Achieving high performance in unconventional operations

Integrated planning, services, logistics and materials management
Achieving high performance in unconventional operations
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The importance of adopting a manufacturing approach to oil and gas exploration – which includes standardization, factory lines and strategic use of inventory – is well known across unconventional operators. This approach has been successfully implemented to varying degrees by different operators. But what are the next areas for improvement?

In this study we examine the operating practices of three key segments: conventional players who have significant unconventional investments, large independents that primarily have an unconventional focus and smaller independents.

We have seen some commonalty across operators in:

- Using an optimal type of rig (top drives, high horsepower draw works and pumps, AC-powered, skid rigs)
- Placing an emphasis on the consistency of rig and fracturing crews (2–3 year contracts)
- Moving towards standardization of pad and well designs
- Using multi-well pads and batch drilling
- Producing a standard set of drilling metrics from the well data
- Increasing use of scanners, bar codes and tablets.

However, the performance of operators in implementing this approach has been varied. In a basin where the top quartile cost per well is US$5 million, some operators still struggle to deliver wells for twice that amount. At the same time, operators in the top quartile are continuing to find ways to reduce costs. Some of the techniques these operators employ represent the remaining areas of differentiation in the manufacturing approach. These are the areas that few operators (only a handful of leading independents) have mastered, but would greatly enhance the efficiency of all operators. Even among leading companies, areas of differentiation in the manufacturing approach include:

- Integrated planning
- Managing drilling and other service contractors
- Logistics management
- Materials management
- Drilling automation and analytics
- Collaborating across functions such as drilling, geology and operations and with service providers

This report focuses on four of the above six areas: integrated planning, management of services, logistics and materials management, using the Eagle Ford Shale oil and gas basin in southern Texas as a model.

Different operators have different operating models when it comes to using technology, focusing on continuous improvement, and investing in people. While all areas are important, one will take precedence, depending on an operator’s situation. Leading operators are constantly making trade-offs and the ability to cost-effectively balance investment in these areas has a clear impact on success.
The basic concepts of standardization, efficient replication across basins and effective supply chains are well known in unconventional drilling, yet there is still a high variability in operator performance, even within the same basin. The gap also seems larger as a result of operational execution practices as opposed to any technological advantage. The objective of this study is to examine the leading operators across multiple segments – from those with a conventional development background to the large and small unconventional-focused independents – to understand what has been implemented and, more importantly, what the remaining areas of differentiation are.

There were four main steps in this approach, as illustrated in Figure 1.

1. Accenture surveyed leading operators in multiple basins on leading practices. These findings formed the basis of the questionnnaire used with the Eagle Ford players.

2. Half-day interviews with Eagle Ford operators. This allowed us to compare how leading operators address similar challenges and to identify remaining areas of differentiation. This gave us a detailed comparative assessment of the operators and a long list of the remaining areas of differentiation.

3. Validation, refinement and application of the information regarding the remaining areas of differentiation and its potential application to multiple basins. Those differences identified in the interviews were then refined and tested with Accenture subject matter advisors (SMAs) and teams from basins all over the world. The resulting output determined the four focus areas of the report.

4. Four focus areas: In the final analysis, we examined each of the four areas, the details of which comprise this report.

Source: Accenture
Remaining areas of differentiation in the manufacturing approach

Unconventional operators have made significant savings in well-delivery costs over the past 10 years by aligning their operating models with the manufacturing approach. However, there are still significant opportunities to further reduce costs and cycle times for executing well delivery. Our study identified four areas where many operators still struggle to reduce costs and cycle times.

By addressing these specific areas, well-delivery costs can be reduced by between up to 20 and 40 percent, while overall well-delivery cycle time can be reduced by between up to 25 and 40 percent, as shown in Figure 2.

Significant improvements in costs and time to drill and complete a well can change the economics of an unconventional operation, making investments that would not otherwise be viable possible. For example, if we apply the 25 – 40 percent reduction in cycle time quantified in Figure 2, to the examples in Figure 3, improvements in these four areas have the potential to reduce cycle time by 106 to 170 days, taking cycle time from 464 days to 254 days in the best case scenario.

Additionally, the 20 – 40 percent reduction in construction drilling and completion costs could reduce overall well costs by up to $1.3 million to $2.6 million per well, taking costs from $6.5 million to under $4.0 million per well in the best case scenario.

Collaborating across disciplines with service providers, contractors and vendors is critical in all four areas of differentiation.

1 Integrated planning
2 Management of services
3 Logistics management
4 Materials management
Figure 2. Benefits of adopting an integrated planning strategy for well delivery

<table>
<thead>
<tr>
<th>Areas of differentiation</th>
<th>Potential impact on construction, drilling and completions cost</th>
<th>Potential impact on cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Integrated planning</strong></td>
<td>Developing a structured approach to integrated planning from long-term field development and economic modelling to well-delivery scheduling and field level coordination can reduce the cycle time of the front-end loading activities. Collaboration across functions (wells, projects, production and service providers) to develop and execute an integrated plan can also reduce costs in well delivery by minimizing delays and reducing the costs for rework and logistics.</td>
<td>5–10% reduction in construction, drilling and completion (CD&amp;C) costs</td>
</tr>
<tr>
<td><strong>Management of services</strong></td>
<td>Due to the heavy reliance on service contractors for well-delivery execution activities, a structured and effective method of managing, measuring and coordinating third-party service providers can achieve significant savings in well-delivery costs and reduced overall cycle time, due to the heavy reliance on service contractors for well-delivery execution activities. Collaborating with service providers can also improve performance.</td>
<td>10–15% reduction in CD&amp;C costs</td>
</tr>
<tr>
<td><strong>Logistics management</strong></td>
<td>Logistics (particularly water movements) is a critical component of unconventional shale operations. Optimizing logistics can deliver significant value, drive down costs and reduce cycle times across the operation. Collaborating with logistics providers can greatly improve the scheduling of well delivery.</td>
<td>5–10% reduction in CD&amp;C costs</td>
</tr>
<tr>
<td><strong>Materials management</strong></td>
<td>Due to the high velocity of well delivery and dispersed geographic area of unconventional fields, standardization of well and pad designs and an effective standardized materials management process can maximize material availability and reduce inventory. A sound storage system can also contribute significant value to the well-delivery process. Note standardization in the materials management process can also have a similar cost reduction impact on maintenance and workovers.</td>
<td>0–5% reduction in CD&amp;C costs</td>
</tr>
</tbody>
</table>

Source: Accenture analysis
Figure 3. Activities and costs that are affected by improvements in integration planning, management of services, logistics and materials management.

**Total well delivery cycle time**

- Scout and location ID: 424 Days
- Environ & mineral study: 60 Days
- Pad and well design: 30 Days
- Permit well and construct pad: 60 Days
- Set cellars and flowlines: 20 Days
- Queue time from construct to drill: 14 Days
- Drilling: 100 Days
- Prep location and move in rig: 30 Days
- Prep location for completions: 14 Days
- Perf and Frac well: 14 Days
- Drill wells on pad and move off: 21 Days
- Flow back/cleanup and tie in to well site facilities: 20 Days
- Queue time from drill to complete: 14 Days
- Completions: 258 Days
- Total well delivery cycle time: 60 Days

**Reduction in cycle time**

- Reduction in cycle time ranges from 25-40%
Integrated planning, services, logistics and materials management  

Source: Accenture Case Study.

Mineral rights scouting and surface land pad construct rig day rate drilling direct materials drilling direct services aux. rentals aux. services wellsite facilities $6.4M $1M $100K $200K $300K $200K $400K $700K $1M $1M $1.1M $1M $400K $300K $1M $100K $500K $100K $400K $200K $400K $700K

Effected by supply chain optimization
Effected by process efficiency
Effected by a mix of supply chain optimization and process efficiency

Total construction, drilling and completion (CD&C) capital costs

20-40% Cost reduction ranges from 20-40%
Achieving high performance in unconventional operations

Eagle Ford Shale is one of the largest producing oil and gas fields in North America, surpassing 1.2 million barrels of oil per day and 6,000 million cubic feet of natural gas per day in late 2013. The basin currently ranks as the largest oil and gas development in the world in terms of capital invested. Estimates indicate $30 billion was spent developing the area in 2013. There are more than 200 operators and 268 active rigs currently on the site.

As the number of wells in the Eagle Ford Shale formation increases, it is clear that the manufacturing approach has been a key catalyst for the rapid growth in basin operations. Essentially, all operators are pushing to standardize well and pad designs and increase pad drilling, and the efforts have made a clear difference. In June 2012, the time it took operators to drill a horizontal well was 19 days on average, down from 23 days in 2011.

Accenture interviewed several companies operating in the Eagle Ford Shale basin and found that operators approach the challenges of unconventionals differently. For example, planning operations vary, as does focus on continuous improvement. Operators’ use of data to inform operational decisions and the ways they manage contractor performance also vary.

Accenture’s observation, illustrated in Figure 6, is that one operational factor may be more important than others in addressing this challenge. Technology, continuous improvement and people are all important in unconventional resource development, but investment in one area often leads to trade-offs in another. Additionally, investing in all three areas is cost-prohibitive in the low-margin environment of unconventionals. Understanding the trade-offs and impact on total well cost is critical. For example, how will investment in new rig technology affect rig moves? Is utilizing new technology a better choice than offering incentives to your service provider to ensure consistency of crew?

Inset

The Eagle Ford Shale oil and gas field

Eagle Ford Shale is one of the largest producing oil and gas fields in North America, surpassing 1.2 million barrels of oil per day and 6,000 million cubic feet of natural gas per day in late 2013. The basin currently ranks as the largest oil and gas development in the world in terms of capital invested. Estimates indicate $30 billion was spent developing the area in 2013. There are more than 200 operators and 268 active rigs currently on the site.

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### Figure 5. Average wells per rig and new oil production per rig

![Bar chart showing average wells drilled per rig and new oil production per rig from Q1-2012 to Q3-2013.](chart.png)


### Figure 6. Relative importance of technology, continuous improvement and people in resolving important challenges in unconventional development

<table>
<thead>
<tr>
<th>Important challenges</th>
<th>Technology long-term step change in performance</th>
<th>Continuous improvement sustained and creative, but often incremental, improvements</th>
<th>People (culture) focus on empowering best people on the frontlines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characterization of the reservoir</td>
<td>✔ ✔ ✔</td>
<td>☑</td>
<td>❍</td>
</tr>
<tr>
<td>Low productivity</td>
<td>✔ ✔ ✔</td>
<td>☑</td>
<td>❍</td>
</tr>
<tr>
<td>Large number of non-technical risks such as land access, local content, permitting and stakeholders</td>
<td>✔</td>
<td>☑</td>
<td>❍ ✔ ✔ ✔</td>
</tr>
<tr>
<td>Drilling high volume of wells efficiently at low costs</td>
<td>✔</td>
<td>☑</td>
<td>❍</td>
</tr>
<tr>
<td>Managing large number of service providers and contractors</td>
<td>✔</td>
<td>☑</td>
<td>❍ ✔ ✔</td>
</tr>
<tr>
<td>Water sourcing and disposal</td>
<td>✔ ✔ ✔</td>
<td>☑</td>
<td>❍</td>
</tr>
<tr>
<td>Environmental footprint</td>
<td>✔ ✔ ✔</td>
<td>☑</td>
<td>❍</td>
</tr>
</tbody>
</table>

Source: Accenture analysis
The leading unconventional operators have the flexibility to focus on each area (technology, continuous improvement and people) depending on the potential impact on the project and the supporting frameworks required to make well-informed trade-off decisions. This agility influences the success of their manufacturing programs, as is clearly evident in the operational metrics of top performers. Top quartile Eagle Ford operators revealed that they could drill wells in as little as 10–12 days in 2013.

The following figures summarize operational metrics for leading operators in the Eagle Ford Shale. These operators vary from large integrated oil companies primarily focused on developing conventional oil and gas assets to large and small independents. Operators in each segment demonstrate important strengths across technology, continuous improvement and people management. These strengths have allowed them to achieve significant production volumes, but, as the operational metrics demonstrate, the large independent operators are leading the pack, managing the largest operations in terms of numbers of rigs and achieving record oil and gas production. They also run the most efficient operations in terms of well costs and days to drill (See Implications for Operators on page 41 for more detail on why large independents are best positioned to deliver value from their unconventional assets).
Figure 7. Eagle Ford operators’ 2013 operational metrics

<table>
<thead>
<tr>
<th></th>
<th>2013 production (MBOEPD)</th>
<th>2013 Eagle Ford production (MBOEPD)</th>
<th>2013 Eagle Ford acreage</th>
<th>2013 Eagle Ford % liquids to gas</th>
<th>2013 Eagle Ford rigs</th>
<th>2013 Eagle Ford producting wells</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Predominantly conventional operators</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Statoil</td>
<td>1,940.0</td>
<td>20.2</td>
<td>68,000</td>
<td>60%</td>
<td>3</td>
<td>300</td>
</tr>
<tr>
<td>BP</td>
<td>3,230.0</td>
<td>-</td>
<td>400,000</td>
<td>-</td>
<td>9</td>
<td>-</td>
</tr>
<tr>
<td>ConocoPhillips</td>
<td>1,545.0</td>
<td>141.0</td>
<td>227,000</td>
<td>79%</td>
<td>11</td>
<td>350</td>
</tr>
<tr>
<td>Murphy Oil</td>
<td>205.7</td>
<td>50.4</td>
<td>149,500</td>
<td>90%</td>
<td>8</td>
<td>320</td>
</tr>
<tr>
<td><strong>Large independents</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EOG Resources</td>
<td>510.1</td>
<td>160.2</td>
<td>632,000</td>
<td>89%</td>
<td>26</td>
<td>440</td>
</tr>
<tr>
<td>Chesapeake Energy</td>
<td>669.86</td>
<td>95.0</td>
<td>449,000</td>
<td>79%</td>
<td>15</td>
<td>945</td>
</tr>
<tr>
<td>Anadarko</td>
<td>781.0</td>
<td>165.0</td>
<td>185,000</td>
<td>65%</td>
<td>11</td>
<td>&gt; 1000</td>
</tr>
<tr>
<td>Marathon</td>
<td>494.0</td>
<td>81.0</td>
<td>211,000</td>
<td>80%</td>
<td>18</td>
<td>290</td>
</tr>
<tr>
<td><strong>Small independents</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pioneer resources</td>
<td>174.2</td>
<td>79.6</td>
<td>117,000</td>
<td>85%</td>
<td>10</td>
<td>300</td>
</tr>
<tr>
<td>EP Energy</td>
<td>92.1</td>
<td>36.6</td>
<td>91,675</td>
<td>80%</td>
<td>5.5</td>
<td>270</td>
</tr>
<tr>
<td>Carrizo</td>
<td>27.4</td>
<td>12.6</td>
<td>62,181</td>
<td>88%</td>
<td>3</td>
<td>95.5</td>
</tr>
<tr>
<td>Goodrich Petroleum</td>
<td>12.7</td>
<td>3.6</td>
<td>66,761</td>
<td>86%</td>
<td>1</td>
<td>73</td>
</tr>
<tr>
<td>Penn Virginia Corporation</td>
<td>18.7</td>
<td>11.2</td>
<td>77,900</td>
<td>89%</td>
<td>2</td>
<td>117</td>
</tr>
</tbody>
</table>

Source: Investor presentations 2Q/3Q 2013 10-Qs, Company Websites.
Achieving high performance in unconventional operations

Integrated planning

Overview

Planning the multi-year development of a conventional field is challenging and can lead to missed production forecasts and project overruns. This challenge is even greater in unconventional, where there are hundreds, even thousands of wells in a single field and the sharp production decline curves of unconventional wells mean the production forecast is largely driven by drilling new wells and workovers.

However, integrated planning can provide a significant point of differentiation, due to the high volume of activity, the number of service providers and vendor-managed materials and the interdependencies of the activities. As one leading operator noted: “Planning represents 80 percent of success. Our time spent on execution is much less than planning.” Integrated planning can be broken into three levels. Level one focuses on the field-level planning activities such as facilities capacity analysis, production forecasting and field constraint analysis to determine the optimal well-delivery plan. The output from level one is then delineated to create a more detailed well and facilities schedule. Level two strives to integrate all the functional groups such as front-end loading, pad construction, drilling, completions, well-site facilities and production operations to develop an integrated schedule that optimizes the plan across the entire value chain. The integrated schedule then feeds the supply chain-integrated schedule at level three that incorporates required supply chain activities such as material management and logistics, service-company scheduling and coordination.
Figure 8. The three main levels of field planning

**Field level**
Full field economics and forecast production simulation.
(Refer to Figure 9 page 17)

**Well scheduling and facilities construction**
Yearly, quarterly and monthly. Also informs facilities construction and supply chain.
(Refer to Figure 10 page 19)

**Supply chain**
Integrated supply.
(Refer to Figure 11 page 21)
Field-level integrated planning

Field-level integrated planning incorporates multiple sources of field-level information to determine the optimal well-delivery plan for the entire field. The information at this level typically includes well type curves, well capital expenditure costs, cycle times, mineral right percentage, and facility flow capacity analysis and lease expiration. This information is modelled to provide scenario options that target the highest production forecasts and economics based on current field-level constraints. In addition to the initial field-development plan setup, this level of planning is used to incorporate current performance and analyze scenarios to determine the appropriate rig count, area development plans and facility investment based on capital budgets and production targets.

While most operators currently perform some level of field-level integrated planning – usually creating economic models to determine the level of capital investment and production volumes from an unconventional program – operators still face several challenges. These can be grouped into the following areas:

1. **Value chain integration**
   Many operators overlook the facility, supply chain, community relations, land owner, and health, safety and environment (HSE) issues that can have a major impact on field development plans.

2. **Manual process**
   In many cases, field-level integrated planning relies on multiple spreadsheet models that require significant manual intervention and can become corrupt over time.

3. **Limited integration with actual performance**
   Most field-level integrated plans start with a set of assumptions regarding type curves, well costs and cycle times. Over time these variables will change or improve, which may have a significant effect on deciding how the field should be optimized. However, they all too often suffer from a lack of data, lack of organizational trust or heavy manual interventions. The models are then not updated to reflect performance, leading to poor decisions at the field level.

4. **Lack of alignment to drilling schedule**
   In many cases, a targeted field development plan is established. But over time the drilling schedule adapts to current capital budgets or constraints, whereas the field development plan does not. This creates a misalignment with the schedules and plans used to make capital budget decisions.

Accenture believes there are several ways operators can address these challenges to adapt and integrate field-level planning into their drilling schedules.

1. **Value chain integration**
   Field-level planning should include all the potential challenges across the field lifecycle. These include facility capacity, supply chain, community relations and HSE constraints. This level of integration will help simulate a more realistic scenario, giving the operator a greater chance of achieving the desired outcome.

2. **Adopt a systematic approach**
   Spreadsheets let end-users perform a quick analysis. They do not, however, allow for the speedy analysis of multiple varied scenarios across the life of a field. A systematic approach using a cloud-based internet server would incorporate large amounts of data and allow operators to link to other systems that can quickly turn around ‘what if’ analysis and lead to faster and higher-quality decision making.

3. **Link with actual performance and drill scheduling**
   Field-level planning should be integrated with actual performance and allow schedulers to easily update planning parameters. Additionally, effective interfaces between field-level planning and drilling schedules help maintain alignment, allowing for consistent feedback loops between the two levels.

Figure 9 demonstrates a typical unconventional network and demonstrates that the field level planning incorporates the potential production volumes of the wells with the capacity constraints across the network (pipelines, compressors, Natural Gas Liquids (NGL), supply chain) in order to conduct what if scenarios and optimize the network.
Figure 9. Field-level planning linked to the drilling schedule

Source: Enersight
Well scheduling and facility construction

While the field-level plan is focused on maximizing field economics and production over the long term, the well scheduling and facilities construction level shifts from a high-level plan to a focus on well-level activity planning. This involves establishing a 12-month activity schedule identifying the wells to be drilled and the activities required to progress them from geology to production. This stage incorporates outcomes from field-level planning and establishes an operational schedule to effectively move the desired wells through the delivery process. It includes upfront planning such as land access and permits, through well-site construction, drilling, completion and finally operation. A high-performing well-level scheduling capability requires strong alignment between people, processes, governance and technology to enable cross-functional teams to efficiently execute a large-scale, repetitive manufacturing approach.

While not a new concept to unconventional programs or traditional well delivery, operators can still benefit greatly from improving aspects of their well-level scheduling. These aspects can be grouped into the following themes:

1. Non-integrated well-delivery scheduling

Many operators struggle to develop fully integrated well-level scheduling. The focus is primarily on the drilling rig and spud dates and the schedule is mostly used as a decision-making tool during status meetings to align activities to meet important dates. This approach, while common in more conventional fields, provides challenges as the volume of wells and functional groups grows in unconventionals. In many cases, unconventional well-delivery programs drill up to three to four wells per month. This level of activity requires a step change in alignment, coordination and communication between functional groups that can no longer be managed through status meeting updates.

2. Multiple versions of the truth

In many cases, due to the lack of integration and disparate systems, well scheduling becomes a department-by-department process, where each team keeps its own ‘cheat sheet’ schedule, and has limited ability to cross reference with other departments. This leads to multiple versions of the truth and potentially results in departments working with outdated information.

3. Project-oriented scheduling

The traditional approach to well scheduling is to view each well as an individual project and progress through the well-delivery process one well at a time. While appropriate for conventional fields, this approach provides several challenges for unconventionals. The high volume of wells and endless schedule changes and adjustments can lead to significant resources being spent on status updates that will only be valid until the next schedule change. Operators need to view unconventional well delivery more from a manufacturing perspective, where keeping an inventory throughout the process reduces the need to drive project schedules for each well from start to finish.

4. Best-case scheduling

In many cases, drill schedules are established using best-case schedules, leading to an inability to deliver effectively as cycle times vary across the portfolio. Operators seem to struggle to effectively provide feedback on performance to the integrated schedule and ensure alignment across departments. This leads to missed targets, significant additional changes to the schedule and conflict between departments.

Accenture believes operators can make several changes to facilitate more aligned, integrated and effective scheduling processes.

1. Fully integrated well-delivery scheduling

With the pace of unconventional programs and the need to coordinate activities across several departments, operators need to view well-level scheduling as an integration tool to facilitate quick decision-making and cross-functional collaboration. The schedule should include all activities across the well-delivery lifecycle, including those where inventory functions as a buffer between steps in the process. The schedule should appropriately link back to the field-level plan and provide everything necessary to deliver on it. In addition to the schedule, operators should develop a process that encourages communication and collaboration across functions. This can take the form of standard cross-functional well-scheduling meetings, where the schedule shows the status of the well-delivery program, highlights challenges in meeting the schedule and helps operators make effective, collaborative decisions.

2. Fully integrated well-schedule software

To effectively integrate operations across all the departments and provide a real-time view of the schedule, operators should invest in scheduling software that provides a user-friendly interface and links all the activities to create one point of truth. Additionally, the software should support visual management, be able to display inventory locations and consumption triggers, perform basic data analytics and report on key performance indicators.
3. A manufacturing approach to well scheduling

With the pace of drilling and the level of standardization of unconventional wells, operators need to view a well-delivery process as a manufacturing assembly line, where standard products move down the line as additional components or materials are added to create a standard finished product. In this case, each product is not scheduled individually; rather, the system is managed to effectively produce the products as quickly and cost-effectively as possible. With continuous variations in cycle times for each step, operators should develop strategically placed work in progress (WIP) well inventory throughout the well-delivery lifecycle to break critical path dependency between activities (where one activity is ‘waiting’ for another to finish before it can begin). Performance health should be measured by the ability to maintain inventory levels, rather than continuous micro-management of each well-delivery activity, which in many cases is out of the control of the operator. This approach also reduces the need to expend resources updating the status on each well and activity only to find that the schedule is outdated.

4. Actual performance and feedback loops

Performance and feedback loop processes need to be established for organizations to learn effectively. One common pitfall of well scheduling is that schedules are established using top-level performance or optimistic estimates. While it’s useful to have performance targets, an effective well-scheduling process is one based on actual performance data, and planning parameters must be regularly refreshed so the schedule, inventory levels and resources are based on current performance. Additionally, well scheduling results must provide feedback to field-level planning to drive the right decisions.

The well-readiness dashboard Figure 10 demonstrates how bottlenecks in the well inventory that feed into the drilling schedule can be made more visible.

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**Figure 10. Well readiness dashboard**

<table>
<thead>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rig1</td>
<td>W-A</td>
<td>W-B</td>
<td>W-C</td>
<td>W-D</td>
<td>W-E</td>
<td>W-F</td>
<td>W-G</td>
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<td>W-I</td>
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<td>W-K</td>
<td>W-L</td>
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<td>W-M</td>
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<td>W-N</td>
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<tr>
<td>Rig2</td>
<td>W-O</td>
<td>W-P</td>
<td>W-Q</td>
<td>W-R</td>
<td>W-S</td>
<td>W-T</td>
<td>W-X</td>
<td>W-Y</td>
<td>W-Z</td>
<td>W-Aa</td>
<td>W-Ab</td>
<td>W-Ac</td>
</tr>
</tbody>
</table>

**Observation:** Wells W-C and W-D have permit problems  
**Action:** Move wells back in schedule, expedite permits  

**Observation:** Current wellhead purchase orders insufficient quantity to meet schedule  
**Action:** Issue new wellhead purchase orders (POs)

---

**Table:**

<table>
<thead>
<tr>
<th>Well readiness status</th>
<th>Readiness elements</th>
<th>Well schedule change drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ready now to mob rig</td>
<td>Well design complete</td>
<td>Well readiness status</td>
</tr>
<tr>
<td>Forecasted on schedule</td>
<td>Pre-drill “Paper Work”, permits, Pre-drill “Paper Work”, permits, Authorization for Expenditure (AFEs) etc.</td>
<td>Capital expenditure, number of rigs</td>
</tr>
<tr>
<td>Not ready on schedule</td>
<td>Equipment available — (wellheads, casing, etc)</td>
<td>Forecast well cycle time</td>
</tr>
<tr>
<td></td>
<td>Services available</td>
<td>Changes in geology/ well design</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Supply chain issues/other</td>
</tr>
</tbody>
</table>

Source: Accenture analysis
Supply chain integrated scheduling

The third level in planning is supply chain integrated scheduling, where supply chain, service providers and material suppliers are integrated into the well-scheduling program. This level of scheduling is typically handled in informal operational discussions or dispatch calls. While this may be effective in more conventional fields with lower volumes of well activity, unconventionals call for a high degree of integration. With the supply chain accounting for approximately 65 percent of well cost, we believe there is a significant opportunity to achieve improvements through tighter integration.

The need for unconventional operators to implement integrated supply chain scheduling results from several challenges facing the industry, which fall into four areas.

1. Lack of demand and forecast visibility

An accurate demand plan and forecast is critical to any supply chain. However, demand plans and forecasts are often not incorporated into the supply chain in a timely manner, if at all. The absence of plans and forecasts is largely a result of the conventional mindset of project-by-project engineering and customized well designs. When no plans and forecasts are available, the supply chain responds with long lead times to allow suppliers sufficient time to get the right equipment to rigs. The lack of visibility forces the supply chain to maintain high stock levels to manage these long lead times, leading to high carrying costs and the tying up of working capital.

2. Lack of consideration of supply chain constraints

The high demand for service providers, resources and materials in unconventional fields places large constraints on the supply chain. In many cases, these constraints are not considered during the well-scheduling phase and result in additional costs or delays in well delivery.

3. Lack of central coordination

Logistics and material coordination takes place on a rig-by-rig basis for most companies and, as a result, operators are missing out on the efficiency gains of a field-coordinated approach. At each rig, the foreman typically handles all interactions with suppliers, basically running a rig-specific supply chain. This practice might be sustainable for a low-volume conventional program; however, with the volume associated with unconventionals, this creates severe logistics inefficiencies. These practices can lead to additional logistics costs across the field, use of non-approved vendors, poor quality and HSE issues.

4. Manual processes and disparate systems

In most cases, interactions with the supply chain represent a series of one-off manual communications to request material delivery or services. This method of coordination results in a reactive rather than a proactive supply chain, which can lead to schedule delays, higher execution costs and poor quality. Additionally, this creates a lack of trust and cooperation as the supply chain is often blamed for any issues that occur. Using the supply chain to proactively increase visibility of the operational status, material requirements and services needed for a project would help operators plan for and respond to operational requirements.

Accenture believes operators can focus their efforts on the following important solutions to accelerate the integration of the supply chain.

1. Integrate the supply chain into the planning process

The supply chain should be considered a major stakeholder throughout the entire planning process. Involving the supply chain early will result in an improvement in the overall logistics of the wells program and ultimately reduce non-operating time. Creating and delivering demand plans and forecasts to the supply chain will also match materials and services to demand. This will ultimately reduce the lead time necessary for materials and the amount of stock inventory needed to meet lead times. With the supply chain participating in the planning and scheduling process, operators will be made aware of constraints that could lead to late material or service delivery. Making the supply chain organization aware of changes to well design as early as possible enables cost-effective sourcing of new materials and planned run-down of superseded materials.

2. Field level supply chain coordination

The high cost of supply chain activity, together with the geographically close nature of wells, creates an opportunity to optimize supply chain and logistics across the field. To gain efficiencies and reduce costs operators should deploy a more centralized approach to coordination with the supply chain that allows the sharing of resources and reduced trucking across wells. Greater visibility of materials and services requested across the field will allow the supply chain to not only plan how to service each well, but how to provide optimized services across the field. For example, the cost of rig moves can be cut by as much as 30 percent by coordinating provision of materials and services across the field.
3. Strategic relationships with suppliers

Common practice is to provide suppliers with a demand forecast and for suppliers to schedule accordingly. A more progressive practice is to give suppliers a mechanism to provide feedback on the demand forecast and identify optimization opportunities that can be considered in the level one and level two planning processes. There is also the opportunity to extend the supply chain network and create flexibility through equipment and design.

4. Implement mobility and cloud solutions for more efficient scheduling and coordination

Operators can increase visibility into the overall supply chain by integrating mobility solutions supported by cloud infrastructure for well-site employees and vendors. Equipping individuals on the rig and vendors with mobile applications can reduce their reliance on phone calls. Mobile applications could allow operators to view the status of deliveries and service equipment, as well as track material movements more accurately, reducing phone call outs, or eliminating them all together. Importantly, supply chains with poor visibility of materials typically suffer from a significant excess of materials, expediting activity to compensate. Providing operators with an easy and reliable way to answer the question ‘exactly where are my materials right now?’ saves time and costs. Increasing visibility across the supply chain opens the door for operators to implement more robust continuous improvement programs.

Figure 11. Integrated supply chain planning

Good supply chain planning in manufacturing runs on a sales and operations (S&O) planning process, collaboratively integrating supply planning and demand planning to create one version of the plan.
Impact on process and cost and cycle time

Integrated planning can reduce cycle time and well cost and improve recovery per well through standardization, measurement, analytics and performance management. Continuous improvement extends to all aspects of the well, from origination and geological prognosis through to drilling operations and handover to production. Integrated planning also has the following effects on process and costs.

**Process**
- Integrated planning and scheduling across functions
- Agile, flexible scheduling that allows for ‘what if’ scenarios
- Efficient process management and workflows
- Analytics that support decision making and continuous improvement.

**Costs**
- Improved capital efficiency
- Reduction in cycle time of up to 10 to 15 percent
- Reduction in costs of up to 5 to 10 percent
- Predictable, repetitive and efficient execution
- Improved communications and organizational effectiveness in the use of people, materials and oil field services.
The challenge of managing the uncertainty of the field development plan evident in the Eagle Ford Shale basin is heightened by the complexity of coal seam gas projects. Among other factors, this complexity is caused by the substantial number of wells required to support the gas rate ramp-up and to maintain this level of production for the longest possible time.

At least a few thousand wells are required to support initial production. A rolling program of well development is also needed to maintain production as the field ages and gas production declines. These wells are distributed through a large and diverse geographical area with a significant number of field facilities and gathering lines required to process and transport the gas. In such a context, the business requires tools capable of supporting capital-efficient decisions by optimizing the allocation of resources to reduce production bottlenecks. These tools must possess a very distinct capability that can combine production rates, field economics, commercial agreements and gas prices to provide an accurate view of the impact of the production strategies to the project value.

Accenture teamed with Enersight to model a client’s upstream field development plan in the Enersight Planning tool. The model created includes the robust physical flows of commodities (gas and water), costs (capital and operational expenditures) and cash flows. The solution leverages the existing information from the client’s geological and reservoir models, the well drilling and connection schedule, the facility’s online dates and capacities, field constraints and the project’s capital and operational expenditure costs to create reduced production and revenue forecasts for the short, medium and long terms.

The introduction of the solution has delivered potential benefits to the business, including integration of market and operational assumptions into a single database, increased accuracy of production forecasting and reduced silos within the organization by exposing potential misalignments between the subsurface, production and commercial plans. The financial savings of these de-bottlenecking opportunities ranged from $400,000 to $10 million each.

Now the business can evaluate development scenarios – including optimization decisions – and test corporate strategies.
Management of services

Overview

Unconventional development is characterized by a large number of service providers on the site. In the US, there are often different service providers for every step in the process – site preparation, drilling, fracturing, completions, water management and logistics. This breadth of service providers is illustrated in Figure 12. Planning, integration of execution activities and logistics are even more challenging in shale plays that produce a mix of high-quality crude and natural gas, since converging or expanding spreads between the two change the optimum location and deployment schedules for rigs and pads.

An operator may choose to accelerate deployment of pads and rigs near locations with higher crude production rates if crude prices surge, only to reverse course and accelerate development at locations with higher natural gas production should crude prices fall or gas prices rise. Alternatively, operators may also slow or scale back a project if elevated hydrocarbon prices increase industry-wide demand for contractors, escalating their prices beyond what an individual operator is willing to pay given the internal economics of a project.

Methods of improving management of service provision can be split into two categories: contractor management and financial controls, and collaboration with service providers.

Contractor management and financial controls

In our interviews we found that approved supplier lists are the most common method of maintaining control over who is on the field, but even this simple method is not always used. There are a number of risks associated with the large number of suppliers on the field including:

- **Health, Safety and Environment (HSE):** Are the suppliers properly trained? Which specific individuals are in the field? Where are they? Do they have the right qualifications?

- **Commercial:** What results are being delivered? Is the operator paying for these results in line with the contract? Is the operator getting fit for purpose staffing?

- **Operational:** Can the operator ensure consistency of crew? What is the productivity of the crew?

Leading practice involves ensuring suppliers are covered by contracts before they are on the field. One of the operators we interviewed had close to 80 percent of suppliers covered by contracts, although this scenario is still relatively rare. However, this would allow for efficient and controlled service requisitions, and support the service acceptance and payment process.
Ideally, there needs to be an independent system for recording results – for example, meters drilled and miles of road laid. In a best-case scenario, this system is populated without manual intervention and without the opportunity to adjust the recorded values without escalation to the project cost controllers.

Leading practice also involves a fit-for-purpose way in dealing with the number of changes to drilling and fracturing when confirming that the services have been received. One operator we worked with established a small unit to manage this process to ease the load on the foreman. This dramatically reduces the time to pay contractors as well as freeing-up the foreman to focus on field operations.

In addition, we found that the consistency of the team is critical to improving the learning curve. Without a sound services sourcing and contracting strategy, it is difficult to ensure this consistency, align objectives and achieve improvements. Leading operators work as an integrated team with their service providers, often benchmarking crews (through league tables or similar) to improve performance and offer incentives.

Controlling exactly who is in the field, what they are doing and when they are doing it continues to be a significant challenge. While a particular supplier has met HSE pre-qualifications, actual performance will depend on the individuals in the team that day. It is incumbent upon the operator to have clear competency models that establish the minimum required qualifications for these individuals. One option, common in some industries, is a ‘passport’ issued after exhaustive reference checks that allow individuals to work anywhere in the basin. By linking a passport system to travel booking, accommodation and time-writing systems it is possible to exert greater control over who is in the field and track hours and locations worked.

Figure 12. Example of the diversity and number of service providers in an unconventional operation.

<table>
<thead>
<tr>
<th>Exploration/appraisal</th>
<th>Site preparation</th>
<th>Development/drilling</th>
<th>Completion/fracturing</th>
<th>Production</th>
<th>Processing</th>
<th>Transportation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seismic services</td>
<td></td>
<td>Drilling services</td>
<td></td>
<td></td>
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<tr>
<td>CGGVeritas</td>
<td></td>
<td>Baker Hughes House</td>
<td>Neighbours</td>
<td>Gas</td>
<td>NGL Frac</td>
<td>Pipeline EPC</td>
</tr>
<tr>
<td>Fugro</td>
<td></td>
<td>Halliburton</td>
<td>Transocean</td>
<td>Processing</td>
<td>EPC CB&amp;I</td>
<td>Bechtel Saipem</td>
</tr>
<tr>
<td>Schlumberger</td>
<td></td>
<td>Schlumberger</td>
<td>Pioneer</td>
<td>Engineering</td>
<td>KBR Jacobs</td>
<td>KBR</td>
</tr>
<tr>
<td>Haliburton</td>
<td></td>
<td>Frac Teck</td>
<td></td>
<td>Important Energy</td>
<td>CB&amp;I</td>
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<td>Tri Country Yodor</td>
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<td>Gas</td>
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<td>Penn Line</td>
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<td>Fracking</td>
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<tr>
<td>Seismic services</td>
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<td>Important</td>
<td>CB&amp;I</td>
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<tr>
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<td>Energy</td>
<td>KBR Jacobs</td>
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<tr>
<td>Fracturing services</td>
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<td>Schlumberger</td>
<td>Frac Teck</td>
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<td>Important Energy</td>
<td>KBR Jacobs</td>
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<tr>
<td>Water management services</td>
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<td></td>
<td>Important Energy</td>
<td>KBR Jacobs</td>
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<tr>
<td>Schlumberger</td>
<td>Aquatech</td>
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<td></td>
<td>Important Energy</td>
<td>KBR Jacobs</td>
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<tr>
<td>Transportation</td>
<td>Ryder</td>
<td>Schneider</td>
<td>DHL</td>
<td>Transported</td>
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Note: Equipment vendors have been excluded
Source: Accenture analysis
Collaboration with service providers

The high levels of uncertainty in unconventional energy production make a vertically integrated operating model undesirable and, flexibility and responsiveness to changing conditions (such as responding to the need to add or drop rigs) far more desirable.

However, the degree of flexibility achieved by outsourcing the various stages of development to contractors and suppliers leads to challenges with coordination and integration, especially as contractors strive to meet the demands of operators for which they work in other locations. Fragmentation coupled with inefficient coordination leads to delays in service, and an increase in the attendant costs and cycle times. Operators interviewed for this paper expressed frustration at the “immense” time spent on logistical planning, as their own plans fluctuated and they tried to coordinate the changing schedules of their supply chain, rig crews and fracturing crews, among others.

Changing the operating model between contractors and operators from a command-and-control model to a more collaborative approach can greatly reduce the inefficiencies inherent in the unconventional upstream business. There are four important opportunity areas for collaboration: planning, execution, decision making and well design.

Planning

The main barrier to optimized planning in unconventional plays is not the erratic nature of the business, but the way operators and contractors organize themselves and the cadence of their work. The current model for planning contracting services requires the operator to make a rough sketch of the project’s timelines, calling for services as they are needed, and then for each stage of production to act as middleman at every handoff point as work is executed. For example, one operator empowers its foremen to order services and supplies, but they must be on site to accept every service and supply delivery and hand off each stage to the next contractor, while also sending physical invoices to head office to be processed and paid. This hub-and-spokes approach opens up the possibility of multiple bottlenecks and lag points, as missed milestones affecting one contractor carry over to the next, and can often increase the chance of errors in communication as information is misunderstood or simply not transferred between contractors.

Execution

Operators would do well to ‘take steps out of the critical path’ to decrease cycle times over and above what could be done with technology and supply chain optimization alone. To do this, the focus has to shift from trying to optimize each step of the process and instead think end-to-end, or to change the process altogether. Instead of having a site foreman order services, coordinate their delivery, inspect the work and invoice the payments, operators can benefit from establishing an operating model where contractors work together to optimize scheduling, while the central office (supported by the required mobile and digital technology) handles planning and administrative tasks for the entire company. This would allow foremen to get back to inspecting compliance and ensuring safety.

Dealing with contractors collaboratively instead of individually in silos can yield benefits by streamlining communications and avoiding costly lapses and delays. Collaboration can be as formal as a management council that comprises all contractors and the operator for each drill site, which coordinates activities and is jointly responsible for execution. Alternatively, it can be as informal as the operator sharing contact information and delegating reception responsibilities to contractors who hand off the project to each other as it progresses. Mobile and digital technology creates an audit trail that makes some of this collaboration more feasible. Operators can also benefit from their contractor’s experience and expertise, utilizing industry-wide leading practices instead of maintaining an operator’s preferred methods – which may no longer be industry-leading.
Decision making

Greater collaboration with service providers can also increase the effectiveness of decision making. It changes the assumption that the operator is always right and the service provider is only there to perform the activities the operator requests. Instead, there's a more collaborative approach where the service provider's expertise leads to more effective decision making. Operators should involve service providers in a cross-functional, cross-company effort to identify opportunities for improvement and make changes. This would allow the operator to not only leverage the skills and expertise within their own company, but also the expertise in the supply chain, which in many cases will be in a better position to bring ideas from cross-operator leading practices.

One area where we have seen this work effectively is in the use of fourth-party logistics providers (4PLs), who can provide operators with planning and optimization expertise, bringing in logistics and leading practices from other industries.

Well design

Operators continue to optimize well design, and drilling and completions programs for unconventional fields, but in many cases these efforts are performed internally with limited involvement from the services and materials vendors. This approach can result in significant cost increases, as designs become too customized, or in poor performance as service providers need to transition to new ways of working. To reduce these impacts, operators should shift from 'over the wall' well design to a more collaborative approach with their supply base. The supply base can leverage cross-operator leading practices and help operators identify well designs that reduce material costs and optimize material management.

Leading practices observed in our study involve working with an operator's supply base to identify industry standards and eliminate the need for internal material management by using consignment and buy-back agreements with vendors. This also allows the vendor to take advantage of economies of scale in its manufacturing processes, leading to reduced unit costs for materials.

Impact on process, cost and cycle time

As operators rely heavily on service contractors, a structured and effective method of managing, measuring and coordinating third-party service providers can significantly reduce well-delivery costs (between up to 10 and 15 percent due to minimizing field delays) and overall cycle times. It also has the potential benefits of optimizing well designs and improving contractor performance. In addition to cost, operators could also see up to 10 percent reduction in cycle times.
The activities of two leading operators – Anadarko Petroleum and EOG – illustrate the greater efficiencies that can be achieved through adopting the manufacturing approach to unconventional resource development. We classify leading operators as those who have delivered impressive production volumes and achieved significant efficiency gains in their unconventional operations. While much of the improvement is due to technical factors such as horizontal wells, multi-well pads, well spacing, and fracture design, the application of manufacturing concepts and the improved learning curve have also played a key role in driving down well costs and reducing drill days.

Completion costs are the expenses associated with enabling the well to produce hydrocarbons. These are generated from such activities as perforating the casings in a production zone, and engineering that ensures the structural integrity of the well bore. Drilling time refers to the time it takes to drill a well before the completion stage enables production. Drilling time is a useful metric for understanding operational efficiency and how many new wells can be created in a given time span.

Figures 13 and 14 summarize the savings derived from adopting a manufacturing approach to development in the Eagle Ford basin. Anadarko achieved a 50 percent reduction in completed well cost and a 33 percent reduction in drilling time from 2010 to 2011, and has seen continued incremental operational improvements through 2013. EOG, one of the largest oil producers in Eagle Ford Shale, has achieved that title through sustained operational improvements, recording a 36 percent reduction in completed well costs and a 43 percent reduction in drilling time in the five-year period from 2008 to 2013.

Figure 13. Cost and time savings derived from adopting a manufacturing approach to development
Figure 14. Cost and time savings derived from adopting a manufacturing approach to development

Eagle Ford – EOG

- **Average oil IP rate (Bopd)**
  - 2009: 483
  - 2010: 631
  - 2011: 999
  - 2012: 1,115
  - 2013: 1,226

- **Completed well cost ($m)**
  - 2009: $9.1
  - 2010: $6.8
  - 2011: $6.7
  - 2012: $6.8
  - 2013 (YTD): $5.8

- **Treated lateral length (Ft)**
  - 2009: 3,911
  - 2010: 4,265
  - 2011: 5,367
  - 2012: 5,779
  - 2013: 5,787

- **Drilling days (Spud to TD)**
  - 2009: 16.9
  - 2010: 15.1
  - 2011: 15.0
  - 2012: 13.4
  - 2013 (YTD): 9.6

Source: EOG Investor presentations, September 2013

36% reduction in completed well cost

43% reduction in drilling time
Overview

Accenture published *Water and Shale Gas Development: Leveraging the US experience in new shale developments* in 2012, an 80-page report with a significant focus on water movements. At five million gallons and 1,000 truck movements per well, efficient water movements continue to provide a competitive advantage in the industry. In our research into Eagle Ford operators, the interviewees felt that good water management and a sound logistics strategy gave them a competitive advantage.

Water transportation in some operations can account for as much as 40 percent of total fracturing cost and 20 percent of total well completion cost, making it a significant contributor to the total cost of operations. This is compounded by rising transport and commodity costs in many of the locations as the scale of operations across the basin increases. Since ‘waiting for water’ can cause bottlenecks, efficient water logistics can also have a significant impact on the time it takes to complete a fracturing operation.

While there is increased use of pipelines, particularly in the sourcing of water, the remote location of many of the shale gas plays and the dynamic nature of the operations make transport by road the most common method, due to its flexibility. Developing on-site wastewater treatment and disposal technology can reduce the requirement for transporting water. However, water sources are not always close to the development area, mobile units are not available for all water treatment technologies and reinjection wells can’t be used in all locations. An overview of the type of material movements and volumes, broken down by phase, can be seen in Figure 15, and a breakdown of a typical logistics network to support shale gas operations is provided in Figure 16.

While most movements involve water and wastewater, the opportunity to improve non-water movements (such as aggregates and proppants) is also significant. Critical decisions include how to design the network to make best use of the rail, road and even water transport, where to locate permanent and temporary storage, and whether to develop an in-house logistics operation and use a 4PL.
### Figure 15. Logistics requirements overview

<table>
<thead>
<tr>
<th></th>
<th>Civil site prep/ projects</th>
<th>Drilling</th>
<th>Completion/ fracturing</th>
<th>Flowback</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duration</strong></td>
<td>60 days</td>
<td>15 – 60 days</td>
<td>15 – 30 days</td>
<td>20 days</td>
<td>5 – 40 years</td>
</tr>
<tr>
<td>~ percent of daily road volume required</td>
<td>5 – 15%</td>
<td>5 – 15%</td>
<td>60 – 80%</td>
<td>2 – 5%</td>
<td>&lt;2%</td>
</tr>
<tr>
<td><strong>Activities requiring road transport</strong></td>
<td>Road construction</td>
<td>Mobilization of drilling equipment and rigs</td>
<td>Mobilization of fracturing equipment and tanks</td>
<td>Mobilization of fracturing tanks</td>
<td>Water tanks</td>
</tr>
<tr>
<td></td>
<td>Site preparation</td>
<td>Waste (fluid and solid)</td>
<td>Freshwater Waste (fluid)</td>
<td>Wastewater Removal of rig equipment in preparation</td>
<td>Wastewater</td>
</tr>
<tr>
<td></td>
<td>Drill pad construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Examples of materials/resources transported</strong></td>
<td>Aggregate</td>
<td>Casing/cement</td>
<td>Water</td>
<td>Water</td>
<td>Water</td>
</tr>
<tr>
<td></td>
<td>Cement</td>
<td>Drilling chemicals</td>
<td>Proppant</td>
<td>Fracturing chemicals</td>
<td>Drilling equipment</td>
</tr>
<tr>
<td></td>
<td>Pipeline</td>
<td>Water</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


### Figure 16. A typical shale gas logistics network

<table>
<thead>
<tr>
<th>Suppliers</th>
<th>Transport mode</th>
<th>Consumers</th>
<th>Treatment/ disposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>National/ regional</td>
<td>Road</td>
<td>Civil site prep/ projects</td>
<td>Road Solid waste</td>
</tr>
<tr>
<td>Local</td>
<td></td>
<td>Drilling</td>
<td>Road Solid waste</td>
</tr>
<tr>
<td></td>
<td>Road &amp; pipeline</td>
<td>Completions/ fracturing</td>
<td>Road Wastewater</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Production</td>
<td>Water treatment</td>
</tr>
<tr>
<td></td>
<td>Rail &amp; road</td>
<td>Impactments</td>
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<tr>
<td></td>
<td></td>
<td>Water</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rigs</td>
<td></td>
</tr>
<tr>
<td>National/ regional</td>
<td>Road</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local</td>
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</table>

Impact on process and cost and cycle times

Streamlining efficient processes, targeting use of specialist software systems, deploying skilled logistics people and better commercial management by operators are helping achieve significant reduction in truck distances and providing improved delivery assurance.

The targeted use of technology to provide live, real-time information on inventory levels and vehicle locations is also achieving potential benefits. This information allows a team of skilled logisticians to effectively manage water use across the basin, helping to reduce health and safety exposure, congestion and costs and provide delivery assurance. The detailed metrics generated through the improved data also allow the logistics team to drive targeted continuous improvements, measure carrier performance and confirm freight payment compliance, all of which further improve operations.

As an alternative to road, the use of pipelines, particularly in sourcing water, continues to increase. Per unit transport by pipeline can be a fraction of the cost of transporting by water and the time saved waiting for water during the fracturing operation is often significant enough to justify the investment. For example, Anadarko has implemented a ‘water on demand’ model in many of its basins and in 2012 was awarded the Outstanding Operator award from the Colorado Oil and Gas Conservation Commission. Anadarko has 14 rigs drilling about 30 horizontal holes per month in Colorado. To address the associated infrastructure growth, Anadarko has installed a water supply pipeline network for on-demand water. In a year, this pipeline system eliminated 3.75 million truck miles, 750,000 gallons of diesel consumption and resulting emissions, and reduced surface disturbance by limiting on-site storage needs. It also saved Anadarko $500 million in costs.9

Similar initiatives to increase rail capacity could also have a significant impact on well cost and cycle times. For example, EOG has loading facilities in Bakken, Permian, Eagle Ford and Barnett and unloading facilities in Cushing, Oklahoma (WTI) and St. James, Louisiana (LLS).10
Materials management

Overview

Materials management has always been a challenge for the oil and gas industry, where the main focus has been on ensuring material availability, regardless of costs. Unconventional drilling has compounded these challenges, given the dramatically increased volume of materials necessary to support the number of wells on multi-well pads and 24-hour crews.

With the landscape shifting to unconventionals, and given the volatile nature of commodity prices, operational efficiencies are imperative for preserving profits. Materials management is the end-to-end process that ensures materials are available at exploration, development and production sites. This includes planning material requirements, releasing purchase orders, coordinating with vendors for the delivery to sites, storing and maintaining materials and working with logistics to ship them to drilling sites, and disposing of unused or obsolete materials.

Hundreds of hand-offs must take place before a well site can be completed. These hand-offs need to be efficient and agile to ensure the timely delivery of materials, reduce downtime and avoid tying up working capital and racking up needless storage expenses.

The industry has been attempting to eliminate non-productive time due to materials handling, standardize well design, and use vendor-managed materials to more efficiently deliver materials to unconventional sites.

Also critical to materials management is integrated planning Level 2 (well-level activity scheduling) and Level 3 (integrated demand and supply planning). Integrated planning allows for predictive materials management with an active supply chain. For materials management efficiencies to truly take effect, an accurate plan of demand must be in place for each well. Moreover, this demand plan should be based on a dynamic planning model, where demand becomes more transparent in the short term (down to the week or day), and less transparent in the medium and long term (down to the month or quarter). Due to the volatile nature of the unconventionals business, near-term demand should be updated weekly to provide suppliers with the most up-to-date information.
Unlike many sectors such as retail and electronics, the use of materials-tracking technologies is not widespread in unconventional oil and gas exploration. The challenge manifests itself at all stages in the supply chain:

- Materials inbound from suppliers are typically not marked with barcodes, radio frequency identification (RFID) tags or other identifiers. The use of Advanced Shipment Notices to warn of impending arrivals is not common and while technologies such as in-vehicle monitoring systems (IVMS) mean tracking inbound trucks is possible in theory, the data is not widely shared.

- Within the storage facility, materials often land where they fall without clearly marked stocking locations or segregation of materials, making them difficult to find. That assumes of course that the materials are within a recognized facility at all; excess materials are often dumped in ad hoc 'storage locations' such as a neighboring field or a facility at or close to the point of use. Challenges arise when staff turnover means this off-location stock gets forgotten about or its origins are lost.

- Movements of materials to fields from a storage location can take anything from 10 minutes to nearly 10 hours and are often undertaken by vehicles equipped with IVMS. In spite of this, the drill rig and construction crews do not typically have easy access to this information and, even if they did, it is unlikely that reliable information is available about what is loaded onto a particular vehicle.

The lack of visibility is not an issue in itself if the supply chain delivers reliable and predictable service levels, however this is often not the case, where:

- Delivery points can be hard to find and reach – especially on new well sites with very little infrastructure and no marked road

- Materials shortages happen, sometimes due to lack of planning for long lead time materials; sometimes due to unreliable inventory data; occasionally because floods or other events disrupt the supply chain

- Materials get 'lost' – typically either misplaced in the store or issued to the wrong team.

Failure to meet delivery promises breeds a lack of trust in the system. Parallel supply chains spring up in an effort by the drilling and construction teams to take control of their situation. 'Integrated services' contracts are negotiated, which put the onus on services suppliers to provide their own materials. This comes at a cost but, can be argued, is considerably cheaper than the cost incurred when the customer is unable to provide the promised materials on time.

A systematic response to taking costs out of the supply chain starts by establishing control and confidence in the system. Without this, parallel supply chains will continue to exist and the use of inventory to buffer against unreliable demand will continue to be ineffective and expensive.

The following outlined steps do not have to be strictly sequential – in particular step 4a, rationalize and control the materials portfolio, can be undertaken at any stage.
Step 1  
**Build the Foundation**

Make full and effective use of your basic Requisition to Pay system to set the rules of the supply chain and make it easier to comply than to evade. These measures have usually been implemented at some point in the past, but rarely have they been maintained effectively:

- Get all repeat use materials catalogued, using standards that make the materials easy to identify, and remove all duplicate materials
- If necessary, capture additional data about materials, such as photographs, to ensure that their purpose does not become forgotten as time passes and people move on
- Get catalogued materials onto basic contracts that include defined delivery lead times and commitments to provide data such as Advanced Shipment Notices when required
- Mark out all store locations clearly and ensure that all locations are described in the system down to pick bin level
- Enforce rigorous and timely receipt of goods and issuing of goods inventory
- Undertake randomized weekly cycle counting to maintain accurate inventory.

Step 2  
**Establish Visibility**  
**Internal**

Once you are confident with the data on which your view of the supply chain is built it is time to start paying attention to understanding your performance and that of your suppliers.

- Understand the customer’s perspective on supply chain performance – in particular, what counts as good service and acceptable turnaround times
- Gather missing data:  
  Require purchase order confirmation and advanced shipment notices from all major suppliers – spreadsheet format is typically fine at this stage and can be readily uploaded into most R2P systems
  Implement delivery: Delivery confirmation – both inbound and outbound.  
- Monitor process performance:  
  Process cycle time at each step (for instance, delivery to receipt)  
  Process outcomes (such as supplier’s actual delivery date versus promised delivery date versus contracted lead time).
- Undertake continuous improvement and quality initiatives to improve the requisition to fulfilment process.

Step 3  
**Make Commitments**

Once the process performance is well understood and is at least predictable, if not outstanding, then the supply chain should begin to make commitments to its customers and be held accountable for those commitments.

- Publish details of supply chain performance to both customers and suppliers.
- Establish formal service level agreements (SLAs) with customers regarding materials availability, delivery lead times and, if appropriate, costs.
- Build supply chain information into regular supplier performance reviews and establish SLA’s if these have not already been built into the contracts.
- Share planning data with suppliers – along with an indication of the reliability of that data.
Step 4a
Rationalise and control the materials portfolio

The complexity and cost of the Plan to Fulfilment process for materials is in large part related to the amount of materials with which it has to deal. Controlling this portfolio is an important source of simplification and cost reduction.

• Implement category-based reviews to identify all the materials that have a common purpose (for example, Artificial Lift) and which are duplicates, substitutes and obsolete.

• Develop an effective channel for materials disposal – either by outsourcing to a specialist or by building the skills in-house; getting obsolete materials out of stores quickly makes a significant difference to quality, cost and safety of stores operations.

• Establish regular meetings for the materials planning team with the engineering and construction teams to help control the creation of materials and manage the rundown of obsolete materials.

Step 4b
Automate and optimize the process

Once the Plan to Fulfil process is running based on high quality data it should be possible to automate many steps for example:

• Supplier integration through a procurement hub using standardized XML messages to exchange purchase orders, purchase order confirmations and advanced shipping notifications where suppliers can cut costs and introduce significant transparency into the Requisition to Pay cycle

• Conversion of requisitions to purchase orders via material requirements planning

• Dynamic recalculation of inventory targets based upon demonstrated volatility of demand and supply

• Capture of goods receipts and issues using barcode or RFID technology.

Impact on cost and cycle time

Focusing only on material availability can lead to excess purchasing, stockpiled materials and increased cost of capital. Purchasing safety stock is an industry norm to protect from unforeseen events. However, excessive contingency provisions result in missed opportunities.

The industry average for inventory turnovers is less than one, meaning a year's worth of inventory is being held and not utilized annually. This means there is a high risk of the inventory losing value and, ultimately, of the operator incurring a loss from an inventory write-down. Inventory obsolescence, due to damaged materials or a change in well design, in some cases accounts for 20–30 percent of the cost of materials.11

It is clear materials management has a significant impact on process, cost and cycle time. However, it has also historically not been an important area of management focus, which has resulted in poor cost control, limited investment and immature practices. There are therefore significant opportunities for improvement as the industry continues to close the gap towards more efficient and effective materials management operations.
Figure 17. Important challenges and leading practices of materials management

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Leading practices</th>
</tr>
</thead>
</table>
| **Inventory management – Increase inventory holding and reduce complexity in what is purchased** | • Materials requirement planning – generating direct material orders when inventories reach reorder levels  
• Suppliers collaboration and operator oversight to ensure vendor managed materials are proactively managed  
• Outsourcing where third party can be more cost effective without introducing undue risk  
• Optimize inventory holding through targeted surplus reduction (materials reuse/transfer/sale & disposal)  
• Proactive management of the materials lifecycle:  
  - Reducing proliferation of new materials by standardizing Bills of Materials  
  - Forecasting the ramp-up of new materials and consequently planning the run-down of superseded materials  
  - Regular review of the materials used in each category to minimize needless diversity  
  - Rigorous inventory counting and relentless focus on stock record accuracy  
• Accurate recording of surplus inventory |
| **Integrated process ownership across comprehensive value chain** | • End-to-end supply chain optimization: standardized robust process with defined roles and responsibilities to create accountability for material reuse and reduce inventory build-ups – right resources, right place, right time  
• Basin level optimization  
• Reduced number of steps and hand-offs |
| **System which ensures proper tracking and visibility** | • Automation to deliver information  
• Ability to deal seamlessly with connected/disconnected situations  
• Increased usage of SAP functionality to track materials  
• All-in-one system to reduce tracking on personal drives/computers  
• Leverage of mobile and cloud capabilities in remote environments  
• Live, end-to-end material tracking – from design through disposal  
• Simpler user interfaces to obtain buy-in of non-headquarters users |
| **Performance management system with important performance indicators** | • Key Performance Indicators (KPIs) to measure materials management  
• Establishing communication requirements  
• Developing policy for managing contingency and handover requirements |
| **Link to well-level activity scheduling (Integrated Planning Level 2) and demand and supply planning (Integrated Planning Level 3)** | • Accurate plan of demand for each well  
• Demand more transparent in the short term (down to the week or day), and less transparent in the medium and long term (down to the month or quarter)  
• Near-term demand updated weekly, to provide suppliers with the most up-to-date information as possible. |

Source: Accenture analysis
Achieving high performance in unconventional operations

Industry outlook

The findings from the Eagle Ford operator interviews and Accenture experience suggest there are significant variations on integrated planning among large oil producers with a mixed portfolio of conventional and unconventional, large independents focused on unconventional, and small independents. These variations involve how formal or informal the integration is (process, structure and people) and the tools used. However, there is a consensus that good integrated planning can give an operator a significant advantage. In one of our interviews, the operator highlighted the issue of having separate plans for projects, drilling and completions, and the supply chain, which makes integration difficult and results in time being wasted. By contrast, another interviewee was confident its planning process was integrated and that while there were different detailed plans, what it has been able to achieve with manual integration is working well. We have not found an operator that has been able to integrate the various plans electronically, but we have found operators with robust manual processes and clear accountabilities and interfaces.

Effective integrated planning encompasses strategies around people, processes, technology and governance. Clear communication between single points of accountability would achieve timely decision making across all functions. The goal is to synchronize field-level planning, well scheduling and the supply chain so the asset has one integrated plan and drilling schedule that the supply chain can support. This would allow the field-level plan to drive the well-level drilling schedule, and changes in the drilling schedule would be fed back into the field-level plan. The right people and processes, coupled with the right technology, would link well-level integrated activity planning systems to existing enterprise resource planning (ERP) systems, allowing for visibility and consolidation across assets and business units. Finally, regarding governance, the annual budget needs to coexist with longer-term commitments. Operators need to move to multi-year budgeting to allow for longer-term planning with longer-term capital commitments.

Leading operators take a holistic approach to managing their contractors at multiple sites, developing plans flexible enough to accommodate short-term changes and stable enough to provide long-term accountability. They also make plans based on rig projections as far as three years into the future, allowing contractors to also plan this far ahead, hiring and providing operators with consistent crews that gain efficiencies through experience and relationship building. While these forecasts contain some uncertainty and volatility, they are multi-basin and the relationship is collaborative, so the operator and contractor can work together to manage risks. Leading operators hold these crews and contractors accountable through site-by-site benchmarking of standard performance measures and often share the results so each crew and contractor knows how they compare against their peer group, and how they can improve their performance.

Leading operators also streamline their interactions with contractors through financial controls and standardized procedures. They select their contractors from an approved list of suppliers with previously negotiated rates and handle all financial transactions from a central office specializing in these functions. This allows contractors to directly invoice the operators’ financial management functions and frees foremen and other operational personnel to focus on the rig. The operator is then more effectively able to complete tasks using its resources, expertise and time appropriately.

Service providers will continue to be a critical element of any unconventional operation. There are clearly opportunities to streamline the on-board, finance, administration, control and HSE elements of managing suppliers, but, more importantly, there is an opportunity for collaboration. The prize is in leveraging a supplier’s expertise for better processes and solutions, innovation and, ultimately, better performance. Given that demand often exceeds supply, suppliers will prefer operators who develop collaborative relationships.
Operators can capitalize on more effective management of materials when it is focused at the basin level, standardization is increased and the vendors’ expertise is leveraged as much as possible. A good example is independents that deviate from standardization only when the change can be backed up with documented examples. Leading operators in materials management record all maintenance, repair and operations (MRO) materials in inventory with a location and optimized warehouse space, properly allocate resources, and organize outbound transportation. For example, some operators have employed RFID technology to track material movements in real time.

While leading operators have greatly improved their materials management strategies, there is still room for improvement in areas such as robust drilling plans, bills of materials, structured phasing in and out of materials and materials planning.

Materials management must be both standardized and agile to effectively respond to the variable and uncertain nature of unconventional exploration. Operators need to continue to standardize to drive supply chain optimization. In addition to supply chain efficiencies, planning must be controlled through more effective well inventory management. Finally, operators’ supply chains should extend to their suppliers, supporting a network design that manages inventory levels but still provides maximum flexibility. Few operators have capitalized on the opportunity to optimize materials management by reducing costs without compromising material availability and this presents a tremendous opportunity for unconventionals – specifically around standardization, planning and collaboration.
Water logistics leading practice processes and in vehicle and tracking systems

Planning

- Automated upload Fracturing Plan from fracturing team
- Utilize data from previous performance
- Build schedule and define costs, optimal routes & carries

Carrier notification

- Flexible choice for notification
- The driver will be made aware of the preferred routes and notified with any changes in plan
- The driver has flexibility and can provide confirmation/acceptance through portal via SMS, email or phone

Carrier acceptance

- Monitor on water withdraw levels to ensure truck capacity is fully utilized
- In vehicle monitoring for Health, Safety, Security and Environmental (HSSE) performance tracking & reporting
- GPS automatically ‘checks in’ the driver on arrival to site

Reporting, analytics & compliance

- Automated system to generate reporting
- Full visibility of all logistics to allow comprehensive reporting
- Opportunities to drive cost reduction

Freight billing

- Self invoice based on captured distance and time of all vehicles
- Accurate performance measure for all carriers
- Eliminate the risk of overpayment

Carrier journey & drop-off

- In vehicle monitoring for HSSE performance tracking reporting
- GPS provides visibility on driver location and checks against the plan
- Real-time notification to avoid congestions

Source: Accenture Analysis
Implications for operators

Improving integrated planning and the management of services, materials and logistics is not easy as they all require the right technology, a continuous improvement culture and strong people. Changes also need to be applied in the appropriate proportion so the implementation is not too expensive, cumbersome or time-consuming. To understand the implications for operators, it is important to understand the types of operator. Based on our interviews and research, we have categorized three main archetypes:

• Predominantly conventional, with a strong bias toward technology
• Large independents focused on unconventional with a bias toward continuous improvement
• Small independents that have a bias toward just getting the people part right.

The following section describes strengths and challenges in approaching unconventional operations for top quartile performers in each archetype. We recognize there is significant diversity in each segment, and that the leading performers in all segments are able to balance technology, continuous improvement and people depending on what is being addressed. We have not tried to represent this range. Instead, the archetypes describe the dominant bias of leading performers in each segment.

Figure 19. Different segments of operators and their attitudes towards technology, continuous improvement and people

<table>
<thead>
<tr>
<th></th>
<th>Predominately conventional operators</th>
<th>Large independents</th>
<th>Small independents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technology</strong></td>
<td>Leader</td>
<td>Fast Follower</td>
<td>Lagger</td>
</tr>
<tr>
<td></td>
<td>Capital budget allows for technology innovation</td>
<td>Technology investments based on field tested results</td>
<td>Capital budget constraints</td>
</tr>
<tr>
<td></td>
<td>Mature IT frameworks enable operational efficiencies</td>
<td>Missed opportunity to create step change in productivity/efficiency</td>
<td></td>
</tr>
<tr>
<td><strong>Structured continuous improvement</strong></td>
<td>Lagger</td>
<td>Leader</td>
<td>Lagger</td>
</tr>
<tr>
<td></td>
<td>Data and technology not leveraged to drive continuous improvement</td>
<td>Strong continuous improvement culture imbedded throughout all parts of the organization</td>
<td>Collaboration enables some continuous improvement</td>
</tr>
<tr>
<td></td>
<td>Missed opportunity to make informed trade-off decisions</td>
<td></td>
<td>Missed opportunity to take a more structured, scaleable, and measurable approach</td>
</tr>
<tr>
<td><strong>People/culture</strong></td>
<td>Lagger</td>
<td>Fast Follower</td>
<td>Leader</td>
</tr>
<tr>
<td></td>
<td>Collaboration challenged by operating model constraints</td>
<td>Enabled through structured process and operating model</td>
<td>Strong people and collaborative culture</td>
</tr>
</tbody>
</table>
Predominantly conventional

Conventional operators have been involved in unconventional resource development for some time, but because their large portfolios include significant investments in conventional resources, the contribution of their unconventional operations to their overall production volumes remains relatively small. However, for many of these operators, their unconventional assets will play an important role in the future. One example is ConocoPhillips, with US land assets accounting for more than 60 percent of the production growth required to reach its 2017 production target of 600,000 bpd.\textsuperscript{13}

Accenture’s research shows that conventional operators are inclined to approach the challenges in their unconventional operations with an emphasis on rig technology, network connectivity and advanced software. For example, they use Wi-Fi and smart phones for logging drilling data in the field, and have developers for mobile well applications. Conventional operators are also beginning to venture into rig automation technologies and rig system well monitoring. They believe this long-term trend provides tangible benefits to the operation by creating opportunities to do more remotely, reduce headcount on location and leverage offsite experts to make decisions about drilling techniques and technologies to use in the field.

These operators have been successful by applying technology in their conventional assets and they have the capital budgets to invest in the latest technologies to develop their unconventional plays. However, many are still structured to manage a conventional operation, which creates challenges in establishing cross-functional teams instilling the continuous improvement culture critical to achieving differentiation in integrated planning and collaborating with service providers. While they have already benefited from their technology investments, conventional operators could improve their processes to ensure they are making the appropriate technology investments to address logistical challenges in their operations. For example, the large and small independent operators in our study have far more advanced water management systems, including closed-loop mud systems on their rigs, pipelines and minimal trucking, where conventional operators are still trucking the majority of their water and are just beginning to move away from using pits.

They could also focus more on continuous improvement, accelerating the learning curve, and getting a consistent cross-functional team. For example, unconventional pilots can start at more than $20 million per well, and leading operators are hoping to reduce their costs to $5 million per well within a few years.\textsuperscript{14} Executing the pilot to ensure that costs can be reduced is important to viability. For predominantly conventional operators, adjusting the processes, ensuring consistency in a cross-functional team to accelerate the learning curve and fast decision making can often be a challenge.

Another common challenge for conventional operators is that the projects, production, drilling and completions departments still all have plans of their own. The presence of silos in the planning process is a barrier for reducing waste, increasing standardization and scaling operations. Virtually every conventional operator Accenture reviewed had strong functional disciplines in conventional operations that supported silos. It is often difficult to get the same geologist, much less ensure that the same important staff on the pilot team can continue until development.

Operators also cite non-technical challenges, namely logistical planning, as requiring the majority of the effort and collaboration during the planning process. This further demonstrates the added benefit of optimizing the integrated planning process by approaching challenges with continuous improvement, collaboration and the right team structure than with rig technology and information technology alone.

Additionally, the team needs to capitalize on the expertise offered by service providers. Conventional operators often have much more formal supplier–customer relationships with their service providers than we found in the other segments, indicating that the culture could be more collaborative and inclusive with their service providers. All participating operators cite consistency of crew as a critical factor for overcoming the learning curve.
Large independents

The large independents are operators primarily focused on developing unconventional resources in the US, and have significant experience in shale and tight oil formations. Many of these operators are working towards aggressive growth targets, with 2012 capital expenditures ranging anywhere from 33 percent to more than 100 percent of their annual revenues.¹⁵

The size and performance of unconventional operations has the greatest variability among large independents. Those reviewed for our study manage anywhere from five to 26 rigs in Eagle Ford, and their well costs are estimated at $5.5 million–$8 million. Days to drill range from 10 to 16 days for the top quartile operators. The learning curve remains an important focus in this segment, and the leaders are overcoming this rapidly. For example, Marathon went from 23 drill days in the second quarter of 2012 to 12 drill days in the third quarter of 2013.¹⁶

Accenture’s research shows that the top-quartile operators are the best at balancing the trade-offs between technology, continuous improvement and investment in people. These are operators with considerable unconventional experience, and they know how to operate in high-volume environments and get the incremental improvements required to achieve margin targets. For example, Anadarko achieved production growth of 45 percent in 2013 for its Eagle Ford operations, as well as significant reductions in drilling costs per well from 2012 to 2013.

Leading large independents do not spend time or money on technology that does not contribute to their returns. They rely on oil field services companies’ research and development (R&D) and industry R&D programs. They are generally fast followers in applying new technologies to their operations. The leading large independents look at the latest and greatest rig technologies but they analyze the trade-offs to assess whether their technology investment will yield a good return. Investment in R&D is limited to a few select areas such as greener chemicals for their fracturing fluid.

One leading large independent operator interviewed noted that its contracts are for modern rigs designed for their Eagle Ford operations, including top drives, AC-powered rigs, skid rigs, high-horsepower draw works and closed-loop mud systems. This operator has also made some investments in rig automation technology such as joystick controls, a distributed operations management system and centralized geosteering. Its approach is to apply technology to improve time, cost and safety metrics.

Leading large independents also selectively invest in improving the effectiveness and efficiency of important processes. For example, Anadarko is well known for its ‘water on demand’ pipeline approach and this clearly provides a competitive advantage.¹⁷ It does not truck any fresh water during sourcing, so in addition to lower transport costs, there is no time spent waiting on water during fracturing. Leading independents have also made strategic investments in their IT framework to strengthen their materials management process. For example, they are able to process goods receipts on tablets and make use of Wi-Fi hot spots in the field to transfer data to centralized systems. They also use IVMS technology and are experimenting with barcodes and smart pen technology.

Leading large independents apply continuous improvement to challenges in their unconventional operations. They are also leaders in aggregating drilling performance metrics and using this data (for example, cost per well, time to drill, cost per foot) to inform decision making. One leading large independent in our study said it pushed for incremental gains to save 1 percent on its well costs and was able to then hone in on shaving 15-minute increments off high-cost areas in the drilling lifecycle.

The operator who had by far the strongest planning process was also an independent. Its drilling plan includes an 18-month rig schedule and processes are well defined and integrated. Geology, drilling, capital projects and operations work together to plan and execute activities (for example, operational geologists help steer the well and the facilities group contributes to where the wells are drilled). This operator views its planning process as an important strength that enables and enforces its culture of continuous improvement. The time spent on planning far exceeds the time spent on execution and its ability to establish long-term forecasts enables it to communicate effectively with suppliers to ensure it has the right equipment, people and materials in place for execution.

A strong planning process enables large independents to capitalize on their relationship with their drilling and fracturing service providers. One large independent in our study can procure 80 percent of its products and services under contract, reducing premiums for last-minute call-outs. Perhaps the biggest benefit of long-term planning is that it can lock in two- or three-year contracts to ensure consistent crews for its operations. Consistency of crew is one of the most important ways of overcoming the learning curve and provides a tremendous competitive advantage in reducing costs and time to production.
A leading independent operator in our study also injects its continuous improvement culture into its relationships with suppliers. For example, all of its Eagle Ford rigs are assessed against a standard set of performance measures and compared so that contractors know where they stand against other service providers. It also benchmarks against its ‘perfect well’ to set time targets, and involves its drilling contractor in the process so that it is clear that renewing the contract is contingent on meeting these targets.

Because their operations were built largely around success on US-based unconventional assets, leading large independents have the right organizational structure to enable cross-functional communication and decision making at the asset level. They understand that their assets need to be managed in reasonably sized portions so the flow of data can inform decisions. A leading independent operator interviewed for our study had managers overseeing no more than seven to 10 rigs and a person responsible for profit and loss statements, including production operations, but not burdened with support services. Support services were involved in the planning process and part of the decision-making process.

Small independents

The operations of small independents hinge almost completely on US land unconventional assets. For those operating in the Eagle Ford basin, the asset is critical to growing production and meeting aggressive financial growth targets. In some cases, capital expenditure is more than twice annual revenue, with more than half targeted towards the Eagle Ford basin. Carrizo plans to spend 60 percent of its capital expenditure budget in the Eagle Ford basin in 2014. For small independents the size of Eagle Ford operations is quite variable, with the number of rigs managed ranging from one to 10. Like the large independents, there is also variability in well costs and drilling cycle time, with well costs estimated to range from $7 million–$9 million and drill days ranging from 20 to less than 12 days for the leaders in the segment. The operations of leading small independents have benefitted by applying the manufacturing approach to their shale and tight oil assets. Standard well and pad designs and pad drilling have led to strong production growth metrics. For example, Pioneer reached 80 percent pad drilling in 2013 and 34–38 percent production growth. Accenture’s research shows that the leading small independent operator manages its operation with an emphasis on strong people and a culture that empowers these people to make decisions. They are able to compensate for weakness in technology and process in their operation by hiring experts, collaborating with service providers, and maintaining a tight group of people they can rely on to overcome the learning curve of the basin.

Small independents are generally not as advanced as conventional operators and large independents when it comes to rig technology. Capital budgets are much smaller than those of conventional operators and large independents, making access to the latest rig technology a challenge. For example, one leading small independent in our study is mainly still using hydraulic top drives and has not yet adopted AC-powered rigs because of issues with connectivity. Small independents are also relatively limited in their use of rig automation, often with only joystick controls and video cameras on rigs. However, some leading small independents have made impressive strides in their water and waste management technology—Southwestern Energy’s water reuse in Fayetteville and Carrizo’s water pipelines are good examples.

Small independents in the Eagle Ford basin are running operations that may not have well-defined process maps and are not yet capitalizing on their data and analytics to achieve continuous improvement in their operations. A leading small independent in our study is collecting standard metrics across its rigs, but only aggregates these metrics if requested by leadership, creating an environment in which the operator is reacting to problems rather than proactively preventing them.
Small independents’ planning processes are generally not well defined, but their operations are small enough and their people are strong enough that a little face time has a big impact. For example, a leading small independent in our study has individual schedules for drilling and completions, but its assets are still small enough that cross-functional collaboration is made possible through regularly scheduled meetings. It is also able to build a single field-development plan for facilities, drilling and infrastructure that includes water management. This unified approach to planning has made the operator very good at moving equipment and enabled it to use equipment at multiple locations. This operator also credits its strong people and communication practices for enabling it to implement standardized manufacturing approach to its wells.

Like their large independent counterparts, the small independents are structured around the management of the asset. They have strong people in place, so there is accountability and authority to make decisions at the asset level. A lot of faith is put into the superintendent; therefore, leading small independent operators rely heavily on strong relationships with their drilling contractors. Like its large independent counterparts, a leading small independent operator in our study negotiates two- to three-year contracts with its drilling contractors to ensure consistency of crew. This has been critical to overcoming the learning curve in the Eagle Ford basin.

The big challenge for the small independent operation is that, despite its strength in collaboration and clear alignment on the direction in the operation, there will come a time when it will need stronger systems and processes to scale up beyond a certain threshold.
Summary

Figure 20 maps the four improvement areas in this report against technology, continuous improvement and people.

For operators with a conventional background, the challenges will not be in selecting the best technology. It will be in prioritizing continuous improvement to reap the benefits of these investments and empowering their people on the front lines.

Large independents are best positioned to implement these improvements, as they tend to have a balanced view of technology, continuous improvement and people. The main area of improvement will be investing in technology that could provide a step change in improvement (for example, in drilling automation) where the investment case is not simple.

Small independents can implement effective integrated planning and management of services through choosing the appropriate people; effective, regular meetings to simplify integrated planning; and establishing good relationships with service providers to lead to collaboration. But to grow, relying on people will not be enough. They will need to invest in structure, processes and systems and structured continuous improvement.

The remaining areas of differentiation in unconventional resource development (integrated planning and service contractor, logistics and materials management) are more complex to implement because they require collaboration across functions and with service providers and vendors.

They also require a pragmatic approach to trade-offs between when to invest in technology to achieve a step change in performance, when to focus on continuous improvement and incremental improvements, and when to focus on getting the people element right. This pragmatic approach needs to balance short-term operational performance with longer-term growth and building sustainable, high-performing operations.
Figure 20. Technology, Continuous Improvement and People - relative importance in improving Integrated Planning, Management of Service Contractors, Logistics and Materials Management

<table>
<thead>
<tr>
<th>Improvement areas</th>
<th>Technology</th>
<th>Continuous improvement</th>
<th>People (culture)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Long-term step change in performance</td>
<td>Sustained and creative, but often incremental, improvements</td>
<td>Focus on empowering the best people on the front lines</td>
</tr>
<tr>
<td><strong>Integrated planning</strong></td>
<td>Planning tools at field, well and supply chain levels</td>
<td>Planning process should be as simple as possible. One version of drilling schedule</td>
<td>Need to overcome silos in organization and involve service providers</td>
</tr>
<tr>
<td><strong>Management of services</strong></td>
<td>Required to support process Mobile, tracking and collaboration technology</td>
<td>Even small improvements in handovers and reduction in duplication of effort will add up</td>
<td>Think of service providers as a teaming relationship. Incentivize competition and team performance</td>
</tr>
<tr>
<td><strong>Logistics management</strong></td>
<td>Control tower required to optimize scheduling of fleet and manage HSE</td>
<td>Data and analytics will continue to provide incremental improvement opportunities</td>
<td>Need to work with logistics providers</td>
</tr>
<tr>
<td><strong>Materials management</strong></td>
<td>ERP backbone material visibility tool, access to supplier information</td>
<td>Small improvements in handovers, sharing of demand and supply information, optimization</td>
<td>Need to work with vendors across wells and facilities</td>
</tr>
</tbody>
</table>

Source: Accenture analysis
### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bopd</td>
<td>Barrels of oil per day</td>
</tr>
<tr>
<td>E&amp;P</td>
<td>Exploration and production</td>
</tr>
<tr>
<td>HSE</td>
<td>Health, safety and environment</td>
</tr>
<tr>
<td>IVMS</td>
<td>In-vehicle monitoring systems</td>
</tr>
<tr>
<td>MMbpd</td>
<td>Million barrels of oil per day</td>
</tr>
<tr>
<td>MMcfpd</td>
<td>Million standard cubic feet per day</td>
</tr>
<tr>
<td>MRO</td>
<td>Maintenance, repair and operations</td>
</tr>
<tr>
<td>RFID</td>
<td>Radio frequency identification</td>
</tr>
<tr>
<td>SLAs</td>
<td>Service level agreements</td>
</tr>
<tr>
<td>TD</td>
<td>Target depth</td>
</tr>
<tr>
<td>WTI</td>
<td>West Texas Intermediate, a light sweet crude benchmark based on crude produced in the US and Canada</td>
</tr>
<tr>
<td>LLS</td>
<td>Louisiana Light Sweet or Argus crude, a light sweet crude benchmark based on waterborne imports to the Gulf Coast market</td>
</tr>
<tr>
<td>Type Curve</td>
<td>Type curve is the expected production profile of a well over time. Type curves are used in unconventional to estimate production and determine capacity constraints</td>
</tr>
<tr>
<td>Gathering Lines</td>
<td>These small-diameter pipelines move natural gas from the wellhead to the natural gas processing plant or to an interconnection with a larger mainline pipeline.</td>
</tr>
<tr>
<td>Well Completions</td>
<td>The process of making a well ready for production (or injection). This principally involves preparing the bottom of the hole to the required specifications, running in the production tubing and its associated down hole tools as well as perforating and stimulating as required. Sometimes, the process of running in and cementing the casing is also included.</td>
</tr>
<tr>
<td>Smart Pen Technology</td>
<td>A smartpen is a high-tech writing tool that records spoken words and synchronizes them with notes users write on special paper.</td>
</tr>
</tbody>
</table>
References


5. Accenture analysis

6. Ibid

7. Ibid


13. Accenture analysis


16. Accenture analysis


19. Accenture Analysis

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Accenture supports the international development of unconventional resources, focusing on the following.

**Integrated planning**
We implement operating models, processes and applications to support three levels of planning: field level, well scheduling/facilities construction and supply chain integration.

**Logistics**
We offer network design and implementation, logistics operating models, processes and systems for water, proppant and well pad equipment.

**Materials management**
We help to implement leading practices around standardization, demand and supply planning, analytics, integration of vendor supply chains, material visibility and surplus management. We also offer materials management as an outsourced managed service.

**Services management**
We offer leading practice management for a large number of service contractors, including basic financial services; health, safety and environment (HSE) controls such as buying on contract, managing change requests and overseeing payment processes; and collaboration tools to support onboarding, tracking and knowledge sharing.

**Water management**
We provide end-to-end support in developing water management strategies (treatment technologies and movements) and implementing water management information technologies to manage flows and quality.

**Drilling analytics**
We are working with Accenture Digital and the Massachusetts Institute of Technology (MIT)/Accenture alliance to create analytics solutions that incorporate large amounts of data from service providers, equipment vendors and operators.

**Unconventional finance**
We develop finance solutions for unconventional, including a finance framework for investment decision making, accounting and policy development, cost control and cost structure setup, supporting systems, planning, budget and forecasting.

**Unconventional IT**
We develop unconventional IT strategies, as well as design and implement data solutions systems (including package selection).

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