Unlocking Unconventional Reservoirs With Data Analytics, Machine Learning, and Artificial Intelligence

Dan Fu, Director of Technology, BJ Services

The concept of the digital oil field has been around for many years and the industry is beginning to experience the benefits of data analytics, machine learning, and artificial intelligence (AI).

The upside of digital technology is it can improve operational efficiencies and reduce costs. The downside of digitization is that many companies have neither the resources nor the expertise to collect, analyze, and interpret a critical mass of data while maximizing its economic return.

Predictive Behavior for Unconventional Reservoirs

As North America shale plays are once again becoming economically viable, operators in all major basins have fast-adopted best practices to optimize drilling and completion processes to drive down the lifting costs.

Adoption of data-driven analytics to improve completion design, drive efficiency, and yield economic gains has been less swift. In years past, an operator would perform analysis on a single well completion and make decisions using publicly and privately available data, well logs, or sometimes nothing more than experience gained through the years.

As the industry moves to more complex multipad, multiwell completion designs, intelligent completion optimization will require more sophisticated algorithms to improve decision making. The question remains as to how operators can use the vast amount of data readily available in the public domain and private data to develop and train models that enable them to realize these operational efficiencies and increase estimated ultimate recoveries.

This is where the use of analytics and AI can directly drive efficiencies to unlock the production potential of unconventional reservoirs specifically during hydraulic fracturing. The growing volume and availability of completion and production public data creates a revolutionary situation in which pad planning and completion design becomes possible with pure AI methods.

Benefits of AI-Driven Analysis

There are two main avenues where digital technologies are expected to make the largest impact: automation and optimization.

With predictive analysis, the industry will be able to automate and optimize the process of completion design to mitigate completion disfunctions such as frac hits or uneven cluster performance.

The inputs can come from quality data curated from wellsite records that include cluster spacing, pressure and rates, volumes pumped, fluids and sands used, diversion and flowback practices, production data, borehole assemblies, analyzed offset data, geology data, the plan of the well itself, and the offset wells that set up the pad development plan.

The most desired improvement of including AI into completion design is speed of the entire analysis and modeling process. The trained AI system does 6 to 8 weeks of manual research in seconds, identifying specific design hazards buried within amassed pages of completion and production reports. This accelerated tempo ultimately leads to reduction of nonproductive time.

Numerous completion parameters can be changed or improved using computational intelligence and mathematical optimization including stimulation volume, fluid types, flow rate, well lateral and cluster spacing, as well as numerous other considerations.

Optimization on these parameters must always be done coupled with economics. Long- or short-term goals will steer decisions to different completion designs. For example, with economics taken into account, the objective of avoiding frac hits at all cost may not be necessary. A trained AI model that predicts type curve and optimizes the cost function provided by economic objectives could discern that a certain level of risk of frac hits is acceptable and even beneficial.

Adoption Challenges

A key challenge to widespread adoption of AI will be proving the overall eco-

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Dan Fu is director, technology for BJ Services. He brings more than 20 years of experience in strategic planning and commercializing innovative technologies with specialties in product development, project management, hydraulic fracturing, acidizing, and lost circulation control. Fu holds a BS degree in chemistry from Beijing University, a PhD in chemistry from the University of Southern California, and an MBA degree from Colorado State University. He has authored more than 50 patents and patent applications and has coauthored 40 scientific publications.

nomic value, its investment return, and overcoming traditional views. An optimization workflow that includes building geological and geophysical models, fracturing simulations, pressure matching, and production predictions has an equivalent cost to 6 months of work by a team of experts. AI offers near-real-time analytics that still needs to earn its trust and prove its long-term value.

Another critical challenge is access to data. Many challenges exist in acquiring, analyzing, and managing subsurface data. This information is quite different from other domains because it comprises many complicated data types including well logs, core analyses, geologic interpretations, well laterals, pumping schedules, pressure records, and more. Each data type is complex and requires an experienced subject matter expert for data acquisition, formatting, and managing.

Analytics cannot thrive unless there are good data available. The amount of information increases with broadening subsurface workspace. The problem becomes more acute when factoring in large legacy applications and data in nondigital formats. A rethinking of the whole process of data management including data acquisition standardization and integration with daily operational business could improve data quality and catalyze data analytics.

Conclusion

The future of AI in completion is the introduction of smart control systems, platforms, and software. The software would have inputs from offset information gathered with the integration of machine learning and human influence, combined to react to changes that occur during completion.

In addition, the way to optimize hydraulic fracturing operations in real time and improve the overall consistency of well performance is using algorithmic controls. For example, AI monitoring pressure during breakdown, fracturing, and diversion will provide consistent design execution, help even distribution of fluid across the perforated interval, improve treatment pressures and rates, and mitigate the risk of screenout and, when coupled with data from offset wells, frac hits.

The use of data analytics, machine learning, and AI can lead to better stimulation and completion design to maximize production while yielding long-term cost benefits. **JPT**