

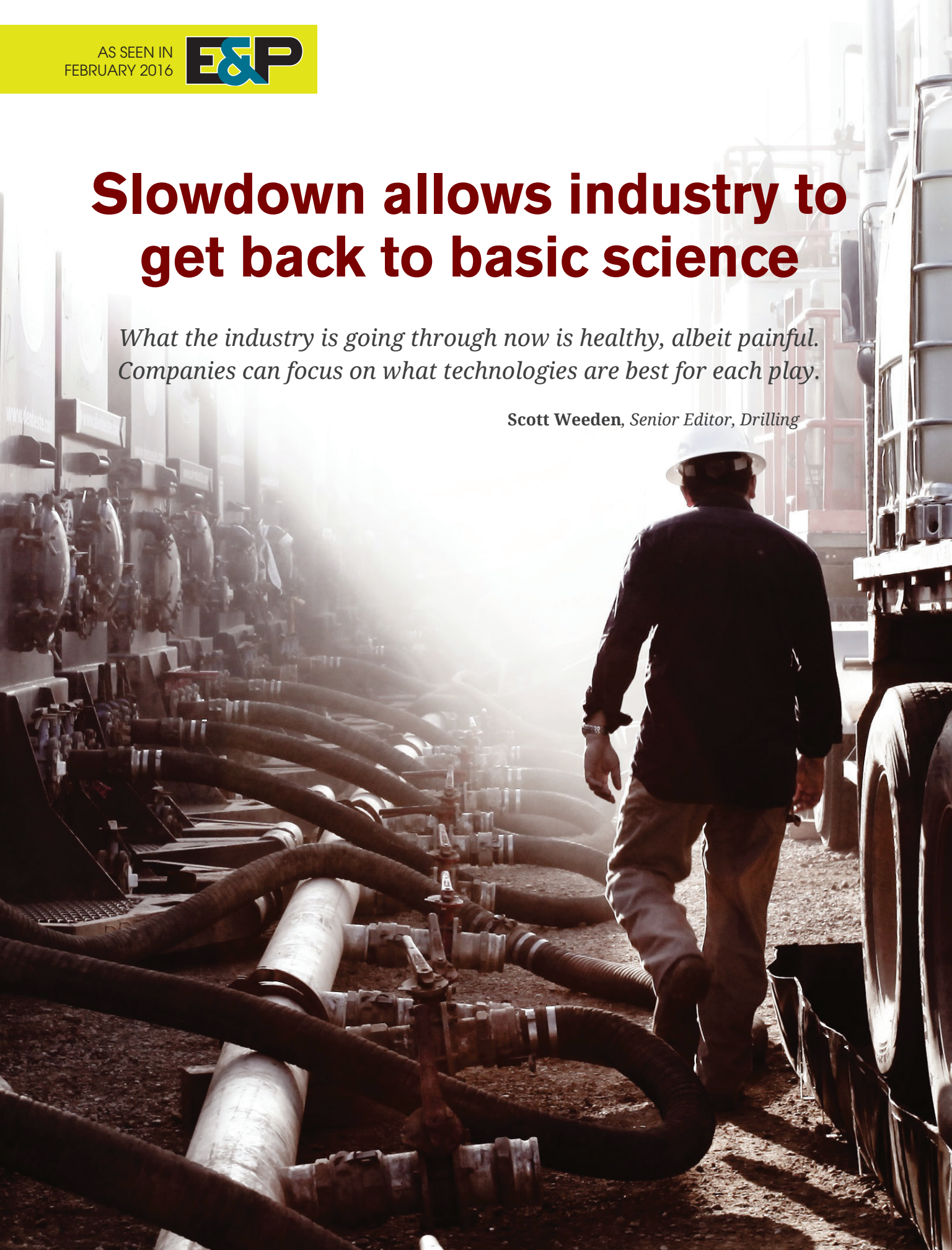
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Slowdown allows industry to get back to basic science

What the industry is going through now is healthy, albeit painful. Companies can focus on what technologies are best for each play.

Scott Weeden, Senior Editor, Drilling





The hydraulic fracturing and horizontal completion business has been almost too successful for its own good. The advance in pad drilling that resulted in more efficient drilling in fewer days is just one example of why oil and gas production has remained high even with lower oil prices.

"In my opinion, most of the completion techniques continue to advance. They're getting better and better. And that is actually one of the problems in our industry. As we keep making better and better wells out of fewer and fewer wells drilled, that creates more gas and more reserves, which make prices economically stay down," said Glenn Hart, president and CEO, Laredo Energy.

"We were joking at a Christmas party, saying, 'Hey, why don't you stop drilling and fracturing, and I'm going to keep on doing mine,'" he laughed. "We're causing our own problems, in a way, with our success."

Ryan Hummer, executive vice president, strategy, NCS Multistage, agreed. "Obviously we can't predict the future, but we think this current low-price environment is likely to persist for a while. We're not going to be able to wait for prices to bail us out. Our conversations with our customers indicate that they are thinking the same thing. To cope with and make money in this current environment, they really need to continue to optimize completion designs and maximize how efficiently they can deploy capital."

Hart and Hummer were part of a roundtable teleconference *E&P* held to discuss the status of hydraulic fracturing, where the technology is headed and what technologies would be game changers for the industry in this price environment. The panel also included John Ely, president, Ely and Associates; Ted Randolph, fracturing engineering manager, NCS Multistage; Don Conkle, vice president, marketing and sales, Carbo Ceramics; and Joel Gay, president and CEO, Energy Recovery.

Q: *E&P: Is there a lower price limit in this environment? Is \$35 oil about as low as prices can go?*



A: **ELY (Ely and Associates):** We have customers that are going ahead with completions but are a little nervous about getting much below \$40, but very successful with \$40 oil. When you get into the Bakken, some of that was questionable at \$80 or \$90. It depends on the reservoir and the capability of the reservoir to produce.

We're going to see substantial downturns if we stay at \$36 or whatever it is today. There are so many of the reservoirs that we deal with where it's just not economic. The service company pricing is about down to a low ebb, completion costs have gone down and efficiencies have gone up dramatically, but there's a limit. I think we're getting there very quickly.



CONKLE (Carbo Ceramics): Let's hope it does not get much lower. The resiliency of the industry and operators in general has proven itself over the decades. Economics are normalizing as service costs come down with commodity prices. Most operators are refocusing on completing the best part of their reservoirs and spending more time evaluating

the completions performed over the past few years as they now have more time with less activity. Every dollar they spend is important now as economics are slim. More engineering is being performed with solid evaluation to optimize completions. This makes the phase that we're in very exciting. It's not the best financial time for any of us, for sure, but it's a great time of learning and reflecting.



HART (Laredo Energy): The [lower limit is] an ever-moving target. Costs are changing constantly. Price is changing constantly. Certainly there are things that don't work economically today that worked a year or two ago, but there are still things that actually do work.

We are really rate-of-return-driven. If we can make a good enough return, with the cost being lower and yet the price being lower, we'll continue to do so.

THE PANEL

John Ely, President, *Ely and Associates*

Don Conkle, Vice President, Marketing and Sales, *Carbo Ceramics*

Glenn Hart, President and CEO, *Laredo Energy*

Ryan Hummer, Executive Vice President, Strategy, *NCS Multistage*

Joel Gay, President and CEO, *Energy Recovery*

Ted Randolph, Fracturing Engineering Manager, *NCS Multistage*

It is another place I'd take Wall Street to task, where they make these broad-brush statements like the entire breakeven of the Bakken is 'x' dollars per barrel or the entire Permian Basin. That one really gets me. It is like, 'How many different horizons are out there in the Permian?' Come on! There are still economically attractive things even at today's prices. Though I'll grant you there are far fewer than there were a couple of years ago.



HUMMER (NCS Multistage): I've been amazed with how quickly the economics have adjusted, even as pricing has come down. Specifically in the Permian, there have been significant strides in lowering breakeven costs given the short amount of time that we as an industry have been pursuing horizontal wells there.

I think there's still work to be done. There's not necessarily a magic number. It is a moving target. As we do introduce technologies and learn more, certainly as an industry, we'll become more and more efficient producing hydrocarbons in the lower price environment.

Long-term I'm still bullish on North American unconventional. What we're going through now is

healthy. We've probably learned more as an industry in the last 15 to 18 months than we have in the previous several years where the activity was so high there wasn't as much focus on costs.

Now everyone is laser-focused on making every improvement we can make, whether it's on the completion side, on the drilling side or reducing operating costs. It's actually an exciting time for the industry as we go through this, even though it's painful certainly for the services industry and painful for our customers as well.



GAY (Energy Recovery): One of the positive externalities of the energy depression has been a rejuvenation of operational efficiency as E&Ps, pressure pumpers and service providers alike attempt to streamline their cost structures such that they can continue to complete wells and generate revenues and ultimately cash flows in very challenging economic circumstances.

When we think about to what extent all of these new and exciting technologies can drive down the cost per barrel to fracture a well, we are not aware of any technology that even approaches a dollar, let alone \$4 to \$5 per barrel.

Q: *E&P: What do you see as the current status of hydraulic fracturing?*

A: **ELY:** We're in a very interesting time, and it's been going on for several years, movement away from the more conventional fracturing crosslinked gel, viscous fluids. We're primarily using slick water or what I call pseudo-hybrid systems. We typically run some slick water, and for deeper reservoirs we use some very unstable crosslink fluids.

We've moved tremendously toward smaller sand. The dominant proppant in the market now is 40/70 and 30/50 proppant. But very rapidly, 100 mesh or very small 70/140 sand has moved into the forefront with success even in oil reservoirs. Much of this is counter to classical fracture theory, but it has led to success.

HUMMER: Things are changing on the fly a lot, as John [Ely] had mentioned. I think we're early in really optimizing unconventional development and improving resource recovery. How do we get more than 5% of the resource out of the ground? Obviously when we were in an \$80 or \$100 per barrel oil environment, prices covered up a lot of inefficiency.

There were high levels of activity that really drove a focus on the logistics of the completion as opposed to doing what was right for the reservoir. John mentioned a lot of the changes that customers are making to optimize. It's changing the completion designs, the fluid systems, tighter stage spacing, tighter cluster density and higher proppant concentrations.

We think there's still a long way to go, especially to learn about the reservoir and to get information to help us do things better. We're still in early innings, and we'll continue to make improvements. I think obtaining downhole information and utilizing it to drive optimization decisions are keys to accelerating those improvements.

CONKLE: The engineering of hydraulic fractures continues to evolve, driven by technology as well as better understanding of the more important parameters that drive production and recovery in each reservoir. Many operators have seen significant success by utilizing data-driven models that incorporate reservoir parameters with completion design to optimize both production and EUR. Operators have found that the four consistent parameters that are impacting production and recovery the most in low-permeability reservoirs are hydrocarbon content in the mud logs; effective permeability; propped hydraulic fracture contact with the reservoir; and conductivity of the fracturing, especially near-wellbore. Technology is quickly evolving,



A significant impairment to operators' lease opex and production is damage caused by scale, paraffin and other production-related problems. Proppant-delivered chemistry has prevented scaling for nearly two years in wells without any wells forming scale. (Source: Carbo Ceramics)

allowing the ability to impact the entry points at the wellbore as Ryan [Hummer] mentioned. It also is evolving to provide increased conductivity through the use of KRYPTOSPHERE or ultralow density proppants such as CARBOAIR, which help to prop the total height/length of the fracture area. We are likely in the fifth inning in understanding optimized completions, and with many reservoirs having only 5% to 10% recovery factors, there is great opportunity to maximize recoveries through proper completion design.

Q: *E&P: What do you see as the current status of hydraulic fracturing from an operator's point of view?*

A: **HART:** I would say continually advancing technology. I think what we see is a little bit of a pause and a slowdown. Everybody's had an opportunity to go back and reexamine things pretty thoroughly. Now we have the benefit of a lot of completions where we can start to see what parameters matter. For example, that's where I see not so much new things but optimizing of things.

Q: *E&P: What would be a game changer for hydraulic fracturing in this environment?*

A: **ELY:** For me with EMP [electromagnetic producing] technology, it's a company called Deep Imaging Technologies. I think it's in very early stages, but it should be able to tell us where the fluid is moving and where the proppant is in the reservoir. That's exciting; that's a game changer. That will drive all the modelers crazy if we really know where



A new missile developed by Energy Recovery could cut the cost of hydraulic fracturing by an estimated \$4 to \$5 per barrel. Liberty Oil-field Services conducted a field test of the VorTeq missile in December 2015. (Source: Energy Recovery)

everything is. If we know where the proppant is, we can spot our wells. We're not going to drain anything in these ultratight reservoirs that we don't prop open and create massive surface area.

CONKLE: Technologies that aid operators in decreasing their F&D [finding and development] cost/boe for each well and their field in general are critical in today's environment. As hydraulic fracturing is a significant cost to the operator, understanding the length and height of your propped fracture volume or propped reservoir volume will allow a better designed field development plan, potentially allowing significantly fewer wells to be drilled to develop a field. A proppant that is detectable will be critical to achieve this. Development is ongoing with CARBO in this area, with positive tests already witnessed.

Another significant impairment to operators' lease operating expenses and production is damage caused by scale, paraffin and other production-related problems in the near wellbore area and within the tubulars. Placing proppant-delivered chemistry within the fracture, which can dissolve slowly from the proppant grain for multiple years, is having a significant impact on operator's opex budgets. The CARBO GUARD technologies have prevented scaling for nearly two years in wells without any wells forming scale with more years expected.



RANDOLPH (NCS Multistage): In earlier days of vertical well completions, it was all about connectivity with the reservoir and focusing the treatment for the reservoir, whether it was more fluid or higher proppant concentrations. Once we had geological information up front, we could make decisions and start optimizing designs. Then we could



Laredo Energy continues its operations in Webb County, Texas. Glenn Hart, Laredo president and CEO, said if the company makes a good enough return, even with the cost being lower and the price being lower, it will continue to do so. (Source: Laredo Energy)



Drilling and fracturing multiple wells from a single pad improved the efficiency of drilling and completion operations. Technology advancements continue to increase both production and EURs. (Source: Liberty Oilfield Services)

come back, evaluate it and make sure that all of our upfront assumptions were right.

It was always about doing what was right for the reservoir. I think we lost a little bit of focus on that as we went into horizontal wells. I think we started focusing on fracture designs around the completions as opposed to the reservoir. I think we have an opportunity to refocus and start thinking about how can we do things better—we can get back to doing what's right for the reservoir. Game-changing results in horizontal wells will come from utilizing technologies that would economically get not just upfront reservoir information but also down-hole data during completions operations to allow us to customize completion designs and better optimize based on reservoir characteristics and responses.

GAY: We believe that the VorTeq technology that we recently licensed on an exclusive basis to Schlumberger will be one of the greatest breakthroughs. However, we don't expect commercialization until 2017. Pump failure is the greatest pain point in that industry and certainly causes operators the most heartache, resulting, of course, in inordinate operating and capital expenditures.

There's been a tremendous amount of research over the last 10 years on rotating equipment and hydrodynamics to extend the life of the reciprocating positive-displacement pumps. Now, unfortunately, the existing pumping technology is 40 to 50 years old, and the R&D efforts are best described as marginal.

The VorTeq allows the complete isolation of the pumping technology from the proppant, which we believe represents a step change. As we think about the current fracture ecosystem, you've got a tremendous amount of horsepower at any given wellhead. Our VorTeq missile allows the transformation of that fracturing ecosystem where you could at some point reduce the number of pumps required from 20 down to three or four large centrifugal pumps. In addition to an economic value standpoint, there's also a tremendous safety and carbon footprint advantage to the VorTeq as well as the savings associated with that, specifically in the depreciable expense and the R&M [repair and maintenance] associated with these centrifugal pumps. We believe that we can drive down the cost per barrel to fracture a well by \$4 to \$5. **ESP**

Editor's note: The interview continues on epmag.com.