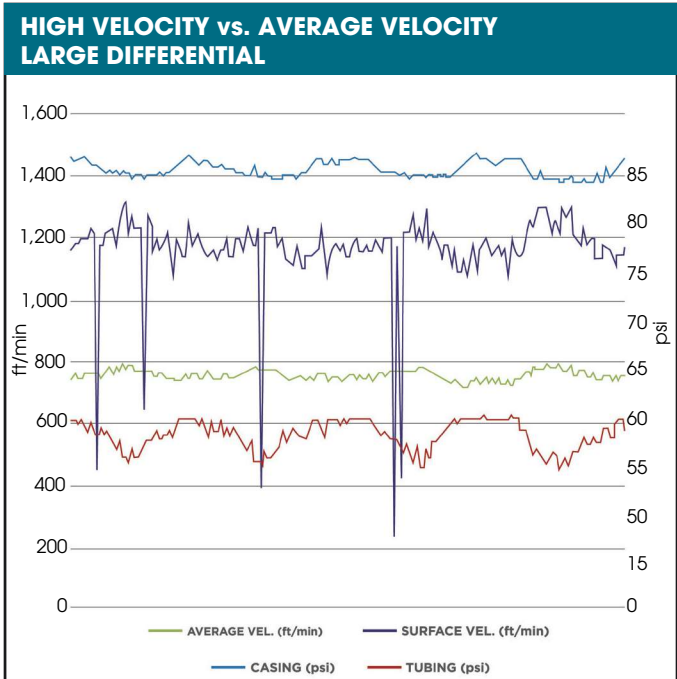
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**FIGURE 2. Testing results from a second well in the San Juan Basin compare an average velocity with the regularly recorded surface velocity. (Source: Extreme Telematics Corp.)**

actual KE of 76 J was substantially higher than the estimated 30 J. This may not sound like a lot, but over six months the spring was absorbing 200 kilojoules of energy. This will likely lead to premature spring wear, resulting in a failure.

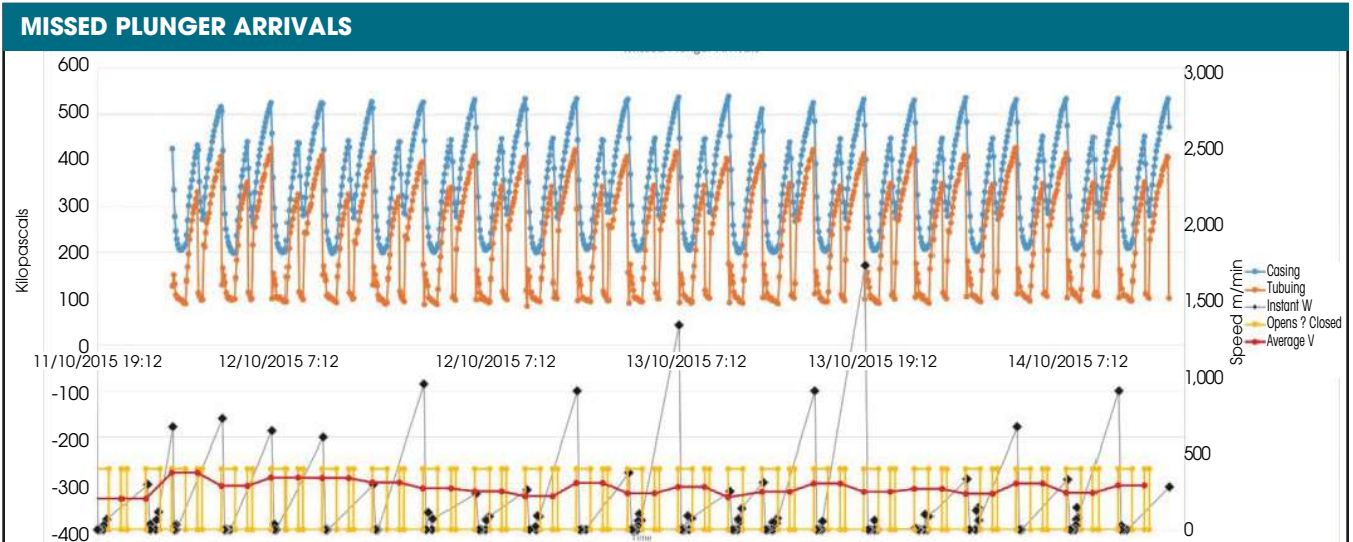
In a third case in Canada an operator was reporting repetitive failures of its springs and plungers. Upon

installing the Sasquatch, ETC found the plunger was arriving at a velocity of 1,714 m/min (5,623 ft/min) as opposed to the average calculated velocity of 250 m/min (820 ft/min, Figure 3). At 10 lb this plunger was arriving with 1,853 J of energy and was able to collapse the spring in a single arrival.

**What's next?**

With the advent of both plunger surface velocity and KE of plunger arrivals, a once stagnant industry is set to go through a revolution. Using KE for safety is simply the first step. The availability of these new operational parameters has sparked numerous discussions throughout the industry. As producers, service companies and technology providers analyze surface velocity data, new algorithms are being generated and tested to enhance production. Additionally, the KE of these arrivals is being used for predictive maintenance of plungers and wellhead equipment.

ETC is one technology provider that is working with several plunger well operators to refine a predictive maintenance model for spring wear. This model takes the cumulative KE of each plunger arrival and uses it to predict when a spring will fail. The goal of this technology is to reduce the number of physical inspections while reducing the amount of premature replacements. Currently, most operators replace their springs on a schedule, which causes issues when springs fail early but also causes them to replace springs that may last for longer periods of time. Many other operators simply run their springs to failure, leaving the opportunity for catastrophic failures that could be easily prevented. **ESP**



**FIGURE 3. Testing results from a well in Canada show a plunger arriving at surface at speeds up to 1,714 m/min when average velocity was calculated at only 250 m/min. (Source: Extreme Telematics Corp.)**

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# Small change, big difference

Smart lube decisions help extend equipment life.

**Andrew Donlon, ExxonMobil**

**K**eeping vital production equipment online is every oil and gas producer's top priority, but achieving this goal will only get harder in the years to come.

ExxonMobil's annual "Outlook for Energy: Journey to 2040" report projects that energy demand will grow by about 25% over the next 23 years. And, in 2040, it projects that oil and gas will still account for 57% of the total energy mix.

To meet that energy demand, producers will have to turn to oil and gas reserves that are in more remote locations with deeper wells and more extreme operating conditions. Equipment will be pushed harder than ever before, facing harsh conditions such as more extreme temperatures, heavier loads and greater exposure to damaging contaminants.

Fortunately, even small changes to an oil and gas operation can have a big impact on equipment performance and longevity.

Lubricants are the lifeblood of any industrial machine, and they are fundamental to enhancing equipment performance, efficiency and uptime. However, lubricant performance can vary widely, and understanding what characteristics to look for in a lubricant and how to best measure lubricant performance in real time is critical to success.

Protecting equipment from the harsh conditions of a typical oil and gas operation will require making smart lubrication decisions. Making the right decisions can mean the difference between ensuring reliable long-term production and dealing with repeated unscheduled downtime.

## No shortcuts

With lubricants, like with most other products, you get what you pay for. Only the best products formulated

specifically to perform for the demanding conditions of a given application can deliver the protection that oil and gas operators need.

Instead of using conventional mineral-based lubricants, operators should consider using synthetic lubricants, which utilize advanced additive technologies that can help protect against conventional wear modes. This protection leads to better equipment protection, durability and, ultimately, enhanced reliability.

These lubricants are worth the initial upfront investment since they often offer significant long-term benefits that deliver cost savings over the course of the equipment life.

Consider the following real-world example. In 2015 a large oil and gas producer was running a White

Superior 12GTL natural gas engine on a conventional mineral-based oil. The company wanted to reduce oil consumption and extend oil drain intervals from 4,000 hours to 16,000 hours to help increase productivity and reduce overall operations and maintenance costs.

Engineers suggested converting the engine to a synthetic lubricant. With that simple switch the unit reached more than 20,000 hours on the same amount

of oil before a coolant leak required an oil change. This reduced oil usage by more than 1,000 gal/year, and the oil demonstrated outstanding oxidation performance over that period, meaning better equipment protection over the long haul.

These equipment benefits are significant, but why exactly are advanced lubricants such as synthetics typically better than most conventional lubricants?

Here are a few reasons:

- The high viscosity index of fully synthetic lubricants can help equipment perform better at higher temperatures since the oil will remain more viscous compared to conventional mineral-based oils. This ensures that the oil can maintain sufficient film thickness to deliver adequate lubrication, thus



**Proper lubricant selection can improve equipment functionality.**  
(Source: ExxonMobil)

helping protect against wear and reducing the risk of metal-to-metal contact that often causes permanent equipment damage;

- Components such as bearings are particularly susceptible to wear, and bearing failure is a leading cause of unplanned mechanical failure of rotating equipment, resulting in production losses. Synthetic lubricants specifically formulated to protect against wear can help address some equipment failures;
- Synthetic lubricants have much greater oxidation resistance than conventional mineral-based oils, which is a key factor in determining oil life. Some synthetic lubricants have been shown to extend oil life up to six times longer than conventional oils, particularly at elevated operating temperatures; and
- Synthetics can extend oil drain intervals and reduce the frequency of oil changes.

### Regular check-ups

While an operator's choice in product is the most important lubrication decision impacting proper equipment performance and protection, conducting regular analysis to monitor real-time performance of those lubricants in service is nearly just as important.

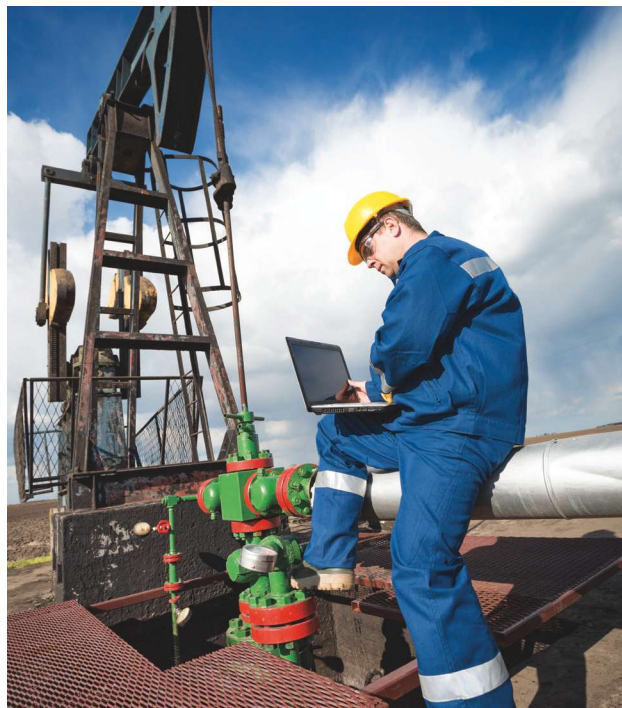
Specifically, operators need to conduct regular used oil analysis (UOA) to track any changes in fluid properties that may take place over time. Through these programs operators can identify trends to understand if there is a potential issue that requires corrective action.

UOA can identify the presence of contaminants and machinery component wear debris, indicate changes in lubricant viscosity or report oxidation levels. These are just a few types of UOA insights.

By implementing a regular, consistent UOA program, operators can ensure that their lubricant and their equipment is running at its best, helping deliver optimized equipment and oil life, reduced downtime, and improved safety and environmental awareness.

A U.S. energy company that extracts natural gas from shale and other tight formations was looking to extend engine oil drain and overhauling intervals for its Waukesha 9390 natural gas engines while maximizing operational efficiency and overall productivity.

Engineers conducted a thorough oil analysis review and gas engine inspection, using those insights to determine that the oil currently being used wasn't the optimal choice. The application instead required a more advanced lubricant formulated specifically to deliver enhanced wear and corrosion protection for more severe operating conditions, thus minimizing CO<sub>2</sub> emissions by an estimated 40.5 tons/year.



**Operators should work closely with their lubricant suppliers to determine if there's an opportunity to enhance the existing strategy. (Source: ExxonMobil)**

The engineering team made a recommendation to switch to a synthetic gas engine oil specifically designed to increase fuel economy, minimize oil consumption and provide enhanced wear and corrosion protection. After converting two of the gas engines and conducting regular UOA to continuously monitor the performance of the new oil, the company successfully surpassed its 30,000-hr oil service goal with no overhauls or filter changes. Additionally, the new oil helped deliver an estimated 1.5% reduction in fuel consumption.

### Major impacts

Lubrication typically accounts for only a small percentage of an oil and gas operator's overall operations and maintenance budget. But, as some of the examples outlined in this article demonstrate, making smart lubrication decisions can have a big impact on any operation.

Operators should work closely with their lubricant suppliers to determine if there's an opportunity to enhance their existing lubrication strategy, either by switching to more advanced products or incorporating a more robust UOA program.

By making some of these small changes, operators will be in a better position to enhance equipment performance and, ultimately, equipment life. **ESP**

# Continued service with composite repairs

Composites extend the life of offshore assets as a valuable corrosion prevention and repair option.

**Buddy Powers, Clock Spring**

When engineers set out to define specifications 20 years ago for offshore units that were expected to stay on site for 20 to 25 years, it was not uncommon to take a very conservative approach. That conservatism is reflected in the many assets that are reaching the end of their design lives but still have the basic structural stability to continue operating for years.

While the hulls and superstructures of some offshore production systems are fit for continued service, some of the components that have been exposed to significant stresses and fatigue over the years are not. For operations to continue safely, it is vital that the necessary repairs and replacements are carried out effectively.



Composites have been used for offshore repairs for years in a broad range of applications, such as riser pipe sections close to the water line and longer pipe networks that are hard to get to. Here, trained technicians use rope access to repair a riser. (Source: Clock Spring)

## Evaluating assets

Today asset owners have no difficulty getting assistance with the task of evaluating their facilities for continuing service, including an analysis of critical parts and determining which components have experienced sufficient wear to warrant repair or replacement.

This is a critical first step, but the next step is most likely the one that will determine the cost-effectiveness

of the life-extension project. If repairs need to be made, how will they be done, and what products will be used?

## Considering composites

Composites could be the answer. Composites have been used for offshore repairs for years in a broad range of applications such as structural repairs to risers, caisson leak repairs and for life extension work on large components that have experienced corrosion and sustained environmental damage.

Crevice corrosion, which is a major integrity threat on offshore assets, is a one of the challenges for which a composite solution is ideal. Because of the way it is formulated and applied, Clock Spring composite repairs provide 360 degrees of protection, ensuring that each square inch of the interphase between the pipe and the sleeve is well sealed. The ability to seal the repair mitigates the effects of previous existing corrosion while preventing further damage.

Because there is not a lot of information readily available to explain how composites are being used offshore, it is difficult for decision-makers to feel confident in selecting composite repair technology for their assets.

As with every technology offering, all are not created equal. It is important to know the historical successes of individual composites to understand when a composite repair is a good option.

## Putting composites to work

External corrosion is a safety issue for assets that have been deployed for extended periods offshore. Particularly important are high-risk areas on the platform that are difficult to inspect because of limited access, such as riser pipe sections close to the water line and longer pipe networks that are hard to get to. These areas also can be difficult to repair using traditional products. Damage to these components can be addressed with composite technology that not only provides structural reinforcement in weakened areas but protection from future deterioration.

A recent repair concern came to light when an asset owner was performing an inspection on a rig that had



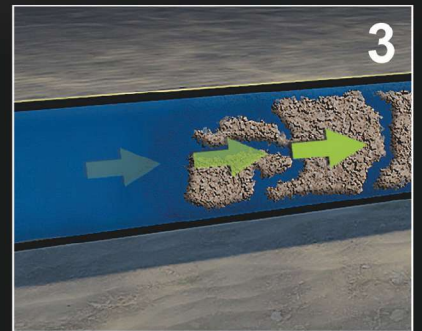
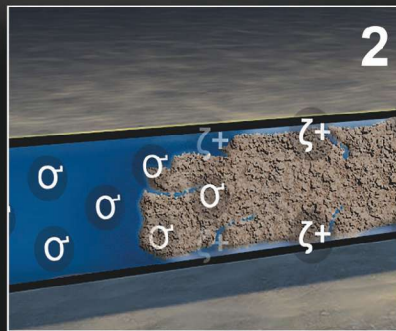
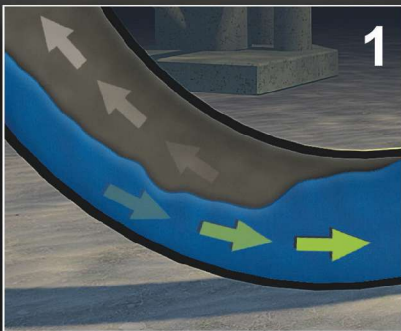
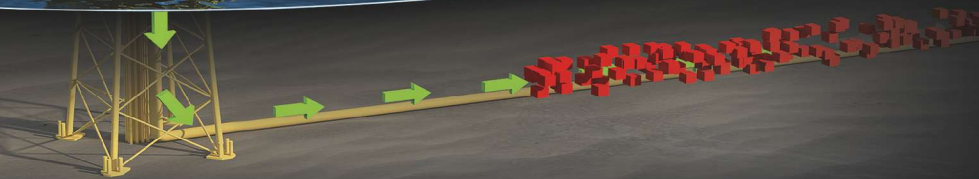
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previously experienced a leak. Unwilling to risk an environmental incident, the owner began looking for a way to address the problem. The most critical criterion was to find a solution that would not necessitate shutting in production. Because the Clock Spring repair could be carried out without taking the system offline, it was ideal for this offshore production unit.

Normally, a composite solution can be designed around two commonly used design specifications—The American Society of Mechanical Engineers' PCC-2 article 4.2 and International Organization for Standardization technical specification 24817. This design guidance allows experts to factor the design conditions and life expectancy of the repair into a formula to determine the composite thickness needed.

Before a product could be introduced on the rig, engineers needed to understand the conditions under which the material would have to perform. The composite solution design was based on knowledge of the pipe, upper bound design temperature/pressure limits and loading conditions that would be experienced in this unique offshore application. Once the specifications were established, the composite repair manufacturing process began with qualifying the manufacturing and design process using one of the trusted international standards. To exercise the best process control, Clock Spring provided a method statement and a full design report that presented the basis for the engineering calculations used in the design and outlined the installation procedure.

Because of the critical nature of these repairs the composite must be formulated accurately. The repair plan included a well-defined scope for surface preparation and an inspection checklist to be used during the installation process and after the composite repair was completed.

Trained installers carried out the repair using Snap Wrap sleeves that were manufactured to specifications. Prefabricating the sleeves ensures the correct size and thickness for the job and allows the installation process to be carried out more rapidly because the composites do not have to be made up on site.

Fabricating the pieces in a manufacturing facility also affords greater quality control in the construction process and allows each unit to be numbered and tracked.

The location of the repair required installers to use rope access to install the sleeves. Using the prepared sleeves, the team began the installation process, receiving the first shell via a pulley system and applying it to a pipe length that had been prepared for installation. Using rollers to apply adhesive, the team placed and



**Using rollers to apply adhesive, the installation team places and secures the composite sleeves. (Source: Clock Spring)**

secured the first sleeve. The next layer was rotated 90 degrees from the first seam so the seams did not overlap. This process was repeated until four layers had been installed on the first riser section.

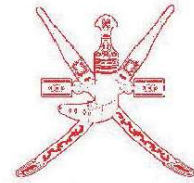
When all the layers were placed, ratchet straps were secured around the shells to keep them in compression until they fully adhered to the riser. This process took about 1 hr. Since the Snap Wrap arrived on site ready to be bonded to the riser, there was no need for it to cure on site. The entire installation of 12 sleeves was accomplished in a single day, three times faster than would be possible using a wet composite installation.

The team inspected the installation as it was being carried out using the prepared checklist and made sure the fully installed system passed all the performance requirements. The team also provided the owner with a check list to be used on subsequent inspections, indicating intervals at which the repair should be evaluated to verify integrity.

### **Future applications**

Composite solutions have been used on riser connections, caisson and hull structures, but the scope for application is far broader. They are ideal for many areas where corrosion prevention and mitigation are required. The simple installation process allows repairs to be executed in a range of conditions, including under water to depths of 9 m (30 ft).

Work is underway to find a way to use ROVs to carry out composite repairs to remove people from the process for improved safety. Because composite repairs can be carried out quickly and at low cost, they also could be valuable in decommissioning projects, when operators must ensure the integrity of pipelines and flowlines to prevent unplanned discharge. As the industry begins to consider composites a viable repair option, the use of the technology will continue to expand. **ESP**



**The Oman Ministry of Oil & Gas are pleased to announce the dates for the 2017 Oman Bid Round.**

Public information (including block summaries and data package pricing) is available at [ldr.omanbidround.com](http://ldr.omanbidround.com) from **September 7**. Site registration, data purchasing and bidding for the round commences on **September 20**.

Four blocks offered as part of the Oman Bid Round 2017 are:

**BLOCK 43B**

**BLOCK 47**

**BLOCK 51**

**BLOCK 65**

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Oil and gas companies experienced in upstream projects are invited to register and participate.

Register at: [ldr.omanbidround.com](http://ldr.omanbidround.com)

Bidding closes **on December 31, 2017**.

**For further information, please contact:**

Suleiman Saif Al Ghuniami, *Director of Petroleum Concessions*

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Tel: +968 24640526

Fax: +968 24602541

Email: [s.alghunaimi@mog.gov.om](mailto:s.alghunaimi@mog.gov.om)



# Current and future technologies to be focus of conference

Companies at SPE ATCE will be highlighting new products and services.

The Society of Petroleum Engineers (SPE) is hosting its Annual Technical Conference and Exhibition (ATCE) Oct. 9-11 in San Antonio, Texas.

“For more than 90 years, ATCE has been the meeting of choice for SPE’s members and other professionals seeking education on current and future technologies that help find and produce hydrocarbons faster, more efficiently, safer and more cost-effectively,” the conference website stated.

The following is a sampling of some of the latest technologies that will be showcased at SPE ATCE 2017.

*Editor’s note: The copy herein is contributed from service companies and does not reflect the opinions of Hart Energy.*

## Data analysis software enhances financial reporting

Aclaro Softworks Inc.’s petroLook is a web-based business intelligence solution used by E&P companies to manage reserves, budgeting and planning. The foundation of petroLook’s value to producers is its ability to gather data from multiple source systems, giving the richest possible pool of data for informed decision-making. petroLook is a comprehensive data analysis tool for budgeting, planning and resourcing. It’s highly configurable and scalable, with extensive reporting capabilities, and can be tailored to the needs of companies of any size. petroLook Reserves (available pre-configured or for Enterprise) lets companies have visibility into their resource positions. The system is an accurate, secure and auditable platform that enables a flexible approval process, automated reconciliation and internal and external reporting. petroLook Portfolio Advisor is an oil and gas software that offers fully constrained multi-objective optimization. This technology can be leveraged to align portfolio decisions with corporate strategic goals and acquisition and divesture activity. [aclaro.com](http://aclaro.com)

## Polymer system enhances proppant placement

Binder Science has developed a viscoelastic polymer system designed to enhance proppant placement. Proppant transport is categorized as either heterogeneous or

homogeneous. Heterogeneous slurries settle and stratify, with coarser particles at the bottom of the flow area. This process, referred to in the industry as “dune and push,” repeats itself until plugging or screenout in the formation occurs. At that point sand placement ends and flushing begins. Frequently, screenout occurs sooner than desired, and the sand placement falls short of the fracture design target. Binder’s copolymer rheology system is designed to keep proppant in the homogeneous flow regime, where proppant does not settle and screenout does not occur. The result of this placement method is significantly increased crude production. [binder-science.com](http://binder-science.com)

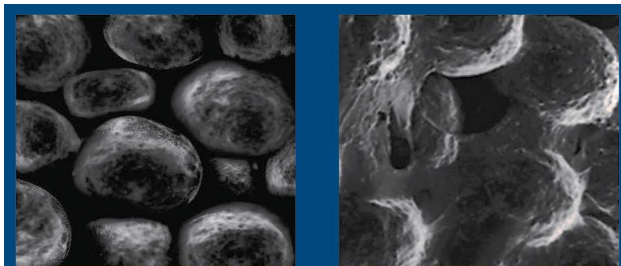


Binder Science’s proppant placement system keeps proppants in the homogenous flow regime. (Source: Binder Science)

## Tool reduces pipe friction pressure up to 85%

BJ Services will be showcasing its ThinFrac MP friction reducer. The tool is designed for maximum regained permeability. The technology has been proven in North American shale plays to significantly increase production. Used in slickwater, hybrid and foam fracturing operations, this synthetic polymer develops instantaneous viscosity, providing superior proppant transport when and where it is needed. Its rapid hydration capability reduces pipe friction pressure by as much as 85% when compared to conventional fluids. The enhanced

polymer has been engineered to contain oxidizable linkages along its backbone, allowing a clean, efficient break with little to no formation or proppant pack damage. New generations of the fluid further improve viscosity and salt tolerance. ThinFrac MP is part of the company's family of linear gels that improve proppant transport and reduce friction to create large complex fracture networks. [bjsservices.com](http://bjsservices.com)



Clean break using ThinFrac MP

Poor break using guar systems

**This comparison shows the difference in breaks when using the ThinFrac MP friction reducer vs. using guar systems. (Source: BJ Services)**

### Get to know your lateral

C&J Energy Services will showcase the LateralScience engineered-completion service. The LateralScience approach leverages commonly available data collected during drilling of the well, which is then used to optimize horizontal completions. Because these data are already on hand, operators can avoid the considerable data-collection expense normally associated with assessing horizontal wellbores. For operators already using other methods to engineer completions, this new technology offers a solution that is more convenient and



**The LateralScience technique enables operators to engineer the completion design using existing drilling data on every completion, whether it's a new well or a refracture operation. (Source: C&J Energy Services)**

orders of magnitude less expensive. This means operators can now afford to optimize every horizontal well they complete. For operators still executing geometric completion designs, LateralScience has been demonstrated to increase production an average of 30%. In addition, the facies logs included in the LateralScience deliverable package benefit users by helping them understand differences in reservoir characteristics between wells. This provides guidance to improve the reservoir development strategy across the entire field. [cjenenergy.com](http://cjenenergy.com)

### Cleaner, more conductive proppant pack

Calfrac introduced CalVisc in the Williston Basin in 2014. Developed as an alternative to traditional crosslinked fluid systems, CalVisc is a polyacrylamide-based (or friction reducer) fracturing system designed to deliver a cleaner, more conductive proppant pack. The system offers a shear thinning characteristic that results in greater viscosities at low shear rates. With relatively low chemical loadings, CalVisc generates significant viscosity, allowing fracture treatments to be placed with the same sand design previously used with crosslink guar systems. CalVisc carries up to 5 ppg sand through about a 3,000-m (10,000-ft) lateral wellbore with viscosities of 15 cp to 30 cp at 511 sec<sup>-1</sup>. It provides higher viscosity while greatly reducing formation damage; reduces friction, allowing proppant placement at lower pressures; and drastically reduces water requirements when compared to basic slickwater systems. CalVisc is a disruptive fracturing fluid technology that helps users make better wells at lower cost. [calfrac.com](http://calfrac.com)

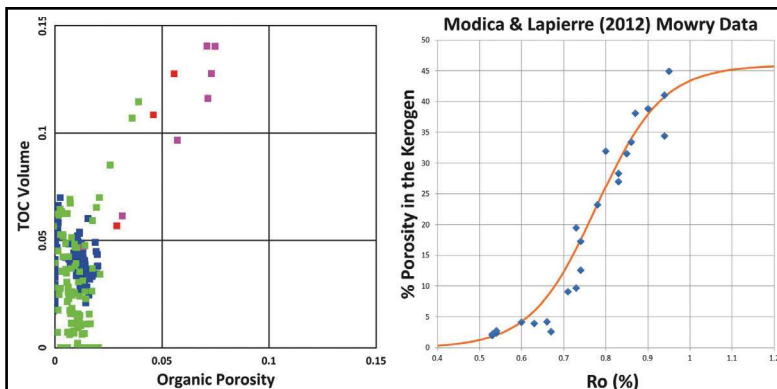


**Calfrac laboratories are strategically positioned to ensure direct support is available to customers and operations. (Source: Calfrac Well Services)**

### Increasing EUR from slickwater fracturing operations

CARBO will be showcasing its new CARBOAIR high-transport ultra low-density ceramic proppant technology. Slickwater fracturing fluid systems are finding increasing applications in unconventional reservoirs to accommodate evolving fracture stimulation designs and cost structures. However, proppant transport and placement in these treatments present challenges for stimulation design optimization and effectiveness due to their low viscosity, which negatively impacts proppant carrying capacity. This can lead to lower fracture conductivity since slickwater treatments are limited in proppant maximum concentration. CARBOAIR has chemically engineered internal porosity and is designed to increase production and EUR from slickwater fracturing operations. The technology has an apparent specific gravity about 25% lower than sand. The technology also delivers increased propped fracture height and length over a range of applications to maximize effective fracture contact area and conductivity. CARBOAIR can increase production across various formations by delivering improved proppant transport, propped fracture geometry (length and height), fracture conductivity and reservoir contact area in comparison with conventional sand. *carboceramics.com*

TOC. Comparisons can be made between organic porosity and TOC. In a comparison of Bakken and Mowry data, it appears that the Bakken has significantly greater organic porosity development. *digitalformation.com*



Examples from the Bakken of North Dakota (left) and the Modica and Lapierre Mowry data (right) are shown. (Source: Digital Formation)

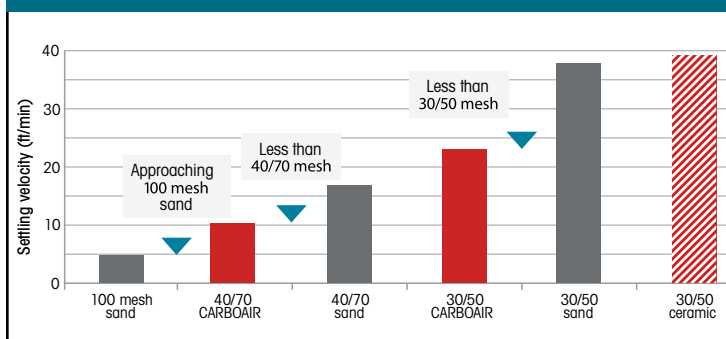
### Partnership results in tool to help reduce overall rod cycles

To provide a holistic approach to the most challenging rod lift applications, Dover Artificial Lift and Liberty Lift Solutions have strengthened their longstanding relationship. Dover Artificial Lift includes Norris Rods and Harbison Fischer Pumps along with Energy Automation variable-speed drive controllers and smart chemical management. The Liberty Lift Long Stroke (XL) Pumping Unit offers an ideal means of managing production cost at an optimum level. The XL Unit provides a high-performance rugged design, greater efficiency and proven reliability. Its extra-long stroke lengths of 306 in. and 366 in. allow the rod pump a slower travel time to provide more complete fillage and higher volumetric efficiency. The XL Unit is well-suited for work in deviated, deep or high-volume wells as an optimal alternative to other lift forms. *doverals.com*



The XL Long Stroke Pumping Unit was installed in the Bakken on a highly deviated well application to help reduce overall rod cycles and transition from the first to the second form of lift in the life of the well. (Source: Dover Artificial Lift)

### SETTLING VELOCITIES COMPARISON



This chart shows the differences in velocity for CARBOAIR vs. comparable products. (Source: CARBO)

### Methodology relates organic porosity to TOC with triple-combo suite

By using triple-combo logs, it is possible to quantify clay porosity, total organic carbon (TOC), effective porosity (inorganic) and effective porosity (organic). Organic porosity is formed during thermal maturation of the

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## Water clarifiers ready to use with no need for inversion during application

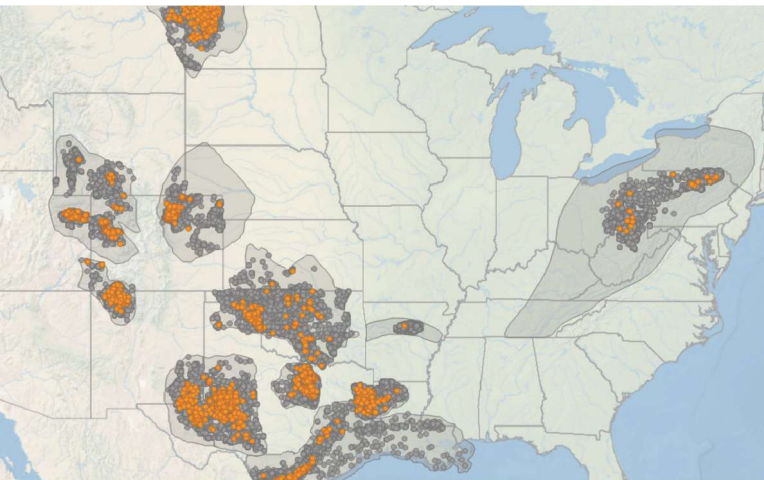
Dow Chemical Co.'s ROMAX 6011 and ROMAX 9011 are the newest water clarifiers offered by the company. These products are formulated to be ready to use with no need for inversion during application and feature anionic acrylic latex as an active ingredient. ROMAX 9011, the freeze-protected water clarifier, withstands cold temperatures down to 40 C (104 F). Acrylic latex was developed during an R&D effort that focused on the optimization of water clarifiers for tough-to-resolve emulsions through systematic analysis of statistically designed products. For more information on Dow's full portfolio of products for oil and gas, visit booth 1177. [dowatce.com](http://dowatce.com)



**ROMAX water clarifiers allow users to separate oil from produced water and reverse (oil-in-water) emulsions. (Source: Dow Chemical Co.)**

## Platform identifies refractured wells worldwide

Refractures are increasingly becoming a more important component of long-term planning. But what really makes a successful refracture? Drillinginfo and DI Refrac Analysis provide an easy-to-use step-by-step guide to identifying refractured wells, understanding how they were completed and their impact on production and pinpointing the most promising candidates for refractures. This platform enables operators to find the information needed

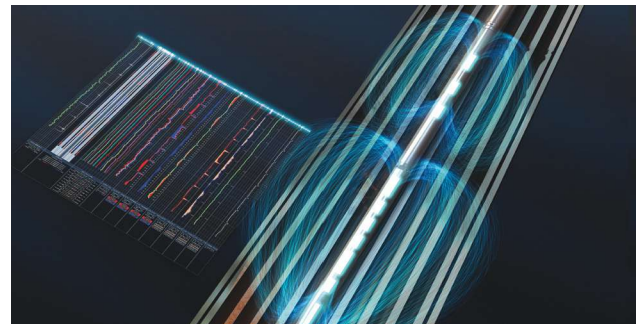


**Identify refractures across the country in seconds with DI Refrac Analysis. (Source: Drillinginfo)**

to maximize production, value assets and companies; identify best practices in refracturing; and conduct competitive analysis. [info.drillinginfo.com](http://info.drillinginfo.com)

## Pinpoint casing defects and metal corrosion

The Halliburton Electromagnetic Pipe Xaminer V (EPX V) tool allows operators to more accurately pinpoint casing defects and metal corrosion to help reduce non-productive rig time. It has the ability to quantify metal integrity in one to five concentric pipes during a single trip in the hole so that users can determine a solution quickly. The EPX V tool operates via mono-conductor wireline, enabling more efficient wellsite operations through the use of cased-hole service equipment. Halliburton's BaraShale Lite water-based drilling fluid is engineered to drill more efficiently in fields that contain salt formations with low fracture gradients such as in the Permian Basin. The system contains a proprietary emulsifier that tightly combines the base fluid, which comprises brine to prevent salt washout and oil to lighten the mud weight. The result is a fluid system that prevents lost circulation and washout while minimizing dilution and waste volumes. [halliburton.com](http://halliburton.com)



**The EPX V service provides intervention capabilities to help improve well surveillance with metal-loss quantification of up to five downhole tubulars. (Source: Halliburton)**

## Proppant helps stimulate microfractures

Uncoated 100-mesh proppants are useful to stimulate microfractures within the reservoir and extend propped fracture length. However, initial well production is often followed by a steep decline. This can be attributed to proppant flowback and significant fines generation due to proppant failure. Rearrangement of the proppant pack also can occur, leading to reduced propped fracture width. Hexion's kRT 100 proppant is an economical, curable resin-coated 100 mesh sand. This proppant supports the intended use of 100-mesh sand within the fracture network, while the resin coating bonds the proppants together in the fractures to keep the grains

# NO PRESSURE

## The PowerScrew™ Liner Hanger Sets Without High Pressure

The PowerScrew™ uses a metal-forming process that forges the liner top inside the intermediate casing—delivering extremely reliable hanging and sealing performance without high pressure. The PowerScrew uses torque and compression to deploy the liner to TD safely, and then uses the same torque and compression to set the liner top. No need for more equipment, lowering expenses. And no need for high pressure, increasing worker safety on the rig floor.

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Learn more about the safety and unique features and benefits of the Seminole PowerScrew at [Seminole-Services.com/NoPressure](http://Seminole-Services.com/NoPressure).



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from shifting or rearranging. The resin coating also provides all of the traditional benefits of a resin-coated sand such as proppant flowback control and fewer proppant fines. [hexionfracline.com](http://hexionfracline.com)



**KRT 100 proppant is an economical, curable resin-coated 100-mesh sand. (Source: Hexion)**

### Tankers transport hazardous and nonhazardous liquid materials

To meet today's challenges in transporting both hazardous and nonhazardous liquid materials, Hoover Ferguson has developed an extensive line of containers approved to International Standards Organization (ISO) standards: stainless steel ISO and IMO (Institute for Marketecology) certified tank containers and UN packaging-certified portable tanks. The ISO tanks are equipped with insulation, steam trace heating and cooling capabilities, and optional safety features such as fall protection with extended safety ladders and custom



**The ISO tanks are equipped with insulation, steam trace heating and cooling capabilities as well as optional safety features. (Source: Hoover Ferguson)**

step fenders and handrails on custom drop-deck chassis. An online container and asset management portal, Liquitrac, leverages the latest barcode technology in combination with an app and smartphone to provide asset tracking, document storage, reporting and level monitoring capabilities. Documentation can be stored, uploaded and retrieved for cleaning, repairs, regulatory compliance and more. Real-time analytics and advanced tracking technologies accompany customizable alerts and reports, which users can receive on demand. Use of the portal delivers increased visibility on assets, enabling quicker and more informed decision-making and greater control over costs. [hooverferguson.com](http://hooverferguson.com)

### Platform empowers digital transformation

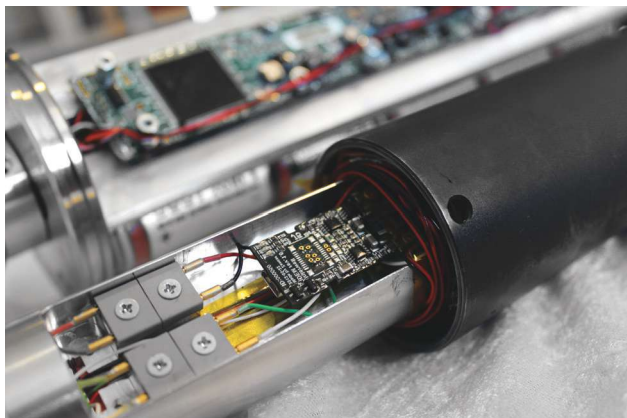
IVAAP is the cloud-enabled platform that will empower E&P companies to optimize performance and unlock significant value. IVAAP is the first digital visualization and analytics web platform that empowers digital transformation in E&P. The platform accelerates development of web-based data visualization and analysis solutions in geology, geophysics, drilling and production by using microservices technology, a lightweight and component-based architecture that connects to multiple data sources simultaneously. Making operational and business decisions requires comprehensive analysis of complex data from many sources. IVAAP was designed to allow operators and service companies to tailor the system for their specific needs; extend functionality; and plug in their own workflow and IP by monitoring drilling, combining well log data with directional information, visualizing schematics and tracking key performance indicators. [int.com](http://int.com)



**IVAAP is a digital framework that accelerates the development of web-based data visualization and analysis solutions for upstream E&P. (Source: INT)**

### System allows test in the direction of flow to be carried out

Testing of any wellbore barriers, including temporary mechanical wireline plugs and permanent installed barriers based either on cement or any other material,



The service is available across industry standard tubing/casing weights. (Source: Interwell)

should always be carried out in the direction of flow. A newly developed concept of the Barrier Verification System allows oil and gas operators to do this. The concept allows the creation of negative pressure between the

installed barriers and a verifying device. In doing so, a test in the direction of flow can be carried out. The Barrier Verification System can then document the setting of the installed barrier, pressure test, downhole temperature and loads that the barrier is exposed to. The overall time spent testing the barrier has been significantly reduced along with stress exposed to the wellbore that would typically be seen during a conventional positive pressure test. The service is available across industry standard tubing/casing weights. *interwell.com*

### New teaching methods include rig installation and operations training

Kerui Group is promoting its drilling rig and digital immersion teaching system, which adopts a combination of operating real drilling rigs and the added safety of digital simulation. The system includes rig installation and operations training. Kerui is able to show the installation processes of rig parts through 3-D and interactive animations, including environmental sounds, alarm systems,

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real-time voice simulations, etc. Kerui's teaching drilling rig can provide training of the rig installation process, round-tripping, rig accessories operation, downhole accidents and complex situations for students. The training rig uses the company's advanced self-lifting mast and box-on-box type substructure. It is also equipped with a train-type rig transportation system, which can move the entire rig integrally. Different from the classical classroom screen projection teaching mode, the teaching drilling rig is a new teaching method that adopts the latest 3-D simulation technology as well as virtual reality. [keruigroup.com](http://keruigroup.com)



Kerui is able to show the installation processes of rig parts vividly through 3-D and interactive animations. (Source: Kerui Group)

### Real-time microseismic completions evaluation analysis

Real-time microseismic monitoring from anywhere in the world has allowed operators to make better and more economic decisions as they see the impact of hydraulic stimulation on the reservoir in real time. MicroSeismic has released its next generation of real-time monitoring, allowing for on-the-spot completions evaluation. For real-time fracture modeling, users can determine fracture size and orientation as data are acquired, allowing a realistic real-time visualization of the fracture treatment. For dynamic stimulated reservoir volume (SRV) estimation, users can model fracture intensity and induced permeability to allow real-time analysis of SRV and productive SRV. For end-of-stage EUR and drainage estimation, users can generate permeability models and type curves for rapid assessment of induced drainage area and overall productivity. In addition, for rapid stress analysis users can get detailed moment tensor data for analysis of the interaction of the stress regime and the treatment. By having the ability to change completions activities faster and with more confidence, operators will have the opportunity to increase productivity and EUR. [microseismic.com](http://microseismic.com)

### Drilling tools designed to increase efficiency

Among NOV's ReedHycalog offerings, the VectorEDGE rotary steerable system (RSS) is the first RSS tool designed specifically for performance drilling of vertical and lateral sections in unconventional wells. This cost-effective and fit-for-purpose tool can be run in conjunction with a mud motor and enables directional drillers to achieve higher drilling performance in vertical sections and extended laterals while maintaining borehole quality and accuracy. The Tektonic drillbit platform offers a comprehensive solution to drilling challenges. By fusing the high durability and toughness of FuseTek hybrid bits with the Chainsaw cutter arrangement of ION 3-D cutters, the platform allows longer intervals to be drilled along with a more robust solution for hard-to-drill applications. Advanced hybrid technologies with high-density diamond-impregnated elements deliver a flexible element that's tough yet wear-resistant, and HydroShear nozzles have been added to the platform to minimize heat cutter degradation and increase hydraulic shear near the cutter face. [nov.com](http://nov.com)



The VectorEDGE RSS is a simple and cost-effective 3-D push-the-bit RSS that provides full directional control of the wellbore under full rotation of the drillstring. (Source: NOV)

### System provides shale inhibitive properties at low cost

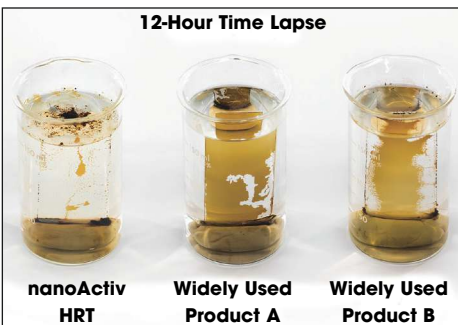
Newpark Drilling Fluids has released Navigate, a direct emulsion fluid system. In today's performance-driven unconventional environments, operators are seeking new ways to deliver a higher quality and more productive wellbore in fewer days and at a lower cost. Navigate was derived through a rigorous product development process focusing on material optimization and has resolved problems associated with conventional invert emulsions. Where formation stability and/or losses are a concern, Navigate provides shale inhibitive properties at a lower cost than conventional invert emulsions. Its shear-thinning rheological characteristics allow a lower

retention on cuttings. In a recent well the Navigate fluid system saved the operator time and money by drilling 28% faster and coming in 33% under budget in the highly unconsolidated and troublesome Oklahoma shales. [newparkdf.com](http://newparkdf.com)

### Enhancing hydrocarbon recovery with nano-mechanical process

Improving well intervention technologies such as hydraulic fracturing and remediation to effectively and efficiently stimulate productivity remains a challenge. Nissan Chemical America Corp. (NCA) will showcase nanoActiv HRT, a high-efficiency hydrocarbon recovery technology well intervention additive package and method. nanoActiv HRT particles penetrate beyond the induced fracture network on a nanoscopic scale, producing a diffusion-driven mechanical force known as disjoining pressure. These particles deliver long efficacy in the recovery of hydrocarbons, fragmenting them into smaller droplets and enabling an efficient backflow to the wellbore. Over the past two years this technology has been applied in more than 50 wells in the Permian Basin in several reservoirs (Wolfberry, Wolfcamp B, Wolfcamp Sand, Brushy Canyon, Woodford, San Andres) and in North Dakota (Three Forks,

Bakken, Codell-Niobrara). In these applications nanoActiv HRT has significantly reduced decline rates after stimulation while consistently delivering higher oil cuts and gas/oil ratios in conventional and unconventional reservoirs. [nanoActiv.com](http://nanoActiv.com)



**12-Hour Time Lapse**

A 12-hr Hele-Shaw time-lapse test consistently demonstrated that nanoActiv HRT (left) delivers more efficiency, better fragmentation and greater production of oil to the surface than other widely used products (center and right). (Source: Nissan Chemical America Corp.)

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## Test mechanical properties of well cement

The TLF-112 triaxial mechanical properties testing system from OFI Testing Equipment Inc. is the first instrument specifically designed to physically measure the complete mechanical properties profile of well cements. It provides compressive strength, Young's modulus, Poisson's ratio and tensile strength (Brazilian method) measurements of set cement samples. These samples can be tested at temperatures up to 240 C (400 F). Confining pressures up to 10,000 psi are applied through an integrated pressure system, which makes operation simple and easy. The compressive strength of a sample is first calculated by applying force until the sample fails. On a separate sample, the precision hydraulic system automatically applies cyclical forces (stresses), while strain gauges measure the dimensional changes. The advanced software uses stress and strain to calculate Young's modulus and Poisson's ratio. Indirect tensile strength is measured by applying force to the sides of the sample via a special fixture until failure. *ofite.com*

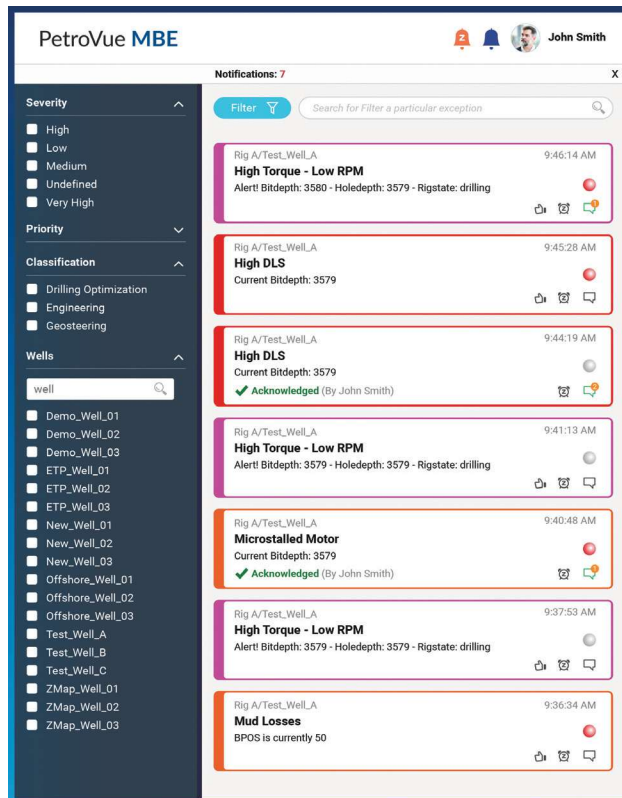


**The TLF-112 testing system measures the mechanical properties of set cement. (Source: OFI Testing Equipment Inc.)**

## System relieves alert overload

The Manage-By-Exception (MBE) system provides the alerts needed when and where users need them. Operators have numerous wells that need to be monitored at all times. Paying attention to each screen and which alerts are most important can be unmanageable. The result is alert overload. MBE lets users define what alerts they wish to see and constantly monitors the condition of the defined rule. The system then raises only the priority alert to exactly the right person, relieving alert overload and ensuring people are paying attention to only the most important alerts. Alerts are distributed to all global users, are viewable to online users and are sent via email and SMS text to remote personnel. An alert activity stream brings the mission-critical and related

drilling conditions front and center, improving the user's situational awareness. MBE generates notifications on predictive alerts and events and includes a display link providing detailed analysis. *petrolink.com*



**Petrolink's MBE alert activity stream helps users work smarter by bringing mission-critical drilling conditions to the forefront. (Source: Petrolink)**

## The last word in last-mile logistics

PropX will be showcasing its PropX Box system and PropBeast Conveyor Belt, which can move up to 20% more proppant per truckload, and because the trailers are standard off-the-shelf flatbed trailers, each truckload costs less to transport. In addition, PropX systems emit much less silica dust than incumbent methods, allowing customers to meet the expected 2018 OSHA standards. Because unload times at the wellsite are an order five to 10 minutes per load rather than 45 to 60 minutes per load and fewer truck traffic jams occur, demurrage (standby time for truckers) is eliminated. The gravity-fed containers are quiet and very efficient, with one Denver-Julesburg fracturing crew delivering more than 9.2 million pounds of sand during a recent 24-hr period and doing it dust-free. PropX systems were designed to help protect the environment. *propx.com*

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This photo shows the minimal footprint of the PropX systems. (Source: PropX)

### Plug provides efficient pump down, secures frack and quick mill up

Rubicon Oilfield International has released the RZR-FRAC Composite Frac Plug. The patent-pending design provides 10,000 psi at 149 C (300 F) anchor and seal using 70% less material than the industry-accepted alternative. Engineers focused on creating the most optimized composite fracture plug designed to provide efficient pump-down, secure frack and quick mill-up. The plug's plastic seal ring delivers a competent seal without responding to fluids, providing a more efficient pump-down operation with significantly less risk. During the fracture, the slips have been designed specifically to interface with the inside diameter (ID) of the casing, providing a higher anchoring force. Finally, during mill-up the 100% composite construction, 24 small ceramic buttons and large ID provide an average mill time of five minutes with very small cuttings. The RZR-FRAC portfolio includes plugs to cover all the standard casing sizes. [rubicon-oilfield.com](http://rubicon-oilfield.com)

### Company provides real-time fracture diagnostics

Seismos provides customers with stage-by-stage fracturing insights including fracture conductivity, fracture network complexity, fracture closure rates, cluster treatment analysis, proppant placement efficiency, gel breakdown times and more. With a combination of smart instrumentation, software and geophysics, Seismos provides real-time fracture diagnostics. The company shows operators their ability to optimize designs and prevent over-flushing to obtain optimal per-stage conductivity. The real-time application allows users to modify designs on the fly to optimize every stage's production. This requires

no operational impact, no offset wells and zero geologic restrictions. [seismos.com](http://seismos.com)

### Liquid-in/liquid-out problems of downhole chemical tracing solidly solved

Any liquid pumped into a formation with pressure is just as easily squeezed out of the formation via pressure. This liquid-in/liquid-out phenomena has been a known problem in the downhole chemical tracing industry for years and produces inflated and/or false positive readings of tracer recovery. Newly patented SOLID tracer chemical products successfully address the pressure-related limitations of liquid tracer chemicals.

The solid particulates (sized 40/70 sand) are pumped into the fracture pack during stimulation and transported deep into the formation along with the proppant. The solid particulates remain locked in the fracture pack, thereby eliminating the liquid-in/liquid-out data errors. These new particulate tracers provide accurate short-, medium- and long-term datasets. [spectrumtracer.com](http://spectrumtracer.com)

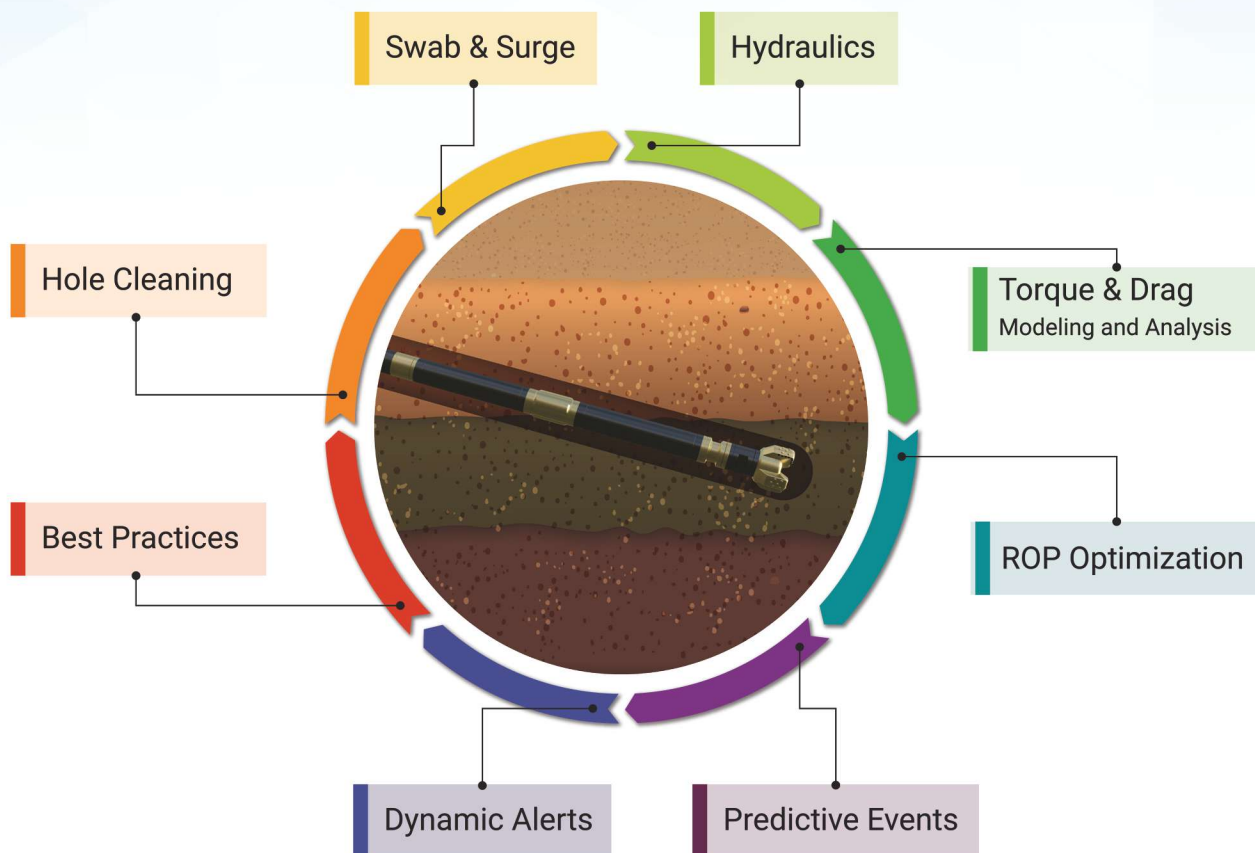


A solid particulate oil soluble chemical tracer is shown. (Source: Spectrum Tracer)

### Stay ahead of the competition

The Sproule Type Curve Analysis Database and Report helps operators shorten time spent screening opportunities, evaluating producing wells and benchmarking performance. From evaluating acquisition and divestiture opportunities to development planning, everyday critical business decisions are made using type curves analysis. Sproule's new up-to-date and accurate dataset helps users increase efficiency. This complete and consistent production profile dataset is available for 14 key resource plays across Western Canada. Visit Sproule at booth 2852 to receive a sample report. [sproule.com](http://sproule.com)

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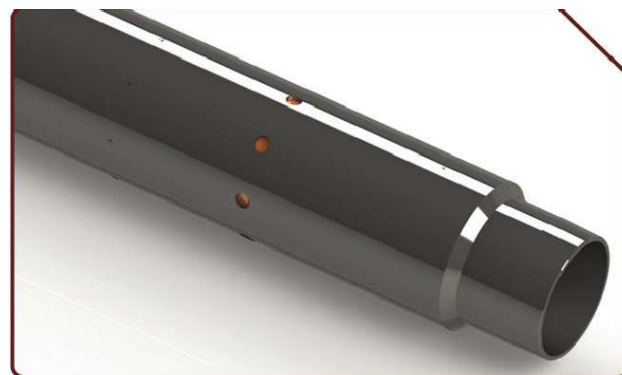


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## Reservoir pattern surveillance and intelligent well rate targets for mature floods

StudioSL's reservoir pattern surveillance module is Streamsim's solution to allow the proactive optimization of mature floods through updating well rate targets. Specifically, streamlines are used to identify well patterns, which are displayed and quantified using a patented Flux-Pattern Map (Figure 1). Based on the pattern metrics, pattern sweep efficiencies are modified through the reallocation of injected and produced volumes. As new production/injection data are collected, the analysis is repeated, allowing a nearly continuous rate-target management strategy to maximize field recovery with existing wells. StudioSL's surveillance module promotes good sweep and demotes fluid cycling. The Flux Pattern map display is particularly helpful in justifying well rates changes to the operations team when cutting back low-efficiency oil production is needed to realign a flood. [streamsim.com/technology/studiosl](http://streamsim.com/technology/studiosl)

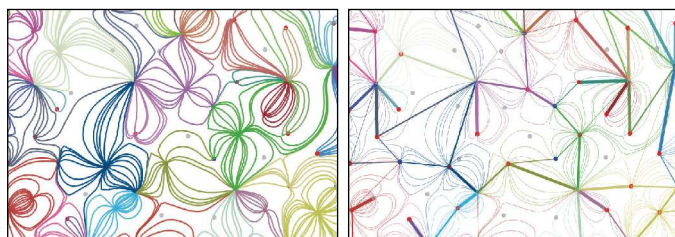


**TAM's hydraulic port collar is ideal for monobore completions. (TAM International)**

packers to improve casing cement integrity without any risk of creating a critical leak point in the casing. Another new technology is a hydraulic port collar that is placed above the inflatable casing annulus packer to allow cement to be placed in the annular space. The hydraulic port collar has a new closing plug seat design that, once pressure is applied, will pump out and fall to the shoe track. [tamintl.com](http://tamintl.com)

## EURs: new production forecast database of all active wells

The TGS Production Forecast Database is a library of every well in the U.S. containing both a monthly production projection and EUR total. When combined with the Longbow

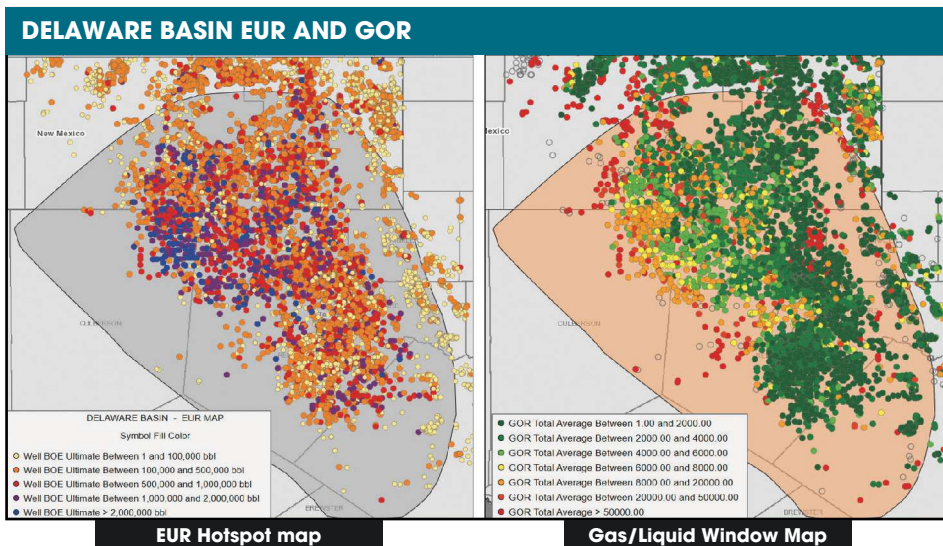


**FIGURE 1. Streamlined paths at a particular moment in time for a mature-pattern waterflood (left) and the associated Flux Pattern Map (right) with connection thickness**

related to each well's production allocation factor are displayed in studioSL. Red points are producers, blue points are injectors and gray points are closed wells. A pattern is considered a parent injector with connected producers. (Source: Streamsim)

## New casing technologies showcased at SPE ATCE

The Deadbolt SafeLok system guarantees casing integrity when using inflatable casing annulus packers to improve cement integrity against gas migration or lost circulation zones. The Deadbolt valve offers the proven reliability of the SafeLok valve system with absolute assurance of preventing any casing leaks after functioning. This system allows operators to use inflatable casing annulus

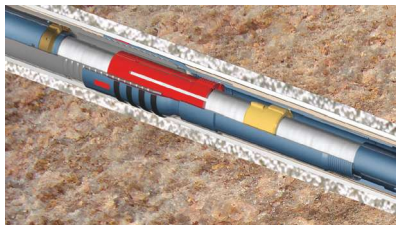


**This image shows a Delaware Basin side-by-side assessment of EUR values and gas-oil ratio (GOR) calculations. The left map, EUR hot spots, identifies spatial patterns of high-value wells and acreage. The right map, correlating wells by GOR value, interprets the oil and gas window in the play, enabling asset evaluators to identify commodity streams of choice. (Source: TGS)**

desktop visualization tool, entire EUR basin studies can be built in minutes. This forecast engine leverages the TGS Well Performance Database to create forward production curves for all active producing wells derived from historical production data. Curves are generated using hyperbolic fitting, but this model's advantage includes extended Kalman filter (EKF) techniques incorporated into the process. EKF emphasizes the most recent data, identifies trends and adjusts logic on the fly using a series of matrix math techniques, resulting in improved efficiency and accuracy. It is the first time to the company's knowledge that the EKF theory is used in oil and gas forecasting. [tgs.com](http://tgs.com)

### System sets size record for expandable liner hanger installation

The XPak expandable liner hanger/packer system from TIW was recently used to successfully hang an 18 $\frac{3}{8}$ -in. outside diameter (OD) liner in 24-in.



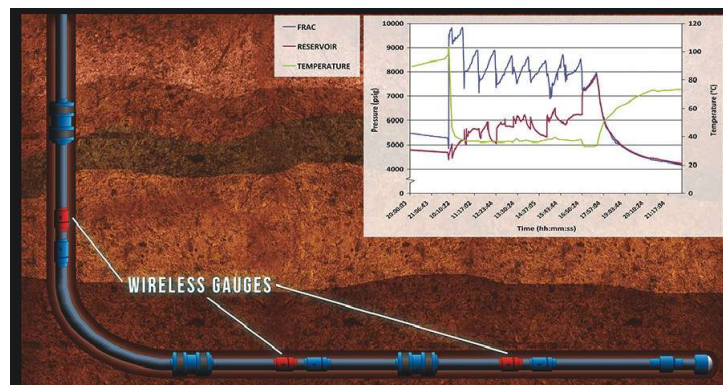
**TIW's XPak expandable liner hanger/packer system is shown with the hanger expanded just prior to removal of the setting tool. (Source: TIW)**

OD electric-resistance weld (ERW) seamed casing. The system design eliminated a two-stage cement job in unstable formations and provided greater well control. The liner penetrated 670 m (2,200 ft) of difficult and unstable geology, including water zones, sloughing shale and lost-circulation zones. The slip design provides a hanging load capacity equal to or greater than conventional liner hangers. Stacked metal-to-metal seals and elastomer backup seals with no extrusion gaps provide a HP/HT gas-tight liner-top seal. A honed inside diameter receptacle in the upper portion of the expander allows tie-back to surface or patching a cased-hole section. Successful qualification testing prior to running the XPak system has confirmed that the modified system can effectively seal in ERW seamed casing. [tiwoiltools.com](http://tiwoiltools.com)

### Wireless gauges provide real-time information

DATALIFT is a plunger module that lifts data from gauges downhole. Gauges record pressure/temperature data to memory and transfer data wirelessly to the DATALIFT as the module approaches the gauges. DATALIFT returns to the surface, and the acquired data are used to identify artificial lift requirements and provide production and reservoir optimization information. SHALECOMM is a real-time wireless gauge for onshore and offshore appli-

cations. The gauge generates acoustic energy to transfer data to the surface using the downhole pipe as a conduit. SHALECOMM replaces cable-based gauges, eliminating rig floor installers, downhole cables, clamps and protectors. Wireless gauges can optimize production, artificial lift and gravel/fracture pack operations. In addition, the company's FRACWATCH high-shock wireless short-hop gauges can be placed in the horizontal section of the well and monitor the fracture flowback and are deployed as part of the casing. [tubelenergy.com](http://tubelenergy.com)



**Tubel's downhole wireless fracture monitor acquires reservoir and fracture pressure/temperature data simultaneously downhole during fracturing. (Source: Tubel Energy)**

### Connection designed for challenging environments

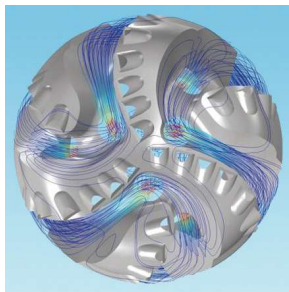
Vallourec will be presenting VAM X-Force, a connection designed to mitigate drilling risks and reduce total drilling costs in challenging environments. This connection pushes the limits of the existing technologies to reach deeper, more remote hydrocarbon reservoirs while achieving higher ROP and lowering nonproductive times. By combining the traditional double-shoulder design with a thread profile, VAM X-Force demonstrates excellent mechanical, operational and economic performance. The tool provides high torque and fatigue life without degrading the tensile strength of the connection. It also increases the speed of makeup, saving time on the rig without degrading break-out torque. [vamxforce.com](http://vamxforce.com)



**VAM X-Force is designed to reach deeper, more remote hydrocarbon reservoirs. (Source: Vallourec)**

## Improving cooling, cleaning and cuttings evacuation

Varel Oil & Gas Drill Bits will showcase its HYDRA hydraulics optimization program for tailoring PDC bit hydraulics. The program improves bit performance with better bit cooling and cleaning along with more effective cuttings removal. The Hydra approach precisely applies curved nozzles, webbed blades and other features using computational fluid dynamics to match the design to the application. The curved nozzles reduce coreouts, plugged nozzles and bit balling, while webbed blades limit cuttings recirculation, eliminate entrainment and increase cuttings volume. Fine-tuning these technologies for the application using the HYDRA optimization program is significantly improving cooling, cleaning and cuttings evacuation for greater bit life and drilling efficiency. Vertical and lateral applications in the Permian Basin have improved ROP and footage drilled in softer clays and shale as well as sands and limestone. For instance, in a Wolfcamp Formation lateral the optimized bit increased ROP 58% and footage by 98%. [varelintl.com](http://varelintl.com)



**The Hydra approach precisely applies curved nozzles, webbed blades and other features using computational fluid dynamics to match the design to the application. (Source: Varel Oil & Gas Drill Bits)**

## Technology enables surface water discharge

Veolia Water Technologies will be showcasing its CoStrip degasifier technology in a technical paper to be presented Wednesday, Oct. 11, at 3:45 p.m. in the Process and Monitoring session. CoStrip effectively removes dissolved gases without the need for pretreatment. Unlike conventional degasification towers with packed beds susceptible to plugging and fouling, Veolia's patent-pending CoStrip degases raw water by introducing microbubbles of a stripping gas counter-current to the liquid stream. Typically installed in a treatment train that enables surface water discharge, it reduces chemical and sludge costs when paired with chemical softening and extends the life of reverse-osmosis membranes. CoStrip is designed for easy reliable maintenance-free operation and can be supplied as a fully assembled skid-mounted system for easy installation and lower total installed costs. For more information, visit the company at booth 1233 to learn more. [veoliawatertechnologies.com/en](http://veoliawatertechnologies.com/en)



**CoStrip is designed for degasification of water streams containing high loadings of oil and suspended solids. (Source: Veolia Water Technologies)**

## Tools provide a more complete understanding of downhole issues

Visuray will be showcasing its downhole X-Ray Platform, a family of tools and services. There will be specific focus on the new VR90s advanced diagnostic service, which is commercially available. The VR90s tool features a smaller tool diameter and higher temperature rating compared to the original VR90 downhole X-ray diagnostic tool, along with millimetric scanning of zones of interest and a wider field of view. During intervention activities Visuray's downhole X-ray diagnostic services provide reliable imaging in any well production fluid without special well preparation. With its improved specifications, the new VR90s tool brings the power of X-ray diagnostics to more wells and provides a more complete understanding of the downhole issue, thus allowing operators to work more efficiently. [visuray.com](http://visuray.com)



**The new VR90s tool brings the power of X-ray diagnostics to more wells. (Source: Visuray)**

## Mitigate risk and optimize performance

Weatherford will feature technologies for drilling performance, fracturing and completion optimization, production optimization, and digital intelligence.

These tools include not only new technologies but also proven solutions. The ForeSite production optimization platform connects the entire production ecosystem to maximize performance throughout the reservoir, wells and surface facilities. The AccuView system supports a real-time collaborative environment and facilitates significant strides in well-construction efficiency. The conventional AutoTong system automates the makeup, breakout and evaluation of pipe connections to enhance well integrity. The company's Compact wireline tools have a long history of reliable performance, helping customers acquire reservoir data efficiently and safely. In addition, smart gas-lift systems monitor production and control injection, and jet-lift systems deliver high volumes without failure, increasing uptime. By connecting insights from the wellsite to the office and combining historical data with forward-looking technologies, Weatherford helps customers mitigate risk and optimize performance. [weatherford.com](http://weatherford.com) **ESP**



The ForeSite platform connects the entire production ecosystem to maximize performance throughout the reservoir, wells and surface facilities. (Source: Weatherford)

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# Enabling the human in a digital age

Are the customers satisfied? Retail and finance metrics can help maintain producing assets.

**JoAnn Meyer and Timothy Deines,**  
3GiG and Previs Consulting

In year three of lower oil prices, cash is indeed king. Companies are using digital technology to wring every last ounce of value from producing assets. Sensors continuously monitor well operating conditions and send alerts when well behavior is not as expected. Engineers then use sophisticated analytics software to diagnose root causes of dysfunction and develop statistically valid recommendations.

But are companies leveraging digital capabilities to enable humans to deliver excellent execution of those remedial recommendations?

With recommendations in hand, how can digital technology help engineers work with operating personnel and contractors to execute remedial actions in the shortest time possible? Companies have processes for the various well interventions needed, but is each person clear on what they need to do today to return wells to production as quickly as possible? Do process team members have the data and tools necessary to analyze and improve the effectiveness and efficiency of execution activities just as remote operations centers continuously improve well diagnosis?

Accelerating the rate at which wells are returned to production increases cash generated and maximizes asset value. There is an opportunity to combine successful practices found in other industries and use available digital technology such as 3GiG’s “Return to Production” Management (RPM) tool to reduce the time needed to perform remedial activities and get wells back online. RPM creates continuous visibility of wells needing attention, where each well is in the intervention process and who is responsible for which actions to return the well to production. Not only does standardizing and optimizing human activity during the response process increase cash flow, it also allows valuable “human” time to be applied to innovation and process improvements.

3GiG’s RPM tool strengthens an organization’s standard human workflows by capturing and codifying them in a technology platform that can be easily modified for process improvements by the user without the IT department.

## A complex challenge

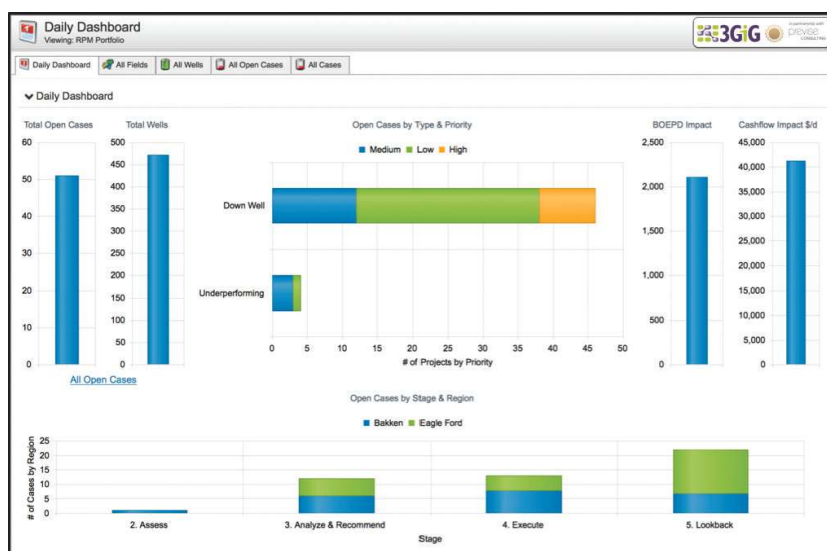
Optimizing intervention in shut-in or underproducing wells is not a new challenge. There are numerous people interactions required, and the ability to reduce the time a well is down is increasingly complex since:

- North American portfolios contain large numbers of operated wells;
- Human and financial resources are limited in the current economic environment; and
- Wells and related infrastructures are aging. Keeping hundreds or thousands of wells producing as expected tests the limits of even the best engineering and operating teams.

To reduce well intervention time, consider the guiding principles of the retail and financial industries:

1. The customer is always right.
2. Time is money.

Top performers in other industries recognize where value is created: their customers. When customers receive what they want when they want it, cash registers. The most successful companies



This overview dashboard shows where dissatisfied wells are in the intervention process, demonstrates the business impact and highlights opportunities to adjust people resources in real time. (Source: 3GiG and Previs Consulting)

commit resources every day to the execution of excellent customer service. Adopting these principles for the well intervention process will reduce the time needed to return a well to production and ultimately increase average annual production.

### The customer is always right

Most would agree that the point of value creation in the upstream industry is the well. But how many companies treat their wells as customers?

If treating a well as a customer seems outlandish, consider the similarities between human customers and well customers: A person exchanges currency for a product or service. The well offers currency in the form of oil and gas production in exchange for an obstacle-free flow path from the reservoir to the sales meter. When an organization acts quickly to remove any barriers in that flow path, the well has received excellent customer service.

To gauge the commitment of a company for offering excellent well customer service, consider what questions are asked at the start of each workday:

- How many wells are down or underproducing today?
- How many wells are in each step of the customer service process (i.e., problem diagnosis, recommendation development, execution of the fix)?
- Who is the “customer service representative” responsible for actions needed today and at every step until the problem is resolved?

If these questions are unasked or unanswered, a company might be leaving barrels in the ground. Companies with excellent customer service recognize that customers should spend as little time as possible in an unsatisfied state. Knowing how many wells are satisfied and how many are not should be a key metric reviewed every day. And an organization’s focus on production surveillance should not be confused with a commitment to providing excellent well customer service.

### Time is money

For producing oil and gas fields, well “on-time” is money.

This reality is understood, but few companies measure and track well intervention time as a key metric that influences revenue. Answers to the following questions should be common knowledge in the organization:

- What is the average length of time a well is down or underproducing once in distress?
- Is the average length of time trending up or down?
- How often, on average, does a well become dissatisfied, either down or underproducing?

The data required to answer such questions, even if available, often have minimal visibility. Similarly elusive is an

understanding of where in the process—problem identification, diagnosis, recommendation development or execution—improvement efforts will deliver the most value.

By treating every well as a customer and measuring key process metrics, daily goals of the well intervention team are clarified: Execute the complete well customer service process to ensure the least time possible in an unsatisfied state.

Instead of focusing on surveillance, analysis or repair tasks, the team needs to deliver excellent customer service to each dissatisfied well.

### Committed to reducing downtime

It’s possible to generate more cash and maximize asset value by incorporating human workflow data into the analytics used for continuous improvement by:

- Committing to minimizing the time wells are dissatisfied by defining and adhering to a “well customer service” process;
- Adopting standard operating procedures for the well customer service process. This replaces unique or random response actions and generates consistent data to assess the effectiveness of each process step while enabling continuous improvement;
- Developing tangible metrics such as time to reinforce the importance of efficient execution of the well process activities; and
- Creating visibility and accountability into the process by tracking wells through every handoff during execution of the “fix.”

Companies using digital technology to enhance both mechanical and human capabilities can outperform their competitors by increasing production through the reduction in well downtime. Tools like RPM can standardize human actions in the well intervention process, modernize measurement of value-adding tasks and reinforce utilization of the most effective, efficient remediation steps.

Marrying state-of-the-art process measurement with the well intervention process will create visibility, clarity and alignment for teams of operating and engineering personnel to get wells back to producing in the shortest time possible. These clear objectives and visibility will promote commitment and unleash the ingenuity of teams.

In the digital age machines are taking on routine tasks, but decisions, execution and process innovation will continue to benefit from a human touch. **ESP**

**Have a story idea for Tech Watch?** This feature highlights leading-edge technology that has the potential to eventually address real-life upstream challenges. Submit your story ideas to Group Managing Editor Jo Ann Davy at [jdavy@hartenergy.com](mailto:jdavy@hartenergy.com).

### Insight into an operator's drillsite

Operational efficiency is the key to running a well-organized job. But what if things aren't going as smoothly as they could be? The OptiWell well construction performance service offered by Schlumberger scrutinizes downhole and surface conditions, helping users pinpoint risks and areas of improvement, and it ultimately lowers HSE risks, invisible lost time and nonproductive time, according to the company. The service is customizable to better address the needs of wells. For one well in deepwater Vietnam, the OptiWell service diminished riser running time by 14% and average in-slip time by 13%. And in an onshore pilot well in United Arab Emirates the service saved the operator two days of drilling time. The customizability of this service empowers operators to identify and correct specific inefficiencies in their current plan for a clean job that runs smoothly and effectively. *slb.com*

### Remote surveillance for subsea equipment manufacturing

DNV GL developed a solution for remote surveillance service for subsea equipment manufacturing, a press release stated. The primary goal of this new alternative was based on cost savings, improved safety for surveyors, increased flexibility on testing schedules, availability of experts and transparency for all stakeholders. Remote witnessing equips technicians with hardware and software that provide remote support or, depending on the type of test and its critical points, a standalone camera system that can be installed to increase savings and flexibility. At the local office a DNV GL surveyor is connected to the technician, delivering technical expertise in a timely manner. *dnvgl.com*

### Real-time monitoring system designed to improve uptime

National Oilwell Varco (NOV) has developed and refined the CTES condition-based monitoring (CBM) system to cover intervention applications for coiled tubing (CT) and nitrogen equipment. The CTES CBM system is a custom real-time monitoring system designed to improve uptime and reduce maintenance costs by identifying potential failures early, according to the company. In CT applications the system can be configured to monitor pump, bearing, filter and engine health along with hydraulic power and lubrication systems or specific bearings of motors or pumps. If equipment is not within acceptable tolerances, a visual alarm is displayed, and recipients on- and offsite are notified. When used in liquid nitrogen (LN<sub>2</sub>) applications, the system monitors the condition of LN<sub>2</sub> in the pumps and piping while simultaneously observing wear components. The system mon-

itors and visually reports on current equipment health, subsystems and processes, including the boost bump, high-pressure pump and vaporizer. Using the CTES CBM system in LN<sub>2</sub> applications allows collection of data for analysis while also helping the operator optimize equipment placement to improve performance. *nov.com*



NOV's CTES CBM system now works with CT and LN<sub>2</sub> applications. (Source: NOV)

### New ROV for energy market

UUV Aquabotix Ltd. has released a new model of its Endura ROV designed specifically for the energy market, a press release stated. The Endura NRG is engineered to be more dependable in high-current situations offshore and effective across a wide range of underwater inspection applications, including infrastructure, dams and reservoirs. The Endura NRG features a grabber arm for stability that enables the vehicle to stay anchored in high currents as well as a 360-degree external camera, unavailable on other inspection class ROVs, which allows users to drive the vehicle into currents and point the camera toward inspection areas. *aquabotix.com*

### Drilling jar clamp designed for increased safety, well integrity

Emerson Automation Solutions has released its PolyOil jar handling clamp for increased safety and well integrity, a press release stated. One key threat to well integrity and safety in drilling and completions operations is the danger of jars firing prematurely at the surface prior to being deployed into the well. Jars are mechanical devices used downhole to deliver an impact load to another downhole component (especially when that component is stuck) and include a firing mechanism that activates when the necessary compression or tension has been applied to the running string. The inadvertent firing of such jars prematurely, however, can pose a hazard and lead to possible injuries and the dropping of the bottomhole assembly if pins are sheared. The new PolyOil jar handling clamp acts a safety device to prevent the jar from cocking and firing, with the jar unable to

fire unless the fishing neck—designed to enable running and retrieval tools to reliably engage and release—is closed. Therefore, when the clamp is fitted to the jar, the rod is kept in the open position, thereby preventing premature firing during the handling of the jar at the surface. The clamp also prevents the jar rod from being damaged during transportation and keeps it debris-free during storage. Applications for the new jar handling clamp include drilling, drillstem testing jars, coiled tubing and wireline applications. *emerson.com*

### Gangway to support work in higher sea states

Ampelmann has launched its latest gangway for personnel transfer: the A-type Enhanced Performance (A<sup>EP</sup>). The gangway provides users with 10% greater workability in sea states with significant wave heights up to 4 m (13 ft). The A<sup>EP</sup> also has the ability to use smaller vessels to obtain similar performance (compared to the current A-type). The gangway features an advanced motion compensation control system with precision controls to enable fast landing and comfortable people transfers. The system significantly improves operational uptime on projects year-round and provides benefits to operators in rougher waters, including the North Sea and the coasts of South America and the Middle East. *ampelmann.nl*

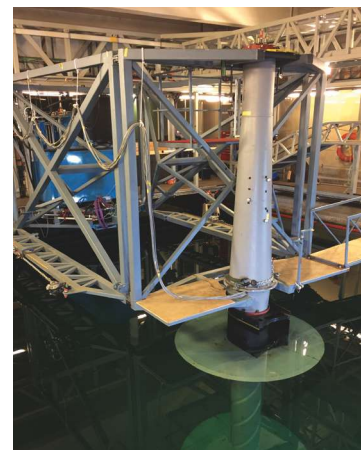


The A<sup>EP</sup> can be used to ensure comparable workability on a relatively small vessel where bigger vessels were needed before, saving cost by allowing flexibility in positioning on the vessel. (Source: Ampelmann)

### Buoyancy design eliminates VIV in high currents

A major milestone was successfully completed under the joint development agreement between Diamond Offshore Inc. and Trelleborg, which focused on the creation of a helically grooved buoyancy design with enhanced performance for drilling riser operations in high current conditions. Test results revealed that when using the patented design, vortex induced vibration (VIV) is effectively eliminated in high cur-

**Tow tank testing on the patented helically grooved design was performed at SINTEF Ocean's Tow Tank facility in Trondheim, Norway. The joint facility, under SINTEF and the Norwegian University of Science and Technology, tested the buoyancy design in the supercritical flow regime representative of offshore current conditions. (Source: Trelleborg)**



rents, with the added bonus that drag loading on the riser is also reduced to a level comparable with fairings, a press release stated. In June tow tank testing on the helically grooved design was performed in Trondheim, Norway. The extensive test program provided valuable hydrodynamic data confirming the design's drag reduction and VIV suppression performance. Fixed and dynamic drag coefficients of the new design were recorded during separate fixed and free vibration tow testing. Drag coefficients at an average of 0.65 were observed for relevant flow regimes, which is comparable to the performance of riser fairings. This is achieved through the highly successful VIV suppression of the design, effectively eliminating VIV response and subsequent drag amplification in the high excitation response range of offshore drilling risers. Forced motion testing of the helically grooved design was also performed to better understand excitation of the riser under high current conditions and for the development of lift coefficient data for use in analytical fatigue damage prediction programs. The helical drag reduction and VIV suppression performance shows strong independence of current speed, which is consistent with the behavior of an external helical strake. However, the underlying flow physics causing the suppression are quite different, leading to the suitability of the helically grooved design for large-diameter drill riser buoyancy. *trelleborg.com* **E&P**

Please submit your company's updates related to new technology products and services to Ariana Benavidez at [abenavidez@hartenergy.com](mailto:abenavidez@hartenergy.com).

To enter your product or service for an 2018 Meritorious Engineering Award, go to [epmag.com/mea/mea-process.php](http://epmag.com/mea/mea-process.php)

Deadline: Jan. 31, 2018







# Middle East producers readjust strategy focus

Investments focus on adding new capacity.

**Abdelghani Henni, Contributing Editor**

Following the dramatic decline of oil prices, oil and gas producers in the Middle East have readjusted their strategies and priorities to adapt to the new price levels, especially since oil revenue remains the main source of income for countries in the region. The Middle East controls more than 51% of the global proven crude reserves and 42.2% of the world's proven gas reserves. These reserves are, for the most part, located in super-giant or giant oil fields. Among the 20 giant oil fields in the world, 13 are located in the region, mainly in Saudi Arabia, which has five super-giant fields that include Ghawar and Safaniya. Additionally, there is Rumaila in Iraq, Zakum in the United Arab Emirates (UAE) and Burgan in Kuwait. Qatar and Iran share the world's largest gas deposit, the North Field in Qatar and the South Pars in Iran.

The region is also the world's leading oil producer. Five countries produce more than 2 MMbbl/d, and the cost of oil exploration from the region is considered the

lowest in the world, at an average of \$3/bbl, compared to other regions, where the cost is about \$20/bbl.

"Amid the current oil prices, the prospects for increased oil production vary significantly from country to country as ongoing investment focuses not only on the development of new capacity but also on compensating for the natural decline in current deposits despite OPEC's decision to slash output to support prices," said Mohammed Maameri, head of research at Saudi Arabia-based Argaam Business Info.

The majority of the announced development projects are offshore fields located in the Arabian Gulf, one the world's shallowest seas with depths rarely exceeding 100 m (328 ft), compared to the Red Sea, which remains underexplored.

## Saudi Arabia: offshore focus

For instance, Saudi Arabia, the world's swing producer, decided to float a 5% stake of Saudi Aramco in a move that aims to diversify the kingdom's economy. Saudi Aramco, which operates 130 fields, according to its 2016 annual review, unveiled a plan to invest more than \$300 billion over the next 10 years in oil and gas as it looks to counter the effects of investment decline and a potential energy shortage.

"We plan to invest more than \$300 billion over the coming decade to reinforce our preeminent position in oil, maintain our spare oil production capacity and pursue a large exploration and production program centering on conventional and unconventional gas resources," said Saudi Aramco's CEO Amin Nasser during his keynote speech at the World Petroleum Congress in Istanbul, Turkey.

Saudi Aramco also reported that recoverable crude oil and condensate reserves totaled 260.8 Bbbl at year-end 2016, little changed from 261.1 Bbbl in 2015. Gas reserves grew to 8.5 Bcm (298.7 Tcf). The majority of the kingdom's oil production comes from onshore sites such as the giant Ghawar Field, which accounts for 7% of total global oil supply. Meanwhile, the company's offshore production contributes to almost 20% of the country's production, namely Safaniya, Marjan, Zuluf, Berri, Manifa and Abu Safah, a field it shares with Bahrain.



**ADNOC's Umm Shaif Super Complex is located 150 km (93 miles) from Abu Dhabi, with 3.9 Bbbl and production of about 300,000 bbl/d. (Source: ADNOC)**



In 2016 Saudi Aramco said it made progress with the Shaybah and Khurais oil fields, which are set to rebalance its crude quality and help compensate for other mature fields, thus keeping Aramco's oil production capacity unchanged at 12 MMbbl/d. The company said it started production at 250,000 bbl/d at the Shaybah Field, raising its overall production capacity to 1 MMbbl/d of Arabian extra light crude oil, doubling the facility's original capacity. Meanwhile, Saudi Aramco expects to start production from Khurais Field by mid-2018, which will raise capacity from 1.2 MMbbl/d to 1.5 MMbbl/d.

The company also has recently launched studies to expand its offshore oil fields Berri and Marjan, as it aims to increase production by 250,000 bbl/d of crude oil from Berri, possibly by building drilling islands offshore in the Gulf, while also processing higher pressure associated gas for sweetening in Khursaniyah. In July Aramco awarded the project management and FEED services to Australian engineering firm WorleyParsons.

The company also is considering building new facilities to add production of Arabian heavy crude from the Zuluf offshore oil field. Zuluf's production capacity is between 550,000 bbl/d and 600,000 bbl/d.

### **UAE: tapping sour gas**

In the UAE the Supreme Petroleum Council, Abu Dhabi's top oil industry decision-making body, approved Abu Dhabi National Oil Co.'s (ADNOC) five-year business plan and budget, which includes a commitment to boost oil production by 400,000 bbl/d by 2018 to 3.5 MMbbl/d. Abu Dhabi controls more than 85% of the UAE's oil output capacity and more than 90% of its reserves, while Dubai and the northern emirates have a minor share.

ADNOC is adapting to the evolving market environment by maximizing operational efficiencies, increasing crude oil production capacity targets and reducing costs.

Currently, ADNOC is developing Upper Zakum Field, the world's second largest offshore field, with 50 Bbbl of reserves. The field's production capacity will increase from the current 640,000 bbl/d to 750,000 bbl/d in two phases and is set to be completed this year. There are also proposals to raise production there to 1 MMbbl/d by 2024. In addition, work on the second phase of development of Umm Lulu, due for completion in 2018, should lift oil production above 100,000 bbl/d.

Meanwhile, increasing gas production remains ADNOC's top priority given the shortage the country faces. ADNOC's investment committee is considering proposals for a \$20 billion development of the Hail and Ghasha, Delma, Nasr and Shuwaihat "ultra-sour" gas

fields. The sour gas prospect is estimated by analysts to contain about 141.5 Bcm (5 Tcf) of gas and forecast to produce 28 MMcm/d (1 Bcf/d), which would equate to about 18% of the UAE's current demand.

"Tapping into undeveloped gas reservoirs is part of ADNOC's focused strategy to drive a more sustainable and economic gas supply," the director of upstream activities at ADNOC, Abdul Munim al-Kindy told local media.

Production costs of deep and mildly sour gas projects in the Gulf are between \$5 per MMBtu and \$6 per MMBtu, but domestic sales prices range from 75 cents to \$2, with negligible prices for household, according to local analysts.

Al Hosn Gas, which is owned by ADNOC (60%) and Occidental Petroleum (40%), respectively, last year delivered the \$10 billion Shah project on time and on budget. Shah produces 28 MMcm/d and has recently unveiled plans to boost production by 14 MMcm/d (500 MMcf/d). The company awarded a FEED services contract to U.K.-based Amec Foster Wheeler.

### **Qatar: lifting moratorium on development**

Meanwhile, Qatar lifted a self-imposed ban on development of the North Field, the world's largest natural gas field, and announced a new project to develop its southern section to raise Qatar's LNG production from 77 million to 100 million tons per year.

"Last April we announced our intention to develop a new gas project in the southern sector of the North Field that can be targeted for export," said Saad Sherida Al-Kaabi, president and CEO of Qatar Petroleum (QP). "With the conclusion of further technical studies, we have decided that the best option would be to double the size of the project to 4 billion cubic feet of gas per day, which constitutes a 20% increase from the current North Field production rate, or about 1 million barrels of oil equivalent per day."

In addition, QP and Total announced in early July that they will invest \$3.5 billion over five years in Qatar's offshore Al Shaheen oil field and expects to keep production running at 300,000 bbl/d in the future. The field will be developed by North Oil Co., a joint venture between QP (70%) and Total (30%), which replaced the field's former operator, Maersk Oil.

### **Kuwait: eyeing 4 MMbbl/d**

Kuwait has continued to expand its capex on oil and gas activities. Kuwait Petroleum Corp. (KPC) through its upstream subsidiary Kuwait Oil Co. plans to increase production to 4 MMbbl/d by 2020 from its current production of about 3.15 MMbbl/d. Kuwait's production



**REGIONAL REPORT:  
MIDDLE EAST**

capacity includes 700,000 bbl/d from the north fields, 500,000 bbl/d from the west fields and 1.7 MMbbl/d from the Greater Burgan, in addition to production coming from joint fields.

A key component of Kuwait's plans to increase its oil production will come from heavy oil resources. This includes the first phase of the Lower Fars Heavy Oil Development Program in Ratqa Field in North Kuwait, which is being developed by a consortium led by Petrofac and set to produce about 60,000 bbl/d by 2018.

**Iraq: opening up border fields**

Iraq also is boosting its E&P activity, as it managed to maintain its production output at about 4.58 MMbbl/d. A recent report by Wood Mackenzie said Iraq's southern technical service contracts have added 2.3 MMbbl/d of oil production since 2009. Of this, 700,000 bbl/d, or 30%, is offsetting baseline decline while 1.6 MMbbl/d, or 70%, is growth. In the report, Wood Mackenzie explained that Iraqi oil fields will require large-scale water injection to achieve the expected

recovery rates. The Rumaila Field is injecting close to 1 MMbbl/d of water sourced from the Shatt alArab river. This will support a 60% recovery factor in the Main Pay (Zubair Formation).

Iraq's Oil Ministry has named nine oil and gas projects—both discovered fields and exploration blocks—along the borders with Iran and Kuwait available for foreign oil company investment by the end of the year.

**Iran: fresh start**

Iran also has unveiled an ambitious plan to invest in its upstream sector, where it would need \$200 billion worth of investments in oil and gas projects in coming years to meet production targets. Most of the investment is marked to come from international companies. National Iranian Oil Co. (NIOC) signed the country's first energy contract in early July with a Western oil major since the lifting of sanctions. Total and China's CNPC agreed with NIOC to develop South Pars Phase 11 under Iran's new contract model, Iran Petroleum Contracts. **E&P**

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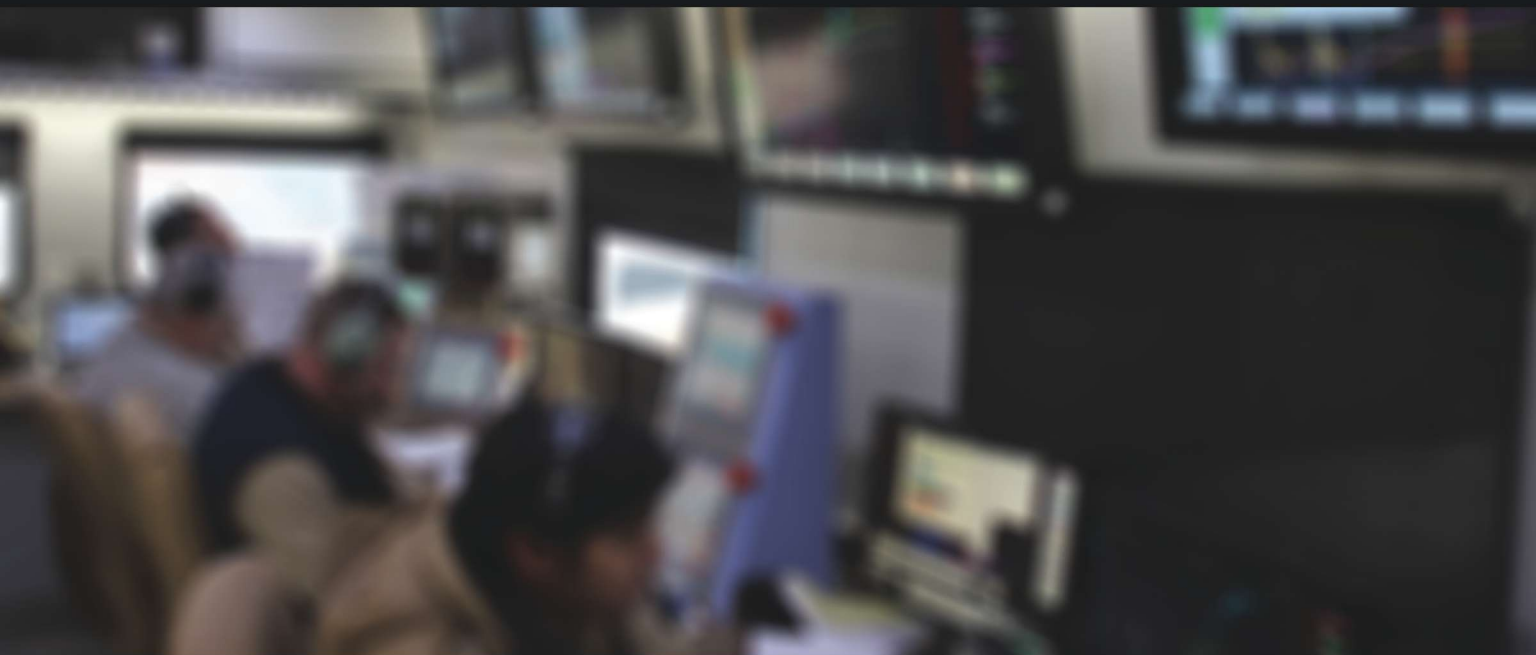
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# Improved completion capabilities for unconventional resources

Stuart Wilson, Packers Plus Energy Services

**A**s development of unconventional resources typically requires deeper and usually longer wells, operators around the world find themselves working in increasingly challenging environments. Two technologies in particular—ball-activated limited entry and HP/HT systems—are being increasingly deployed in the Middle East to help operators boost production from existing fields and access new reservoirs.

## Ball-activated limited entry systems

Identifying technologies that can both increase production and improve efficiency to reduce costs is a key step in turning a contingent resource into a proven commercially recoverable reserve.

Acid stimulation is one method to increase hydrocarbon production and long-term reservoir drainage from tight carbonate reservoirs; however, the stimulation treatment is only as effective as the placement method. Packers Plus' QuickFRAC multistage completion system combines the limited entry aspect of cemented liner completions with the efficiency of a ball-drop system.

A configuration of RockSEAL H2 packers and several QuickPORTV sleeves allows multiple individually isolated stages to be grouped together in a single treatment zone. Using a designed pump rate to maintain the desired pressure differential, the system evenly distributes batch fractures to the select zone. After stimulation, the well can be immediately flowed back and put on production.

An early success with the system occurred in Turkey as part of a pilot project to shift development from vertical to horizontal wells. Two of the four wells in the pilot project used the QuickFRAC system to deliver the matrix acidizing completion. All stimulations used three concurrent sub-stages of 15% hydrochloric (HCl) slick acid, 15% HCl gelled acid, 15% HCl self-diverting acid and 2% potassium chloride spacers. The combined volumes of these sub-stages were successively increased throughout the job. Maximum treating pressures were calculated using an estimated

formation breakdown gradient of 1 psi/ft, fluid hydrostatics calculated for stimulation fluids and estimated friction pressures.

Results of the pilot project indicated a successful stimulation and a significant increase in production from all four horizontal wells compared to offset vertical wells.

## HP/HT systems

The Packers Plus Titanium XV line of products is specially designed for differential pressure treatments up to 15,000 psi and has been run in several HP/HT formations around the world.

Two recent wells in Oman pushed these HP/HT capabilities to their limit and required a customized solution with a working differential pressure of 15,000 psi (max design pressure rated to 18,000 psi). Having used cased-hole plug-and-perf systems previously, the operator wanted to trial an uncemented openhole system that would increase near-wellbore conductivity, reduce treating pressures and be robust enough to function in temperatures up to 176 C (350 F).

Following a successful installation of a six-stage system on the first well, the first three stages were stimulated, and the well was flowed back. IP from those stages surpassed expectations and prompted the operator to forego the remaining three stages in the first well. Best practices from the first installation were transferred to the second completion, leading to significant improvement of installing and stimulating the four-stage openhole multistage lower completion.

The specially designed Titanium XV RockSEAL packers deployed for these jobs maintained zonal isolation throughout the stimulation despite the harsh conditions. The effectiveness of the packers was verified with radioactive tracers.

By delivering the planned stimulation program in challenging formations, high-efficiency HP/HT completion systems are helping operators deliver some of the top performing wells in their fields. ■

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### 1 Mexico

Eni has concluded drilling and testing the #3-Amoca discovery well in Mexico's Campeche Bay in Area 1. The company has raised the resource estimate to 1.3 Bboe in place, with 90% oil. Water depth at the prospect is about 25 m (82 ft). The well was drilled to 4,330 m (14,206 ft) and encountered about 410 m (1,345 ft) of net oil pay with 25- to 27-degree-gravity oil. It penetrated several Pliocene reservoir sandstones, including Cinco Presidentes, where 45 m (148 ft) of reservoir was tested flowing 6 Mbbbl/d. Eni has temporarily suspended the well, and the development plan indicates an output of 30 Mbbbl to 50 Mbbbl/d beginning in 2019.

### 2 US

Chesapeake Operating Inc. completed a high-volume Marcellus Shale well. According to IHS Markit, #6H McGavin flowed at a peak rate of 1.7 MMcm/d (61.8 MMcf/d) of gas. The Mehoopany Field well is in Section 9, Auburn Center 7.5 Quad in Meshoppen Township on an 841-acre lease in Wyoming County, Pa. It was drilled to the northwest to 5,695 m (18,684 ft), and the proposed true vertical depth was 2,283 m (7,489 ft).

### 3 Argentina

GeoPark announced a new oil field in the Cuenca Neuquina V Block (CN-V Block) in Argentina's Neuquén Basin in Mendoza Province. The #1-Rio Grande Oeste was drilled to 1,676 m (5,500 ft). It was targeting Grupo Neuquén, where 15 different potential reservoir sands were identified at depths between 549 m (1,800 ft) and 1,676 m (5,498 ft) with a potential net pay of 122 m (400 ft). The preliminary log-

ging information indicated hydrocarbons in the upper, middle and lower zones, and additional testing is planned. Production tests in four reservoir sands were about 300 bbl/d of 28-degree-gravity oil. This discovery de-risks other delineated and adjacent light oil prospects in the CN-V Block for future drilling. GeoPark and partner Wintershall are evaluating subsequent activities in the CN-V Block, including a development plan for the Rio Grande Oeste oil field.

### 4 Brazil

A commercial oil discovery was announced by Petrobras in a pre-salt layer in Marlim Sul Field in the Campos Basin. According to the company, this is the first commercial discovery of oil in the presalt layer. Well #6-BRSA-1349-RJS was drilled to 4,568 m (14,987 ft) and is in 1,107 m (3,632 ft) of water. The analysis of current data using profile data and gas detector fluid samples indicates carbonate reservoirs of good porosity and permeability features at 4,420 m (14,501 ft) within a 45-m (148-ft) interval.

### 5 Senegal

Results from the #1-FAN South exploration well were announced by Cairn Energy. At the offshore Senegal South Fan Prospect, the well encountered 31-degree-gravity oil in the Lower Cretaceous reservoir. It was drilled to 5,343 m (17,529.5 ft) and is in 2,175 m (7,136 ft) of water. According to Cairn, the venture was targeting dual prospects—an Upper Cretaceous stacked multilayer channelized turbidite fan prospect and a Lower Cretaceous base-of-slope turbidite fan, similar to the #1-FAN oil discovery in 2014. The #1-FAN South is being plugged and abandoned, and the rig is being moved

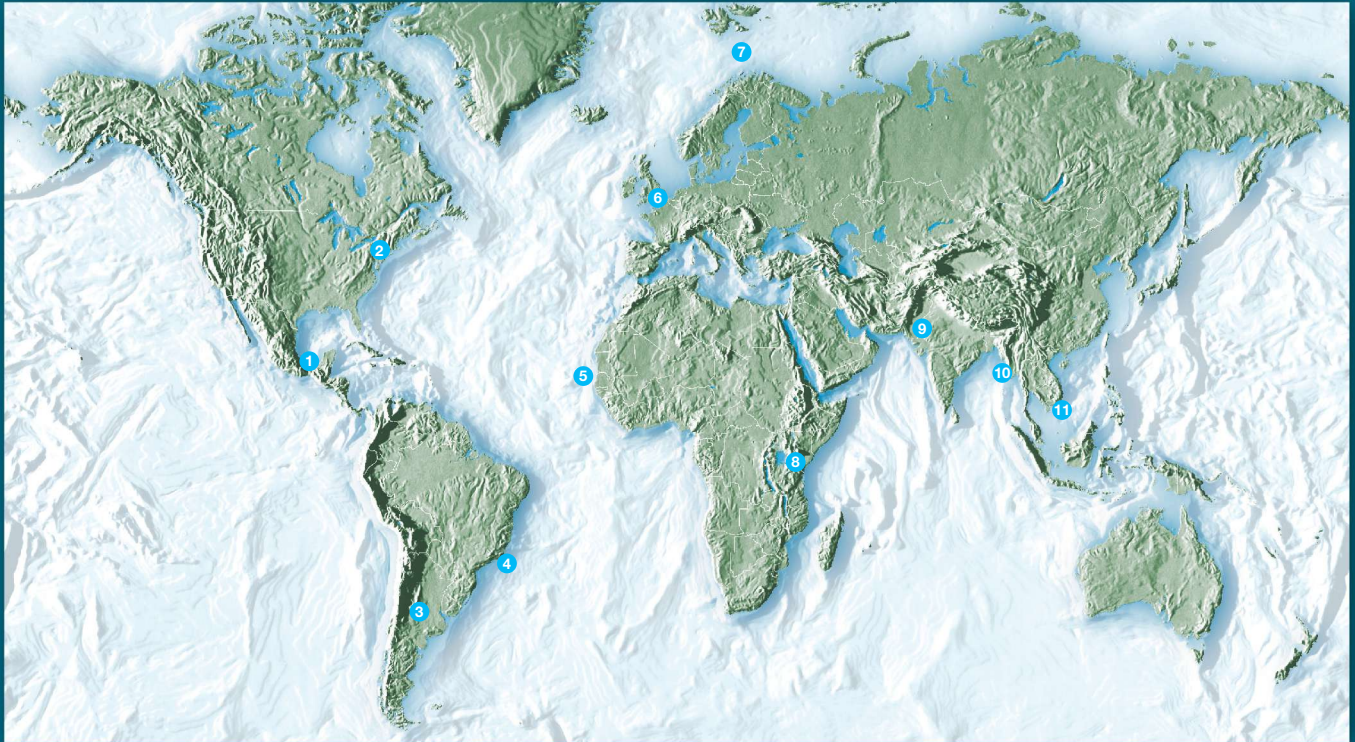
to an area about 15 km (9 miles) north of discovery well #1-SNE. Cairn has estimated that SNE North has a prospective volume of more than 80 MMbbl of total resource in multiple objectives. The well will be in 900 m (2,953 ft) water depth, and the projected depth is 2,800 m (9,186 ft).

### 6 UK

UK Oil & Gas Investments has announced results from a Kimmeridge Limestone (KL1 to KL4) target section at its 100% owned exploration well, #1-Broadford Bridge, in license PEDL234 in West Sussex, U.K. According to the company, a gross Kimmeridge Limestone (KL1-KL4) oil-bearing zone was found in a section at 1,225 m to 1,679 m (4,018 ft to 5,508 ft). A second highly fractured Kimmeridge shale and limestone reservoir zone, KL0, also was discovered from 1,679 m to 1,719 m (5,640 ft). The zone may extend farther upward into fractured zones above 1,158 m (3,800 ft). The Weald Basin well was drilled to 1,783 m (5,850 ft).

### 7 Norway

Lundin Petroleum AB is planning exploratory drilling in the Norwegian sector of the Barents Sea. A rig is drilling #1-Korpfjell in PL859 Block 7325/4, and after completion it will move on to PL609 Block 7220/6 to drill the Borselv Prospect on the Loppa High. The Loppa High is on trend with Lundin's Alta discovery. After the well in PL609 Block 7220/6 is drilled, the rig will be moved south to PL533 to drill the Hufsa and Hurri prospects to the west of Alta. The Hufsa prospect has an estimated gross unrisked prospective resource of 285 MMboe. The Hurri prospect has an



estimated gross unrisks prospective resource of 218 MMboe.

**8 Kenya**

A Tullow Oil Plc well, #1-Emekuya, in Kenya's Block 13T encountered 75 m (246 ft) of net oil pay in two zones. The well is about 2.5 km (1.5 miles) north of #2-Etom, and the objective was to test a fault block on the flank of the Greater Etom structure. It was drilled to 1,356 m (4,449 ft) and penetrated reservoir-quality Miocene sandstones similar to those found at #2-Etom. Downhole pressure measurements and fluid samples indicate the main oil reservoir is on the same static pressure gradient as #2-Etom. The reservoir sands encountered also appear to be extensive, which further de-risks the northern play area in the region. The rig will be moved

to drill an updip appraisal well on the Greater Etom structure.

**9 Pakistan**

Oil & Gas Development Co. (OGDC) reported results from a new gas field in Sindh Province's Sukkur District, Thal Block 2769-15, at exploration well #1-Bhambhra. The well was drilled to 4,023 m (13,199 ft) and was tested flowing 162 Mcm/d (5.73 MMcf/d). It was tested on a  $\frac{39}{64}$ -in. choke with a wellhead flowing pressure of 1,000 psi from Basal Sand of Lower Goru.

**10 Myanmar**

An exploration well by Woodside Petroleum in offshore Myanmar's Block A-6 hit a 65-m (213-ft) gross gas column with an interpreted net gas pay interval of about 36 m (118 ft). The #1-Pyi This is in the south-

ern Rakhine Basin and was drilled to 4,570 m (14,993 ft). A drillstem test across a 29-m (95-ft) section of the reservoir flowed at 1.4 MMcm (50 MMcf) during testing on a  $\frac{44}{64}$ -in. choke over a 44-hr interval.

**11 Vietnam**

A shallow-water oil discovery by Murphy Oil Corp. was announced in offshore Vietnam's Con Son Basin with its #1X-CT exploration well. The well was drilled in Block 11-2 in the South China Sea. Preliminary estimates of the find indicate 10 MMbbl to 12 MMbbl of oil. Additional drilling, exploration and evaluation are planned for this year. **ESP**

For additional information on these projects and other global developments:



PEOPLE

The board of directors of Petroleum Geo-Services ASA (PGS) appointed **Rune Olav Pedersen** president and CEO, succeeding **Jon Erik Reinhardsen**.



**Jakob Sigurdsson** joined Victrex in September as CEO-designate and was scheduled to become CEO Oct. 1, succeeding **Dave Hummel**, who retires after 24 years as CEO.

Enphase Energy's board of directors selected **Badri Kothandaraman** as the company's new president and CEO and member of its board.

DEA Deutsche Erdoel AG appointed **Maria Moraeus Hanssen** CEO and chairman of the management board, effective January 2018. Hanssen will succeed **Thomas Rappuhn**.

Hunting Plc promoted and appointed **Arthur James ("Jim") Johnson** to CEO, succeeding **Dennis Proctor**, who will retire.



Weatherford International Plc named **Karl Blanchard** executive vice president and COO.

Comstock Resources Inc. COO **Mack D. Good** has retired. Comstock also announced that **Daniel S. Harrison** has been appointed vice president of operations and will oversee the company's drilling and E&P activities.

AXT Inc. appointed **Wilson Lin** COO.

Patterson-UTI Energy Inc. named **C. Andrew Smith** CFO.



**Styk Bekkenes**, president of Palfinger Marine, stepped down from his position.

**John Heyman** has joined HDR as oil and gas business development lead based in HDR's Charlotte, N.C., office.



BCCK Holding Co. appointed **Kevin J. Blount** vice president of corporate development.



Vallourec Drilling Products named **Ludivine Laurent** (left)

global key account manager and **Maximilien de Maisonneuve** (right) vice president global sales, marketing and technology.

Advisian appointed **Adam Boughton** to the newly created role of regional director infrastructure for Europe, the Middle East and Africa.

GEODynamics selected **Raymond Ross** as technical CGI director.

Danos named **Clay Carter** operations manager for the company's coatings service line.



OEM Group appointed **Malcolm Christie** to a senior technical support role in response to growing its U.K. and international business.

McDermott International Inc. named **John Freeman** senior vice president, general counsel and corporate secretary. The company also appointed **Philippe Barril** to its board of directors. Barril will serve on the company's governance committee.

**Brigitte Köck** and **Elena Menasse** have been appointed to the functions

of additional OMV press spokespersons on the public relations team.

**Shannon Coates** joined Tap Oil Ltd. as joint company secretary.

**Tom Whalen** was appointed to Drillform Technical Services Ltd.'s board of directors.

Newly formed Roan Resources' board will be initially comprised of four LINN Energy and four Citizen Energy designated directors. Following the appointment of Roan's CEO, the board will be expanded by one position to be filled by the CEO. The new directors are **Mark E. Ellis**, **Evan Lederman**, **Andy Taylor**, **Matthew Bonanno**, **Michael Raleigh**, **James Woods**, **John Lovoi** and **Paul B. Loyd Jr.**

**Howard Dawson**, **Graham Riley** and **Kim Parsons** have resigned as directors of Entek Energy Ltd. **Mark McAuliffe** has been elected as chairman. The composition of the Entek board will be **McAuliffe** as nonexecutive chairman and **Peter Stern**, **Clare Pope** and **Tony Walsh** as nonexecutive directors.

Newfield Exploration Co. appointed **Edgar R. Giesinger** to its board of directors.

Cabot Oil & Gas Corp. elected **Amanda M. Brock** and **Marcus A. Watts** to its board of directors.

COMPANIES

**LINN Energy Inc.** closed on the transaction with **Citizen Energy II LLC** to form **Roan Resources LLC**.

**NCS Multistage Holdings Inc.** announced Aug. 30 that it has agreed, through a merger agreement, to acquire **Spectrum Tracer Services**.



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**Jericho Oil Corp.** has closed the acquisition of about 9,400 net surface acres in the oil window of the Anadarko Basin Stack play in Oklahoma.

**ThinJack Ltd.** plans to significantly expand its presence in the Malaysian market.

**U.S. Silica Holdings Inc.** acquired **Mississippi Sand LLC** for \$95.4 million in cash in August.

**Patterson-UTI Energy Inc.** entered into an agreement to acquire **Multi-Shot LLC d/b/a MS Energy Services.**

**Andeavor** has begun operating in Mexico and has successfully opened the first ARCO station in Tijuana, Baja California, Mexico.

**FairfieldNodal** is in advanced discussions with **Thalassa Holdings** to acquire **WGP Group Ltd.**, a pre-

mier provider of marine geophysical services.

**Paramount Resources Ltd.** completed the acquisition of **Apache Canada Ltd.**, which has been renamed **Paramount Resources (ACL) Ltd.**

**WaterBridge Resources LLC** acquired **EnWater Solutions LLC**, a produced water gathering and disposal company in the southern Delaware Basin. WaterBridge plans to expand the existing gathering business into a full-cycle closed-loop water infrastructure system that offers regional producers an integrated all-in-one array of water supply and management solutions.

**White Knight Production I LLC** acquired certain Marble Falls assets from **Newark E&P LLC**, primarily located in Jack, Palo Pinto and Parker counties, Texas. The transaction closed in June. **ESP**

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# The crew has changed

Younger minds prevail, but solid science still needs to lead the way.

Peter Duncan, MicroSeismic Inc.

A couple of months ago I found myself sitting in a room full to bursting with eager earth scientists at a major technical conference. The audience strained to hear an account of the latest hydrocarbon pursuit from one of our community standing at the podium. The speaker was articulate, enthusiastic, engaged, sincere and ever so young. At least that is how it seemed to me. Then I looked around the room and realized the majority of those present came from the same demographic. Was there a pattern here?

frenzy, driven by high oil prices and the “shale gale,” meant there were ample seats at the table for those of us of my generation. But the collapse of 2014 that has turned into “lower for longer” has changed that. Workloads have dropped, and companies, quite properly, have started sending the last shift home—time to complete the crew change.

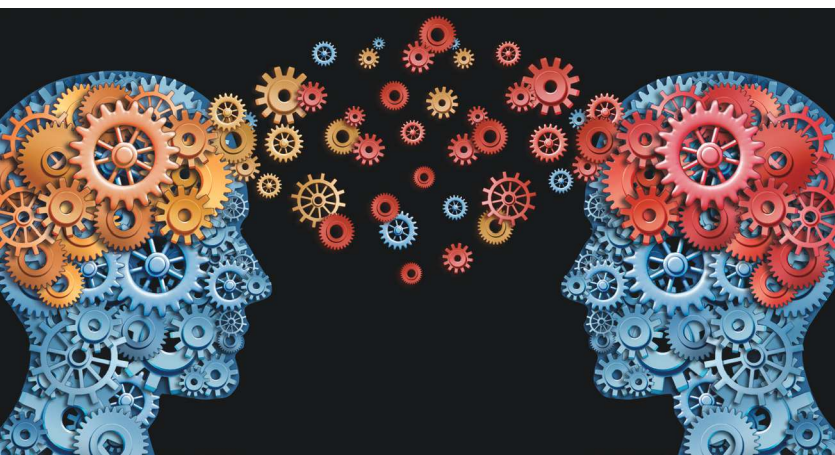
Frankly, I think this is a good thing for our industry. If you plant the same crop in a field over and over again, eventually the nutrients are depleted, and the crop fails. This bright and enthusiastic new generation is bringing its energy and ideas to an industry that continues to reinvent itself. This generation has benefitted from a great education and stands squarely on the shoulders of the crew mates that have gone before. It is not burdened with a “this is the way we have always done it” attitude that often slows progress.

This is music to the ears of someone like me who has made his living bringing new technologies into practice in an industry famous for being slow on the uptake.

However, I must add a word of caution. The paper I was listening to was full of great observations. The story was well documented. The facts were well presented. But there was little insight drawn from the data and no model to explain the observations presented. It seemed to me that some of these observations, tied to a little physical insight, might have shed real light on the problem being addressed.

But that didn’t happen. This is one of perhaps many examples where those of us from the retiring crew can still play a role. This very capable presenter just needed someone to ask what the data meant and to provide some direction to the fundamental principles that might tie these observations together and give structure to the data, turning data into knowledge. The researchers didn’t need to be dictated to; rather, they needed to be drawn out and challenged to think a little more deeply—in short, to be “educated.”

So the crew change has occurred at last, and the prospects for the future are bright. I just hope that a few of the last shift will stick around for a while to provide a little mentoring to the shift now on duty and to marvel at what they will accomplish. **ESP**

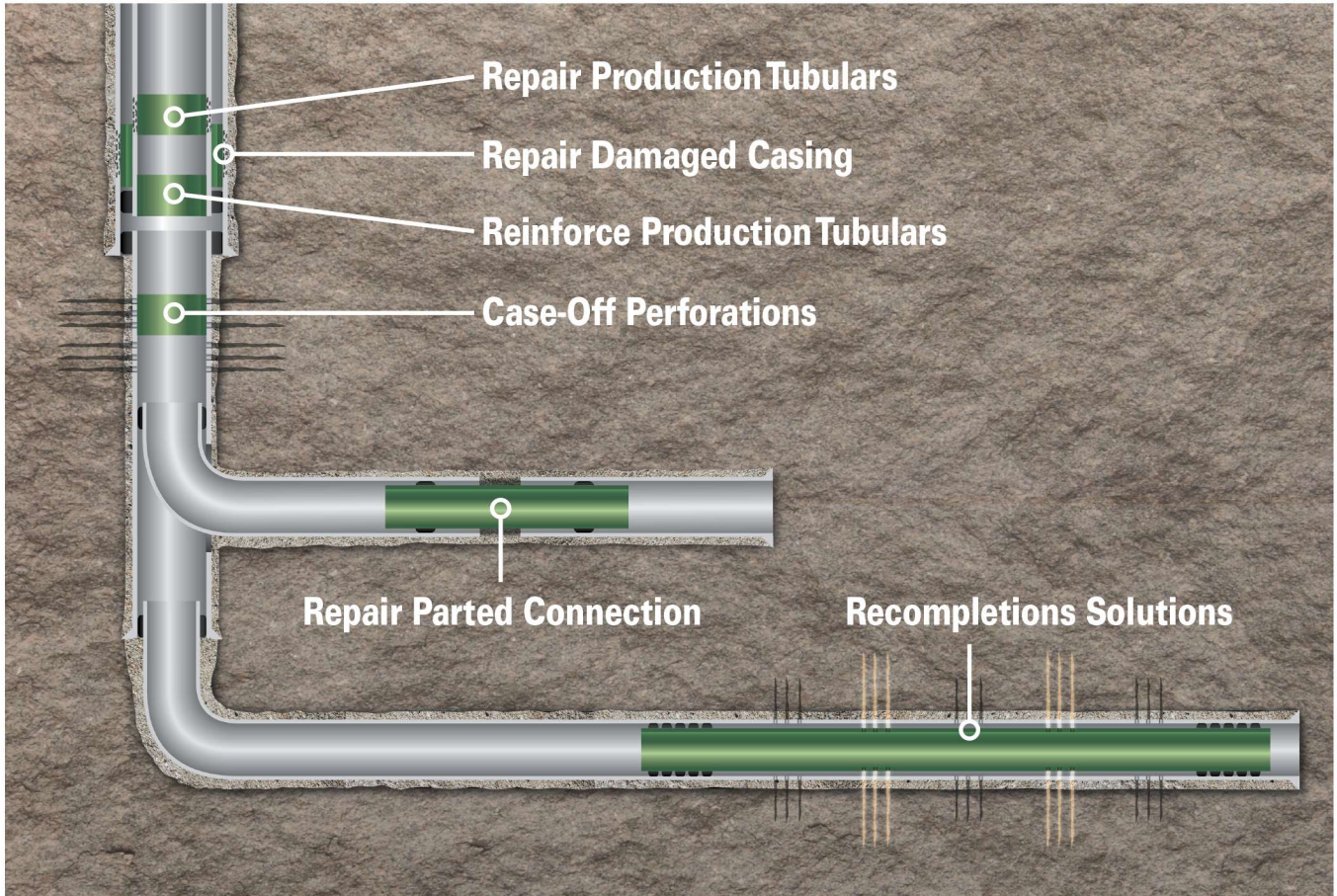


Knowledge transfer is key to accomplish success in the future.  
(Source: Lightspring, Shutterstock.com)

One of my favorite roles in my day job is that of road warrior—heading out to meet clients in their place of work, extolling the virtues of our offering, making presentations on the technology we practice, answering questions, sharing our vision and trying to arrange the next meeting. As I sat in that technical session scanning the audience, I recognized that more and more the clients I was meeting with and the groups I was presenting to had fewer gray hairs in their ranks. Then it dawned on me: The impending crew change that was so commonly, even anxiously, written about and discussed a decade earlier had finally come to pass.

It seems that we’ve talked about this crew change for years without it actually happening. The industry

# Get Out Of Trouble. Stay Out Of Trouble.



**Enventure's ESeal™ solid expandable products are the advanced, efficient, economical way to mitigate troubled casing intervals... permanently.**

Onshore or offshore, conventional or unconventional, Enventure ESeal™ products are designed to provide permanent solutions to sealing off troubled casing intervals, restoring integrity. Each product represents an effective and permanent alternative to cement squeezes. Plus, with ESeal, wellbore ID is maximized.

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# CONTROLLED INTENSITY™

## *Bigger, faster pinpoint completions: more stages, more sand, higher rates—and no runaway fracs.*

Multistage Unlimited® pinpoint fracturing delivers maximum SRV with far less risk of frac hits and well bashing during infill and high-density field development, compared with plug-and-perf. You put fracs where you want them, and you control how much sand you pump into each one, preventing “super clusters” that can hurt production from offset wells. With repeatable frac placement from well to well plus recorded downhole pressure/temperature data, you can truly optimize stage count and spacing in a given formation with just a few wells.

### **More stages per well**

NCS pinpoint fracturing delivers more individual entry points with far higher frac efficiency than plug-and-perf. For example:

- 147 stages (Permian)
- 134 stages (Montney)
- 125 stages (Duvernay)
- 116 stages (Marcellus)

### **More sand per well**

More intensity means pumping a lot more sand, and NCS Multistage pinpoint fracturing handles it:

- 15 million lb @1,711 lb/lateral ft (Duvernay)
- 14.9 million lb @1,825 lb/lateral ft (Montney)
- 14.2 million lb @1,973 lb/lateral ft (Permian)

### **Faster execution**

NCS Multistage pinpoint completions are being executed faster than ever. Here’s why:

**Higher rates.** Technology and design advances have boosted Multistage Unlimited frac rates through the coiled tubing/casing annulus to nearly 80 bbl/min in 5.5-in. casing, far higher “per cluster” than plug-and-perf and more than enough to transport sand (>12 ppg) with slickwater.

**Fewer coiled tubing trips.** Almost 90% of NCS Multistage jobs are performed in a single coiled tubing trip. As many as 134 sleeves have been fraced without tripping out of the hole.

**99+% sleeve success rate.** More than 120,000 NCS sleeves have been installed, with the highest sleeve-shift-success rate of any coiled-tubing completion system.

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Predictable. Verifiable. Repeatable. Optimizable.

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