Deloitte.

Using the downturn to build an agile manufacturing approach for O&G unconventionals

New development approach helps shale asset operators to improve capital efficiency and well performance

MAKING AN IMPACT THAT MATTERS
since 1845

Back in the early 2010s, as oil and gas (O&G) operators began to fully understand the differences between conventional and unconventional formations, momentum around a new asset development approach began gathering steam across North American exploration and production (E&P) companies: As there was little risk of hitting a dry hole in unconventionals relative to conventional formations, could adopting a traditional, assembly-line-type manufacturing approach deliver large-scale efficiency gains to help drive down break-even economics throughout the well delivery life cycle?

Given the scale and pace of development required to combat unconventional wells' rapid production decline rates, the proposed approach would apply the same rigor, consistency, and repeatability required for manufacturing success to drilling and completing a well. After all, if an operator was planning to drill 1,000+ wells to develop an asset, couldn't such an approach improve efficiency? Couldn't the operator determine the optimal materials and well design up front, hit start on the "conveyor belt" to deliver wells in a repeatable fashion, and assume steady, predictable production profiles?

While a manufacturing approach has considerable potential to improve productivity and recovery, few operators have followed through with implementation. Engineers and technical teams continue to experiment to find the right recipe that can improve productivity and recovery. An analysis of key completion parameters since 2017 for selected operators in three Permian Basin counties highlights this challenge. While these operators are all delivering wells in the same area, each shows a wide range of completion design parameters and their resulting impact on initial productivity (figure 1). This indicates that operators are still trying to derive consistent correlations between completion design choices and well performance.

Figure 1. Completion parameters and results range for select companies in Reeves, Loving, and Ward counties (823 wells drilled 2017–18)

Notes: 1) 1P-180 rates are normalized to a 10,000-foot perforated interval 2) The upper and lower limits represent the average value of bottom 10 percent and top 10 percent wells in each variable
Source: Deloitte analysis based on data from Enverus DrillingInfo database, accessed 2019.

While operators are dusting off their "manufacturing approach" textbooks, there is a glaring hole in how they handle experimentation.

This juggling act has occurred for a multitude of reasons. Before 2015, market prices were high enough to sweep many inefficiencies under the rug, and operators could turn a profit regardless of how the well performed or how planning inefficiencies affected well delivery. Then, as the industry struggled through the heart of the 2015 downturn, many operators cut back on drilling rigs and completion crews, opting to focus mostly on short-term cost cuts versus addressing structural and operational inefficiencies, so scale and resource constraints were not an issue. Further, there was greater focus on cutting short-term costs to meet financial targets.

Then, as the industry began to modestly recover in 2017 and activity ramped back up operators simply dusted off their "manufacturing approach" textbooks in hopes it would apply. Yet, there is a glaring hole in how they handle experimentation. In an industry that prides itself on the science of the rock, operators still have more to learn to experiment with well design "recipes" to unlock full reservoir potential and improve recovery factors. While a traditional assembly-line approach does not appear to be entirely applicable, a hybrid operating model that couples targeted well design and agile manufacturing may provide the consistent designs, stable plans, repeatable results, and better overall performance that operators need to extend the shale revolution (figure 2).

Figure 2. Hybrid operating model

As the industry faces yet another downturn, potentially graver than the last, now is the time to adapt and prepare for the future. Simply squeezing costs out of the service companies will not suffice. As the saying goes, "never let a good crisis go to waste." Use this downturn to cement the operating model and digital tools needed to deliver an agile manufacturing model. One that balances the predictability of a consistent execution approach with targeted experimentation in critical areas where additional well potential is possible. This could maximize assets' value potential and optimize capital efficiency while capturing additional production. On top of the current crisis, as described in our recent series, Moving the US shale revolution forward, the unconventional industry has a $24 billion well productivity and cost optimization opportunity as well.[1]

Bringing agile manufacturing to asset development

In recent years, the concept of "agile" has been front and center in the software application and DevOps world as a means to drastically improve development velocity, scalability, and overall performance. The same guiding principles that drive agile can be applied to how cross-functional teams manage field development and well delivery. How can shale operators use this new asset development approach to improve capital efficiency and well performance?

In a traditional assembly line manufacturing approach, emphasis is placed on well construction efficiency and lean principles to enable speed and scale. By applying agile, the focus on efficiency can be balanced with experimentation and accelerated learning to rapidly identify improvement opportunities. The shift to an agile manufacturing model would deliver a structured, iterative, and repeatable process with time to reflect and adjust field development and well delivery strategies based on near-real-time results of targeted experimentation and rigorous well performance assessment (figure 3).

Figure 3. Shift to agile manufacturing well delivery

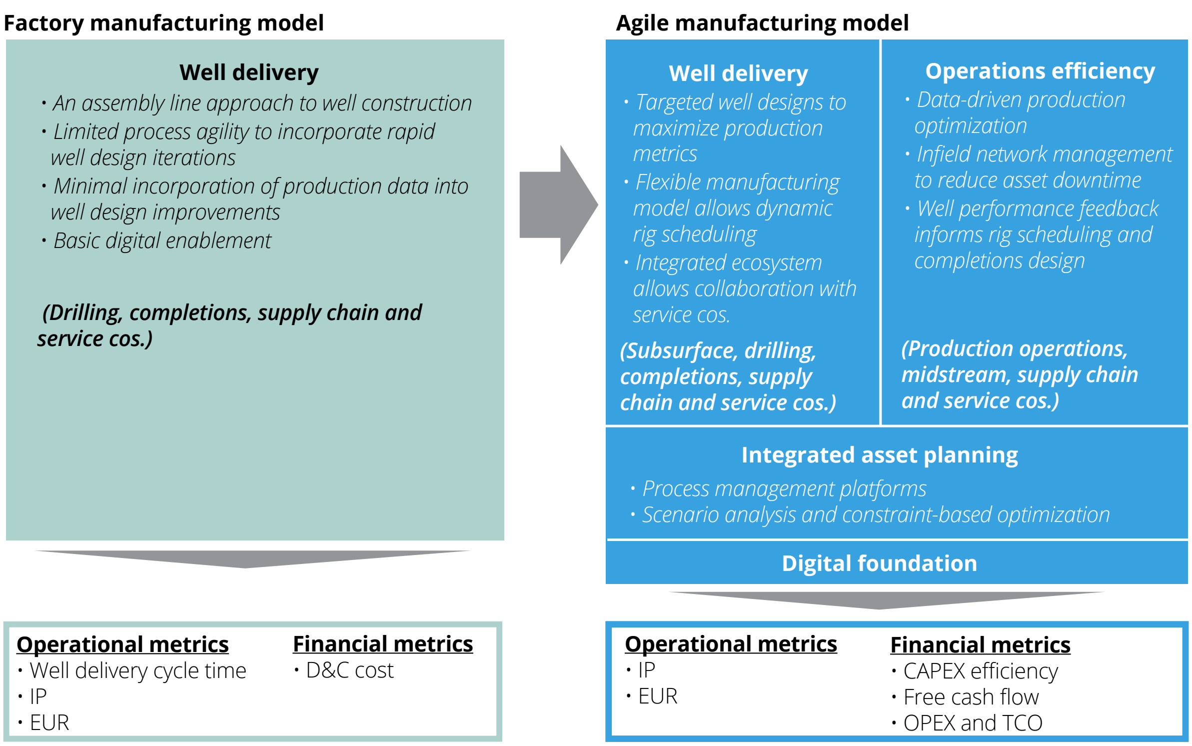
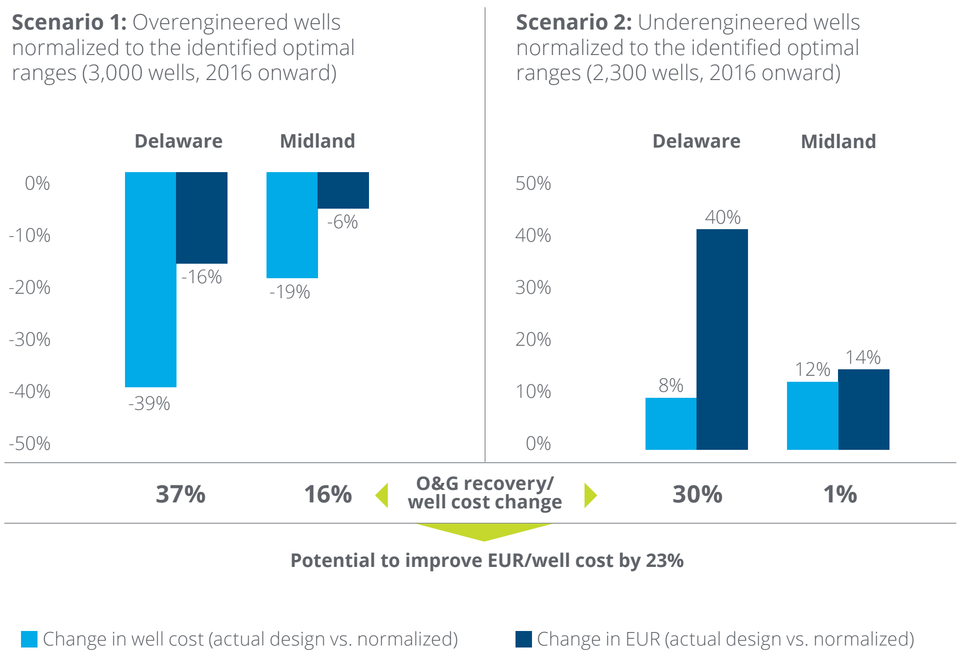


Figure 4. Maximize recovery per unit cost by optimizing designs

A scenario modeling on 5,300 wells reveals an opportunity to enhance capital efficiency by 23% in the Permian



- Delaware holds the maximum potential to reduce cost in overengineered wells and improve EUR in underengineered ones.
- Some big players have compensated for these losses by realizing notable gains from massive surface infrastructure while others continue to struggle.

This agile approach to accelerated learning and optimization is especially critical in unconventional resources, where operators must deploy capital, develop fields, and bring on new wells at a swift pace due to the rapid decline of base production wells. Having too rigid a well development process or being too slow to learn and act may lead to significant value erosion. As described in our recent shale series, an analysis of more than 5,000 wells brought online in the prolific Permian Basin since 2016 estimated that nearly 70 percent were over- or underengineered against the optimal range that delivered the highest estimated ultimate recovery (EUR) per unit well cost, offering an opportunity to enhance capital efficiency (figure 4).[2]

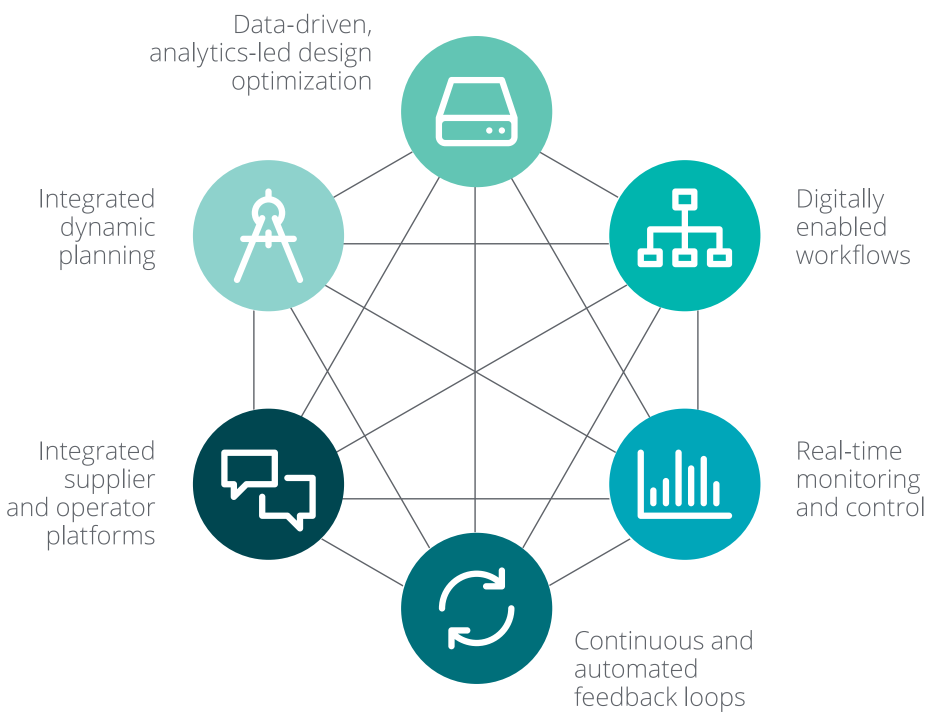
If operators across this representative data set had been able to more quickly identify the well design parameters that drive improved well productivity and had implemented those changes, they could have improved overall recovery per unit well cost by up to 23 percent. In the current market environment, where investors are demanding increased capital efficiency and improved free cash flows from shale operators, instituting new approaches that combat value pool leakage across the well life cycle is critical. Traditional, siloed well delivery operating models make collaboration across functional teams difficult and diminish the scientific rigor required to successfully experiment and evaluate changes in well drilling, completions, and facility designs. Using an agile manufacturing approach to accelerate learnings and strengthening the feedback loop can help operators enhance capital efficiency and deliver better-designed wells that improve margins throughout their life span.

[2] Ibid.

Transitioning to an agile manufacturing model

Transitioning to agile manufacturing will likely require operators to rethink traditional ways of working and leverage new and enhanced digital capabilities. In our experience, the process should incorporate six elements (figure 5):

Figure 5. Elements of an agile manufacturing approach



Integrated dynamic planning
It is not uncommon to see both operators without a formal field development planning process and those with an overly rigid plan. Few have achieved an optimal balance, and often the pendulum swings from one end of the spectrum to the other as management reacts and over-corrects. As activity ramps up it becomes increasingly important to use an integrated, dynamic plan that is flexible to changes that may optimize responses to internal and ecosystem constraints.

With integrated dynamic planning, an operator can use scenario analysis and plan manipulation to optimize rig and frac fleet based on production performance data and development logistics constraints across the well value chain and lifecycle. For example, as new wells are evaluated, it can shift priority for drilling locations or well designs. By only targeting critical areas for design experimentation, much of the well design can be consistent across a given field area, making delivery execution more repeatable and efficient as there are fewer changes occurring.

Success factors include:

- Defined and structured process around designing the well and managing the plan to drive consistency while allowing for flexibility
- Frequent and intentional cross-functional reviews of the plan to drive out inefficiencies
- Visibility into status and performance of the well delivery process from pre-spud to first oil

Data-driven, analytics-led design optimization
Determining which aspects of a well design impact a well's performance from initial production (IP) to EUR can be a complex process. Add in considerations around reliability and cost impacts later in the well's life and it becomes clear that operators need robust computing power. Cognitive analytics and machine learning provide capabilities to more quickly identify which well design parameters most influence well results, thus helping avoid the opportunity cost of developing wells with suboptimal designs. Operators should apply machine learning to well designs in three ways: 1) Rapidly align on the key design parameters that most influenced well results. 2) Compress the learning curve by more quickly linking targeted design experimentation to well results to de-risk the decision to adjust well designs. 3) Evolve to a truly predictive model that applies AI to determine in advance how a well will react to design changes. Doing so can allow for smarter targeted experimentation, pushing the performance envelope and enabling more consistent aspects of the well design in the agile manufacturing delivery approach.

Success factors include:

- Robust architecture and data management capabilities that provide on-demand access to the right data
- Collaboration of data science capabilities and engineering expertise to interpret output from machine learning and apply it to tactical well design strategies
- Trust in analytics' reliability and a culture that embraces innovation

Digitally enabled workflows
Decluttering or eliminating manual and time-intensive processes can free up engineers and field leadership to focus on more value-added activities. Digitizing workflows can enable process automation, create faster and easier links across systems, and improve collaboration by bringing the right information to the right people at the right time. This combination can improve efficiency, ease scalability, and increase standardization across workflows.

Success factors include:

- Clear view of all workflow steps
- Mindset to challenge traditional ways of working to focus on what is really needed for success
- Planning tool that helps manage the life-of-the-well delivery process from pre-spud to first oil

Real-time drilling and completions (D&C) monitoring and control

Using remote operation centers (ROC) to conduct real-time monitoring and control of D&C (e.g., directional drilling, geosteering, and controlling frac intensity) helps operators to more rapidly learn and react throughout the well delivery process. This institutionalized approach to real-time data and analytics can improve well execution and, ultimately, well results and apply learnings to the next well in the factory. In an industry where much of the relied-upon experience and expertise is aging-out, this process should improve resource utilization and knowledge transfer to the future workforce. ROCs also facilitate collaboration across functions and asset teams to more quickly uncover drivers behind recent performance and more quickly industrialize a consistent optimization process.

Success factors include:

- Real-time data connectivity with the field and seamless integration with enterprise analytics solutions
- Enabling tools and dashboards to improve analysis and collaboration
- Well-structured process and workflow interfaces across ROC and onsite operational teams

In today's rapidly changing digital environment, where no single entity can stay ahead of the curve on all fronts, being part of an ecosystem can provide opportunities for all members to leverage the leading technologies they need to succeed.

Continuous and automated feedback loop

Machine learning can help operators better determine the impact of well designs on well performance during the early life of a producing well. However, many operators are slow to capture analytics insights more broadly and even slower to translate them into actions to improve future wells. At the root of this challenge is ineffective collaboration and communication.

Digital solutions available today can enable operators to more quickly uncover key findings, automate sharing with relevant engineers and stakeholders, and feed information back into an integrated, dynamic plan that maximizes well and field potential.

Success factors include:

- Intentional collaboration to break down functional silos
- Digital solutions to drive analysis and automate sharing of key insights
- Integrated data platforms to combine and synthesize information across the well life cycle

Integrated supplier and operator platforms

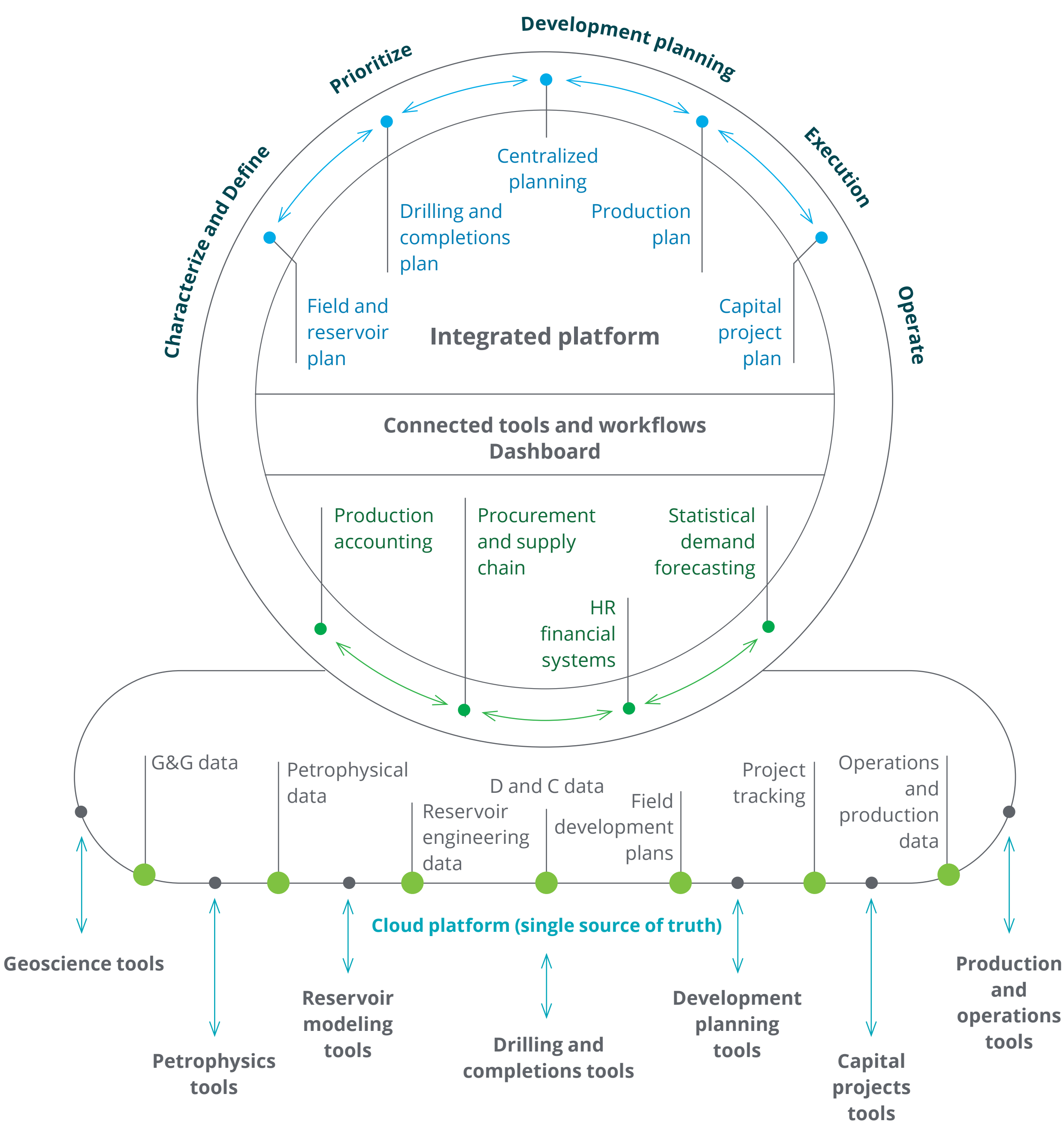
It is time for the traditional transactional relationship between supplier and operator to evolve to meet the new realities of pace and scale in unconventional assets. As operators establish integrated data platforms that strengthen cross-functional collaboration, there is significant value potential in extending this to the partner ecosystem to create a more transparent and efficient operating model. In addition, realigning operator or supplier partner incentives can help make value creation a shared goal.

Technology-led innovation is an essential enabler of the shift to an ecosystem partnership mindset. In today's rapidly changing digital environment, where no single entity can stay ahead of the curve on all fronts, being part of an ecosystem can provide opportunities for all members to leverage the leading technologies they need to succeed. This may be accomplished by operators and suppliers creating a shared, open platform like the recently announced Open Subsurface Data Universe (OSDU) that improves collaboration, matches the right supplier capabilities with the operator's needs, and transparently shares key information in real time to improve execution and well delivery (figure 6).

Success factors include:

- Commercial terms and incentives aligned to value creation across the ecosystem
- Secure, integrated technology platform solutions
- Complete and accurate supply and demand forecasts
- Culture shift to encourage operator-supplier collaboration

Figure 6. Collaborative operator-supplier ecosystem



How agile manufacturing changes the game

	Example today	Example tomorrow	What is needed
Integrated dynamic planning	• Loosely constructed plans with minimal tools in place • Mostly informal touchpoints to communicate changes • Planning not a core capability • Make plan changes without full impact analysis on business metrics	• Defined and structured process • Governance that enables variability only around a set number of variables • Intentional lookbacks	• Planning as a core capability with clear ownership by asset development • Supporting tools that quickly link well inventory, prioritization, and execution • Plan revisions based using analytics-driven design
Data-driven, analytics-led design optimization	• Multiple ongoing design experiments, sometimes multiple on one well • Different designs even on neighboring wells, often driven by the individual engineer	• Analytics determine which set of parameters engineers toy with • All other parameters are set more consistently across wells, regardless of individual engineer preferences • Unique well designs based on analytics and collaborative cross functional review vs individual engineers	• Historical data set • Data scientists to run ML to identify key design variables across different target benches • Structured design process that allows flexibility on agreed variables, but consistency in others
Continuous and automated feedback loops	• Limited feedback from well performance into drilling and completions • Suboptimal design of experiments delays value capture through learnings	• Standard work flows that tie production data back to subsurface, drilling and completions	• Data analytics capability built upon ML/AI tools • Common data infrastructure that enables consistent design decisions and captures learnings • Intentional touchpoints to ensure effective collaboration and rapid learnings dissemination
Real-time monitoring and control	• ROCs have varying buy-in and capabilities across operators • ROCs mostly focused on real-time actions and less on rapid learnings	• ROCs that cover the end-to-end well construction • Managing decisions and actions based on the value and life of the well, not at a single point in time • Integrated dynamic planning as a key lever to improve intentional collaboration across functions	• Analytics-driven capabilities for both real-time and historical analysis • Intentional lookbacks with feedback into planning team
Integrated supplier and operator platforms	• Ecosystem collaboration is ad hoc and constrained by the lack of tools, commercial models, and legacy customer-vendor relationship • Most relationships considered tactical, rather than strategic • Value loss due to avoidable downtime and supply-cost escalation	• Intentional coordination and transparency in every phase of field operations • New commercial models incentivize collaboration • Improvement in operational and financial metrics by reduction in downtime, as well as less variability in D&C Capex spend	• A culture change that moves away from the legacy operator-OFS relationship toward strategic partnerships • Common data and platforms that enable full visibility into upcoming operations • Smart contracts that enable new commercial models
Continuous and automated feedback loops	• Limited feedback from well performance into drilling and completions • Suboptimal design of experiments delays value capture through learnings	• Standard workflows that tie production data back to subsurface, drilling and completions	• Data analytics capability built upon ML/AI tools • Common data infrastructure that enables consistent design decisions and captures learnings • Intentional touchpoints to ensure effective collaboration and rapid learnings dissemination

The agile manufacturing approach balances consistency and rapid experimentation and learning.

Foundational capabilities to enable agile manufacturing

To effectively adopt an agile manufacturing approach to asset planning and well delivery, operators likely will need to augment two foundational capabilities: operating model transformation and digital enablement.

Operating model transformation

Operators in unconventional assets face complex challenges across the life of a well; for example, identifying a drilling and completion design in the subsurface that maximizes reservoir recovery at the lowest development cost or reducing takeaway capacity constraints and offsetting D&C activity in surface operations that may interfere with asset development plans. Executives can apply agile manufacturing's guiding principles of strong collaboration, empirical learnings, response to change, and iterative, repeatable processes to drive operating model transformation across the organization, capabilities and processes, data and analytics, and digital tools (figure 7) to make better, faster, more consistent, and safer decisions.

Figure 7. Applying agile to operating model transformation

Organization

- Functional and asset operations team roles and& responsibilities clearly define?
- Scope of authority and decision rights for asset planning and development optimized?
- Competency management & training programs in place across key roles?

Capabilities and Processes

- Processes and cross-functional interfaces aligned to new ways of working?
- Capability roadmap defined?
- Iterative review and learnings processes embedded in well delivery life cycle?

Data and analytics

- Minimum data standards aligned with processes and MDM established?
- Integrated data platforms and systems architecture?
- Dynamic analytics capabilities?

Digital tools

- Tools set up to support new ways of working?
- Fit-for-purpose digital solutions driven by human-centered design?
- Automation in place to optimize resource utilization?

Change management foundation

Clear goals, objectives, and incentives | Cross-functional collaboration | Innovation mindset | Well delivery continuous improvement

Agile manufacturing vision and approach

Underpinning this agile-enabled operating model are performance metrics and governance systems that align functional incentives to optimize capital efficiency and fuel continued margin-accretive asset development. The agile manufacturing approach balances consistency and rapid experimentation and learning. To fully embrace this model at an enterprise level, executives should take a leading role in establishing a culture that is centered on collaborative individual interactions and data-sharing across functions and the well life cycle.

Digital enablement

The O&G workforce is ever-changing, and executives should take intentional and strategic steps to put digital solutions in place that enhance productivity. Yet even though operators recognize and endorse digital's growing importance, some struggle to realize the full value of the investments they have made thus far in their digital journey. We have identified seven core elements of digital enablement that operators should prioritize and support to help scale and sustain integrated dynamic planning and operational execution in an agile manufacturing approach.

Even though operators recognize and endorse digital's growing importance, some struggle to realize the full value of the investments they have made thus far in their digital journey.

- **Digital fluency:** A digitally native workforce that embraces the potential of digital capabilities and fosters a culture of innovation and continuous improvement
- **Data foundation:** The enterprise infrastructure and tools to enable seamless access to a data set with the required standards of integrity and fidelity
- **Digital transformation roadmap:** The strategic vision for how digital capabilities can disrupt and evolve ways of working and the clearly defined path forward aligned to business priorities, interdependencies, and capacity to drive the change
- **Analytics engine:** The resources, skill sets, and tools to use cutting-edge analytics and machine learning capabilities to enhance technical analysis and improve decisions
- **Digital factory:** An agile DevOps approach to incubate innovation and digital concepts, from ideation to successful implementation and sustainment, that delivers measurable business value
- **Synchronizing ways of working:** Rewiring processes, expectations, and decision rights at key interaction points between legacy and digital ways of working to increase synchronization and adoption of digital operations
- **Handling risk and cybersecurity:** Modulating risk and security boundaries to balance cybersecurity requirements with the need for access to information

Making agile manufacturing a reality

Over the past decade, technology and process innovations have continued to unlock new value in the US unconventional resources sector. As the shale revolution continues to mature and evolve, operators likely will need to change their business model to compete for capital and deliver free cash flow to investors. Forward-thinking organizations continue to test new technologies and D&C designs to cost-effectively increase the hydrocarbons which can be recovered from shale reservoirs. Adopting an agile manufacturing approach should enable operators to more efficiently deploy capital, maximize reservoir recovery and productivity, and optimize lifting costs across the asset life cycle.

Endnotes

1. Tom Bonny et al., "Moving the US shale revolution forward," Deloitte Insights, October 23, 2019, https://www2.deloitte.com/us/en/insights/ industry/oil-and-gas/us-shale-revolution-playbook.html.

2. Ibid.

Contacts

Tom Bonny
Managing Director
Oil & Gas
Deloitte Consulting LLP
tbonny@deloitte.com

Samrat Das
Senior Manager
Oil & Gas
Deloitte Consulting LLP
samratdas7@deloitte.com

Mike Orton
Senior Manager
Oil & Gas
Deloitte Consulting LLP
miorton@deloitte.com

Deloitte.