PIONEER
NATURAL RESOURCES

LIFE OF A DROP OF OIL

Completions

Drop of Oil

Chapter six:

Years ago, Pioneer Area Completions Supervisor Kevin Necaise and his family were vacationing in the Wolf Creek Ski Area near the southwestern Colorado town of Pagosa Springs.

Tucked between the San Juan and Rio Grande national forests, the resort boasted the most snow in the state – 430 inches of natural powder annually – along with a reputation as a laid-back family spot.

Kevin had notched 13 years of his quarter-century oil and gas career in Colorado – first at Evergreen Resources, Inc., then **Pioneer** after the companies merged in 2004. During his stint in the Centennial State – arguably among the most prickly to do business in if you were in his line of work – he witnessed the pushback: Slashed tires. Protesters blocking bulldozers and drilling equipment. Legislators pledging to send "Big Oil" packing. Literal shots fired. So when he was able to take the PTO, it afforded a welcome respite. On the slope's longest ski lift, he locked into his chair while his wife and daughter took the two seats ahead. A man jumped into the vacant chair next to him just before the lift began moving.

"So, what do you do?" the man asked, making small talk.

"I'm in oil and gas."

The passenger's demeanor soured.

"The mood completely changed right after I said that," **Kevin** remembers.

Where others might have recognized the tension hanging in the thinning air and disengaged, **Kevin** saw an opportunity.

As the lift carted the men higher, **Kevin** explained how oil and gas explorers work to protect the environment, and how water aquifers were safeguarded during the drilling process.

"I told him we're not just extracting something from the ground and leaving the roadkill," **Kevin** says.

As the lift approached the top, the man's disposition had improved dramatically.

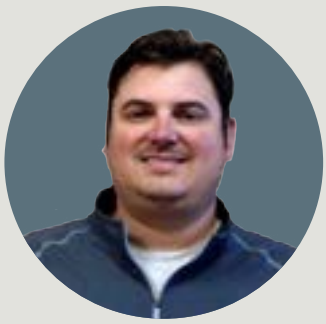
"I had no clue," the man confessed.

"People like him had no idea how we got the resources; they're thinking we're there to destroy the Earth, and it's based on pure ignorance," **Kevin** says. "Many people don't know what we're doing. There are certain folks you're never going to convert – but we have to keep trying."

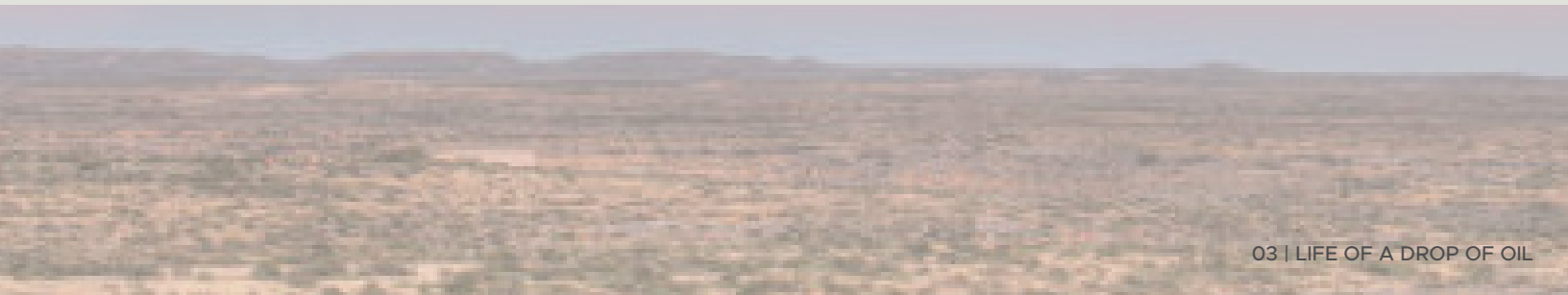
We've spent the past five weeks explaining the elaborate planning that goes into drilling a well. At this point, **Pioneer** geoscientists and engineers have calculated where to drill, our Land department secured the acreage after obtaining a clear title, and we've developed a site plan to begin recovering oil and gas. Sometimes it's taken years of planning to arrive here.

Last week, we introduced you to our Drilling team, who work around the clock to bore a well, secure the casings in cement to avoid groundwater contamination and prep the site for the next step in the life of a drop of oil.

We've also dispelled a myth that recovering oil is as simple as inserting a tube downhole and waiting for the substance to come whooshing up from the ground. In reality, it's far more scientific and laborious, with numerous departments playing a part.



"It's not like there's a big swimming pool down there that we can start sucking out with a straw," says Field Drilling Superintendent Daniel Doverspike, who we met last week.



There's no time wasted: After our Drilling crews rig down and begin prepping the next job, our Completions team arrives. Like the drill phase, downtime isn't calculated in days and hours; it's a matter of minutes and seconds.

Our well is drilled, but the subsurface rock isn't ready to produce oil yet. At this stage, the rock isn't permeable – imagine trying to extract oil or gas from a substance like concrete.

To solve that problem, the 70-member completions team uses a method called ***hydraulic fracturing***, or ***fracking.*** The process injects highly pressurized water, sand and other fluids deep underground to crack the rock and release the hydrocarbons trapped inside. Even though some method of fracking has been around for more than a century, energy companies like **Pioneer** were able to refine and capitalize on the technology, touching off the ***"Shale Revolution"*** in the Permian Basin and beyond. For the first time, we could access trapped hydrocarbon reservoirs once thought unreachable.

The immense water pressure opens the rock, while sand prevents it from ***"healing"*** and closing completely back up. On average, we use roughly 40 barrels of water and ***1,700 pounds*** of sand per foot of laterally drilled well. That's around a half-million barrels of water and 17 million pounds of sand per well.

"When you think of Completions, think of logistics," says **Gerry Torres**, vice president of Permian Completions. "It's a tremendous amount of horsepower we're using, and we're pumping continuously into our well. This is a 24/7 operation."

It takes roughly four days to frac a well, multiplying for the number of each additional wells on a pad. Once a well is drilled, crews insert casings and pump cement to isolate the drill zone from groundwater sources. When a well transitions from the drilling phase to completions, both the casing and the rock are perforated with dozens of holes to facilitate the fracking process – a stage known as ***wirelining***.

Since no two wells are the same, or require the exact amount of water and sand, Completions engineers strive to create "a certain frac geometry," as ***Gerry*** calls it.

"We aim to come up with a different recipe for each zone we drill in," he says. "No one size fits all, and that's why I would also say it's a work of art.

"When you go to one of our locations, you see how everything is laid out perfectly, with sand trucks coming in, loading and unloading – some of these wells require 60 trucks of sand a day – along with all the water and chemicals used on a daily basis. You're looking at a well-oiled machine," he says.

Gerry's been with **Pioneer** for 17 years, and earned his stripes notching tours in Drilling, Completions, Production Engineering and as an individual contributor running 13 vertical rigs. He knows the Permian like the back of his hand.

Like its Drilling counterparts, the Completions team measures its success by the minute. It's a 180-degree adjustment from how the industry once operated.

"We didn't measure anything," **Kevin** remembers. "Back then, we said, 'go rig up and let me know when you're done, and then we'll come over and open the well and start pumping.' If something broke down, we said, 'OK, let me know when you have it fixed and we'll go back to pumping.'"

Contrast that casual approach with the present day, when every minute of the day and dollar out the door is scrutinized.

"Once we really started measuring, we were able to quickly improve across the board," **Kevin** says. "Even when you think of ***swap times*** – the period between the completion of one well job and the start of the next – you can do it in six to eight minutes now, where it used to be an hour and a half or two hours."

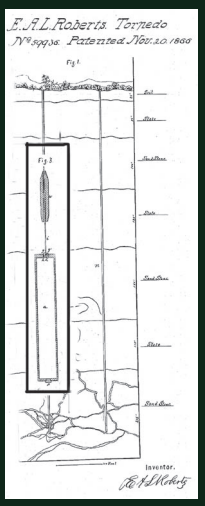
Two fracking techniques have paved the way for unprecedented success in the oil patch: ***zipper fracking*** and ***simulfracking***.

But we can't properly tell that story without telling a much larger and older one – in this case, about ***160 years older.***

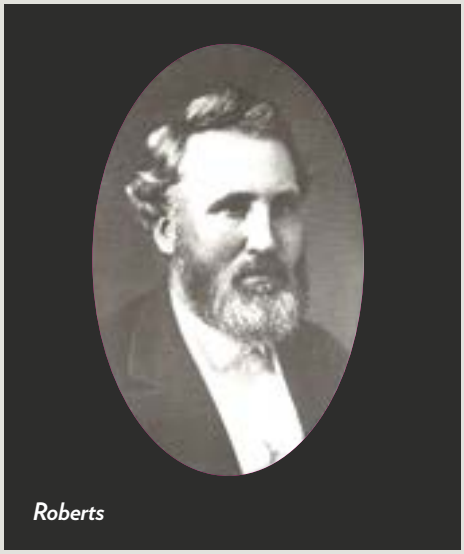
Fracking traces its lineage to mid-December 1862, on a foggy Civil War battlefield in north central Virginia. That's where we find Union Col. Edward A.L. Roberts, commanding a New Jersey regiment during the brutal, four-day Battle of Fredericksburg.

What impressed ***Roberts,*** even amid the cacophonous barrage of rifle shots and cannon blasts, was the Confederate Army's deft use of explosive artillery in the narrowest of spaces, like canals, to reshape the battlefield.

It immediately sparked an idea: How could that technology be adapted to suit the country's emerging oil industry, which only three years earlier saw Edwin Drake drill the first successful well in ***Titusville, Pennsylvania, in 1859?***



U.S. Patent No. 59,936 in 1866 for his *"Roberts Torpedo"*



Roberts

The result? Roberts was awarded U.S. Patent No. 59,936 in 1866 for his ***"Roberts Torpedo,"*** an explosive device encased in iron that was lowered deep into a well, then detonated from the surface. After the explosion, the borehole was immediately flushed with water to break up the loosened rock. His Roberts Petroleum Torpedo Company reaped a fortune from the devices he priced between $100 and $200 each, plus a cut of one-fifteenth of the well's profits. The practice became known as "shooting the well."

Reading about Roberts' exploits today – especially if you're in the business – can be cringeworthy, but his namesake torpedo wasn't a complete bust. The technique of using intense water pressure to unlock hydrocarbon-rich rock formations proved a solid foundation for the evolution of the technology.

Modern-day ***fracking*** has been safely used in the U.S. since the late 1940s. In fact, more than 1.7 million wells have been completed using the process – yielding more than ***7 billion*** barrels of oil and ***600 trillion*** cubic feet of natural gas, according to the Independent Petroleum Association of America.

The first frackers-shooting oil wells with nitroglycerin torpedoes. Source: Petroleum History Institute, 2013.

Now that we've got arms around its unique history, let's revisit the two fracking methods our Completions team has perfected to a science.

Instead of the traditional concept of horizontally drilling one well at a time, ***zipper fracking*** allows us to drill several wells at one site. We'll typically frac a stage in one well, simultaneously prep a second and do wireline or perforation work on another. ***Simulfracking*** involves stimulating two horizontal wells while perforating two more at the same time.

Together, the efficiencies have sliced days off work schedules and saved untold millions of dollars. And in a business where time is money, both methods have allowed companies like **Pioneer** to shatter the norm of what is possible in oil and gas exploration. With the ***zipper method,*** we can complete 2,600 feet per day; with ***simulfracking,*** it's around 3,500 feet per day.

For years, **Pioneer** made its money drilling traditional vertical wells that yielded maybe three barrels of oil a day. As technology improved, the vertical wells got deeper, and the production of 100 barrels of oil a day was viewed as a milestone.

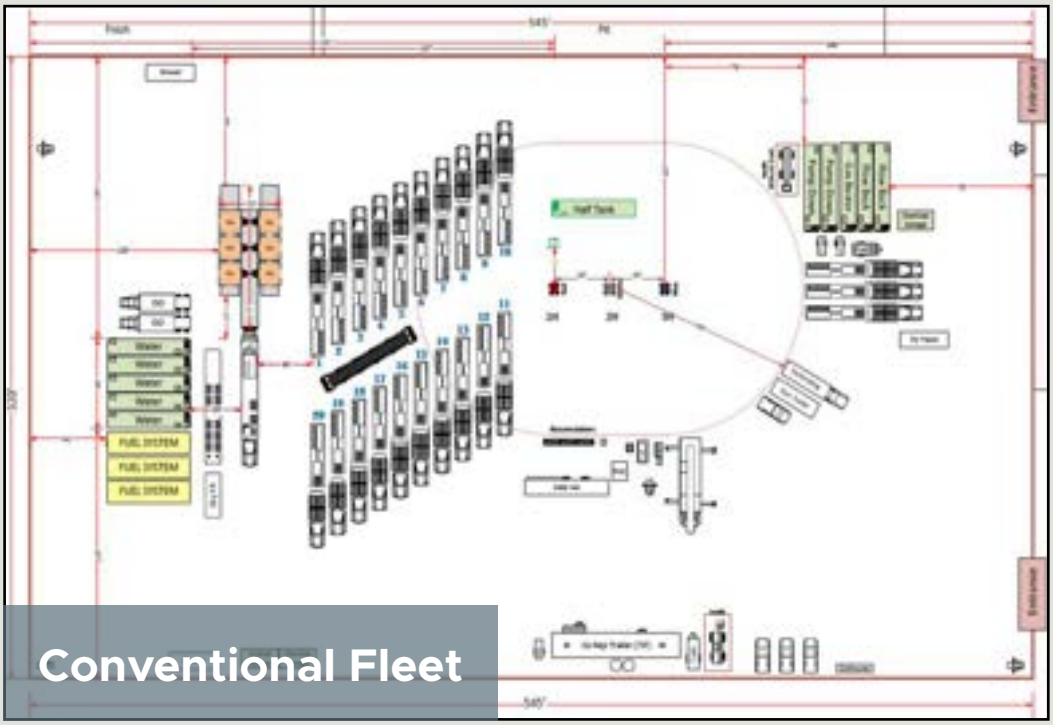
Horizontal drilling shattered every previous benchmark. Now, a new well can produce anywhere from **1,000 to 3,000** barrels of oil per day.

"Fracking's been around for decades, however, once the shale game started, you really had to figure out a different way," **Kevin** observes. "The days of pool oil were over, which means you can't just drill into a pool of oil and pump it out of the ground. Now, getting the oil from the rock with these two methods became an industry-changing thing; it redefined who we were."

During his time in Colorado, **Kevin** helped buy Evergreen's first frack fleet, which back then mainly targeted small coalbed methane wells.

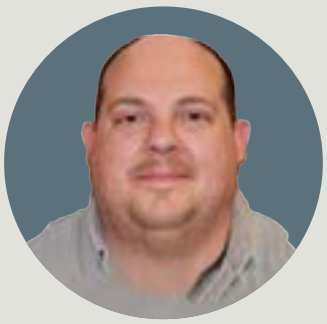
"They were really quick," he says. "You'd rig up, you'd frac for four hours and you rigged down. These wells were just 800 feet deep, so we could pump one stage all day and feel like we were killing it.

"Even after the horizontal game started, in 2012 and 2013, we could go frac three stages in a 24-hour day, and we were taking people to dinner that night. And now, with **simulfracking,** we can pump 24 or 25 stages in a day," **Kevin** says.

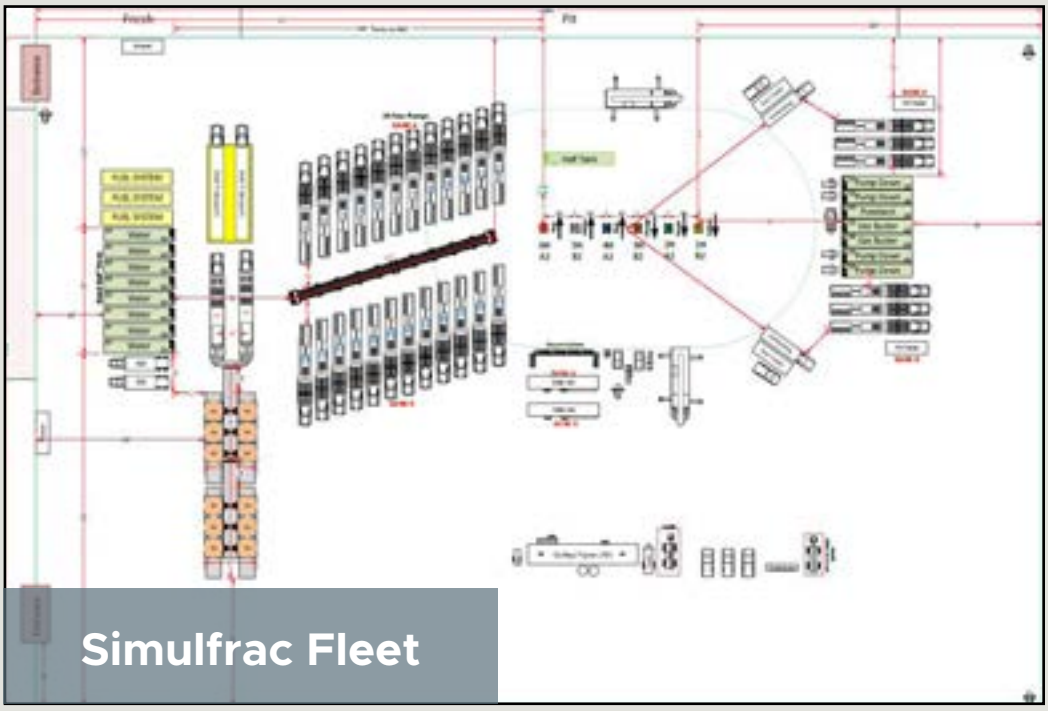


Conventional Fleet

Simulfrac vs. Conventional Fleet setup: A simulfrac Fleet rig ups almost twice as much equipment as a conventional fleet - i.e., 2 wireline trucks, 2 cranes, 2 pump down spreads, 2 silo packages and approximately 50% more HHP as shown in the pad layouts below. This allows a SF fleet to pump 2 wells at the same time at a combined rate of 150 bpm vs the standard 100 bpm with a conventional fleet.



Senior Field Completions Superintendent **Charles Woodall** has seen firsthand how the new methods have revolutionized the business. **Woody** – as everyone here calls him – started the first zipper frac jobs in the industry in the Barnett Shale in 2005, working his way up in the business with stints at **Halliburton, Chesapeake** and then **Pioneer.** The Henrietta, Texas, native witnessed the transformation on drill jobs in the **Dakotas, Colorado, Utah, Pennsylvania, Oklahoma, Arkansas and Kansas.**

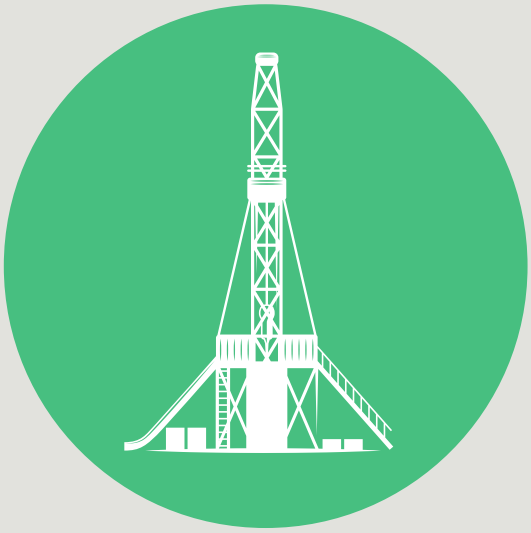


Simulfrac Fleet

"I've seen a lot, been all over the U.S. when I was fracking, and how we've developed the technique changed the game," **Woody** says. "I've seen it in how different shale formations were fractured and what kinds of jobs they pumped, and how we've been able to simplify the process over the years. Now, it's very efficient and everybody's thinking outside of the box to where we can save money and still be as efficient as we were previously."

Once a well is fracked, the heavy-duty equipment is moved to the next location and a *workover rig* takes its place.

The ***workover*** rig is smaller than a drilling rig and designed to ease the process of inserting or removing tubing in the wellbore. After injecting the sand, water and other chemicals into the lateral, the Completions team must now drill out all the ***bridge plugs*** that were set to isolate segments of the well during the fracking process. Crews then run and install Production tubing and ***bottomhole assembly*** into the well.



After the wellbore is cleared, crews prepare it for the Production stage by connecting the ***production tree***. Known in the trade as a ***"Christmas tree,"*** it consists of the valves, pipes and casing spools that will eventually divert fluids and hydrocarbons to oil and water tanks, heater treaters and other destinations during the Production phase. (We'll learn more in next week's chapter.)

It may seem counterintuitive

to think the wild success of the Completions group – and nearly every other unit we've profiled – is a double-edged sword.

That's for several reasons – what **Kevin** likes to call **The Three Ps:** pipe, permits and people.

"In my 33 years, I have never seen this industry getting stretched in so many different directions, and it's taking a toll like I've never seen before," **Kevin** says.

Geopolitics, COVID-19 and a bumpy economy here at home have disrupted supply chains across every industry. **Kevin** says there's not a single steel mill in the U.S. turning out tubulars and locating enough piping for a drill job is like searching for the proverbial needle in a haystack. His crews have gotten creative to work around the economic constraints, like breaking pipe segments into different sizes or using slightly downgraded tubing. Pioneer has also capitalized on its buying power to secure months and years' worth of critical supplies like sand, chemicals and diesel fuel.

Permitting is another headache, even in industry friendly Texas, and Kevin and some of his colleagues sense what they believe is a lack of urgency among some officials to greenlight projects.

Maybe the highest hurdle to clear for Pioneer and its peers is the dearth of skilled labor. Some workers got spooked by the pandemic-related downturn, while others are jumping to big-box retailers who have hiked their minimum hourly wages or even offered signing bonuses.

"We're losing people to SpaceX and Amazon," says Senior Completions Coordinator **Kathryn Briggs**, who assists with Pioneer's campus recruiting campaigns. "We have seen a decrease in the number of petroleum engineering students due to the downtown and the fear of the boom-bust cycles. They are concerned about the volatility."

The lesson? Even when times seem flush for the industry, the journey of a drop of oil is sometimes a precarious one.

PIONEER
NATURAL RESOURCES

Drop of Oil

COMING NEXT WEEK:

With the Drilling and Completions work finished, it's now time for the Production team to begin recovering our first drops of oil from the wellbore. We'll meet the 950-employee department – Pioneer's largest – and learn how its "never quit" credo helped power the company through a 100-year winter blast and a global pandemic.

MISSED A CHAPTER? Catch up here:

Chapter 1: *A story unlike any other*

Chapter 2: *Where does oil come from?*

Chapter 3: *Finding oil*

Chapter 4: *Securing the land*

Chapter 5: *Drilling for oil*

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