THINK ACT
POINT OF VIEW

INNOVATION IN OIL AND GAS
Overcoming conventional approaches to unconventionals

NOVEMBER 2014

BEYOND MAINSTREAM

Roland Berger
Strategy Consultants
With less than half a percent of revenues spent on R&D, the oil and gas industry has one of the lowest levels of R&D intensity of any sector. Nevertheless, with the shift in focus towards unlocking the vast reserves in unconventional formations — which we define broadly to include tight oil and gas, oil sands and heavy oils — the need for innovation has increased dramatically. Driven by a combination of economics and environmental pressures, new technology solutions are essential to fully realize the opportunity.

For example, a typical shale gas well may consume around 10 million barrels of water for hydraulic fracturing, cost USD 5-10 m to drill and complete, yet on average produces less than 10 percent of the overall resources in place within the reservoir. As illustrated in Figure A, there are tremendous opportunities to improve well performance through the application of new — as of yet undiscovered — technologies.

Where there have been major technology advances in unconventionals, the oil majors have been left behind by smaller, more nimble players. The clearest example is the role played by Mitchell Energy in perfecting hydraulic fracturing in the 1980s and 1990s. Mitchell Energy’s success in sparking the shale gas revolution — due largely to its persistence in trialing new methods spun out of the US DOE research labs — highlights the difference between the disruptive thinking and relentless experimentation of the true innovator compared with the linear, measured approach of traditional R&D organizations.

Another example is the development of the SAGD process for oil sands by Canadian independents, the origins of which began with the Alberta Oil Sands Technology and Research Authority (AOSTRA), an Alberta Government supported research initiative from the late 1970s and 1980s.

In our view, much more can and should be done to create the right conditions for technology breakthroughs in unconventionals. Despite an increase in upstream technology spending, in general the industry has continued to focus on incremental R&D rather than on more radical innovation. As a result, major breakthroughs remain elusive.

From what we have seen in our work with many different players in this space, more of the same is not enough: the industry continues to face significant barriers to innovation, and needs to shift to a new paradigm.

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**INDICATIVE RECOVERY EFFICIENCIES BY RESERVE TYPE**

<table>
<thead>
<tr>
<th>% of economic recover of oil in place¹</th>
<th>35</th>
<th>30</th>
<th>25</th>
<th>20</th>
<th>15</th>
<th>10</th>
<th>5</th>
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<td>tight oil</td>
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¹) Estimates based on current prices and technology

Source: Roland Berger analysis
What are the barriers to innovation?

As illustrated in Figure 8, strategic, organizational and cultural issues are all at play in constraining innovation in unconventional oil and gas.

Companies’ business strategies often reflect managers’ greater comfort with traditional upstream businesses than with unconventionals, resulting in inertia when it comes to considering different approaches and placing a few small bets. Even when a business strategy recognizes the need to overcome longer-term technical challenges, disconnects with technology strategies can result in unclear R&D objectives and create imbalances in resource allocation. Innovative technology is often an after-thought or a bolt-on to the ‘deal’ and the long-range field development plan and associated economics.

A common organizational constraint to innovation is the existence of R&D and operations silos, with cross-functional interactions being more transactional than collaborative. These silos act as barriers to effective collaboration internally, and between companies, governments, and research institutes. Also, many technology organizations adopt a reactive role rather than spearheading the search for step-out solutions, and R&D management processes are designed to meet incremental rather than stretch objectives. In unconventionals, we have found that these organizational barriers can add years to the delivery time of high-potential new technologies.

Another issue which is often faced specifically by integrated players is a lack of collaboration between the upstream and downstream organizations, even though certain downstream technical capabilities — for example in water management, catalytic processes, and advanced materials — are relevant when it comes to addressing technical barriers in unconventionals. Scope for collaboration is made more difficult by cost-reduction pressures in downstream R&D.

Company culture, however, is probably the most significant challenge, and is often the root cause of strategic and organizational constraints. While innovation is synonymous with openness to new ideas, experimentation and risk-taking, upstream oil and gas organizations tend to be introspective and conservative. And their tolerance for risk declines sharply moving from exploration to development to production, in opposition to the need for fast-cycle experimentation and learning in the production phase of the unconventionals business. In unconventionals, this plays out in a number of ways:

> An unwillingness to fund longer-term R&D
> A bias toward detailed analysis instead of rapid experimentation
> Reward systems in operations acting as a disincentive for experimentation
> A reluctance to collaborate outside normal organizational boundaries.

In other words, unconventionals are being tackled conventionally.
BARRIERS TO INNOVATION

Strategic
> Near-term focus
> Lack of clarity of R&D objectives
> Imbalances in resource allocation

Organizational
> Functional silos
> Reactive R&D organization
> Lack of cross-business collaboration

Cultural
> Introspective
> Conservative
> Low risk-tolerance
> Unwillingness to experiment

Source: Roland Berger analysis
Since the oil and gas industry is not known for rapid innovation, let’s turn to other innovators to identify alternative paradigms.

First, a word of caution. In any discussion on new approaches to innovation, Apple and Google are invariably mentioned as the gold standard. While few would disagree that’s the case in consumer electronics and the internet, one needs to be much more careful in drawing lessons for companies in other industries. In upstream oil and gas, commercialization of new technology is not an annual event announced at a gala dinner in Las Vegas — as illustrated by the two decades Mitchell Energy spent in the development of hydraulic fracturing. Differentiators such as product design and the customer experience are largely irrelevant, and direct measures of technology impact are often difficult to obtain. For example, whether or not a new fracking cocktail improves the ultimate recovery of a shale oil may well take five or more years to assess.

However, in some respects Apple and Google's approaches to innovation offer insights into new methods that could accelerate the pace in oil and gas. Both companies have clearly been highly successful in the mobile phone industry, with Apple making around USD 1 bn per month on iPhone sales while Android's market share has increased hugely in the last few years. But their innovation paradigms are very different, falling at opposite ends of an "open-closed" continuum.

As outlined in a recent article in Roland Berger’s think:act magazine (number 19, ‘Polar Opposites’), we describe how Apple is well-known for its "closed" approach to innovation. It is introverted, secretive and perfectionist, insists on end-to-end control over its products, and keeps hardware, software and content all carefully cross-matched and strictly under wraps. In contrast, Google is an open-source, fast-moving, almost anarchic organization. The company launches products during various stages of testing and development, changes them constantly, and takes a "crowd-sourced" approach to product decisions.

The "closed" approach to innovation is particularly well-suited to maximizing efficiency, profitability and bottom-line growth — similar to the traditional path taken by most oil and gas companies — while the "open" approach is better suited to rapid top-line growth and developing new processes, products and business models. It has a steeper learning curve, and is more productive in yielding new ideas. Although Google’s style of innovation is foreign to the oil and gas industry, we believe that companies need to move in this direction to achieve technology breakthroughs.

Let’s take a look inside Google to see an example of their approach. Within Motorola Mobility, acquired by Google in 2012, the Advanced Technology and Projects (ATAP) group spearheads the search for breakthrough innovation. Modeled on DARPA, the Pentagon’s Defense Advanced Research Projects Agency, ATAP focuses on challenging, real-world problems that leverage advances in science and technology; has a high degree of independence in project selection; and assembles leading external experts to work on relatively short-term, intensive projects in highly-collaborative, multi-disciplinary teams.

ATAP points the way to alternative paradigms for innovation — complementary to traditional, incrementally-focused R&D organizations — to accelerate the search for technology advances in unconventional oil and gas.
## PROS AND CONS OF ALTERNATIVE APPROACHES TO INNOVATION

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<tr>
<th>&quot;Closed&quot; approach to innovation</th>
<th>&quot;Open&quot; approach to innovation</th>
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<tr>
<td>&gt; More suited to efficiency, profitability and bottom-line growth</td>
<td>&gt; More suited to rapid top-line growth and developing new processes, products, and business models</td>
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<tr>
<td>&gt; Strong internal relationships breed trust and result in reliable solutions</td>
<td>&gt; Steeper learning curve and more innovative</td>
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<tr>
<td>&gt; Promotes groupthink and a fortress mentality</td>
<td>&gt; More lax approach; chaotic and vulnerable in a crisis</td>
</tr>
<tr>
<td>&gt; Less flexible approach</td>
<td>&gt; Weaker relationships undermine reliability of solutions</td>
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<tr>
<td>&gt; Encourages people to take themselves too seriously</td>
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Source: Roland Berger analysis
Taking the first steps

Overcoming cultural and organizational barriers and finding new paradigms can be daunting for any company. Some managers may not even accept the need for technology innovation in unconventional in the first place. So where to start?

As illustrated in D, three steps are key to jump-starting a technology innovation initiative: creating alignment on where to focus; shaping the technology portfolio and priority programs; and setting the pathway to implementation.

In the first step, a clear articulation of critical strategic objectives are translated into what we call 'Grand Challenges.' Identified jointly by technology and business leaders, Grand Challenges are technology-enabled business objectives that, if achieved, will create a major competitive advantage and stream of value. There must be a limited number of Grand Challenges to ensure that resources are not spread too thinly, but are focused on a small number of high-value, breakthrough opportunities. For example, a Grand Challenge for unconventional might be to triple the ultimate recovery of a shale well in a 10 year time span.

Once Grand Challenges have been defined, the next step is to understand the extent to which they are aligned with current and potential technology programs, and supporting technology platforms and core competences. This invariably highlights issues to be resolved and gaps to be filled at the intersection between Grand Challenges and technology programs, and requires a rebalancing of short, medium and long-term objectives.

The resulting risk/reward profile of the overall technology portfolio should match the goals of the Grand Challenges. In our example E, key short term objec-

THINK ACT
INNOVATION IN OIL AND GAS

THREE STEPS TO JUMP-START TECHNOLOGY INNOVATION

WHERE TO FOCUS
Building corporate/technology alignment around Grand Challenges

WHAT TO PRIORITIZE
Shaping priority programs, platforms, and the technology portfolio

HOW TO IMPLEMENT
Defining specific projects, sourcing strategy, and roadmap

Source: Roland Berger analysis
SHALE GAS
Illustrative example

GRAND CHALLENGES

Triple recovery efficiency from 5% to 15% in 10 years

GRAND CHALLENGE WELL PROFILE TARGET

Well production vs. years

Current production profile
Target production profile

PRIORITIES AND MILESTONES

Fracking productivity
Geophysical analytics
Production transformation

Years 1 2 3 4 5 6 7 8 9 10

IMPLEMENTATION PATHWAYS

Develop internal competences;
Optimize processes and organization

Expand third-party collaboration through bilateral agreements and consortia

Source: Roland Berger analysis
tives might be to increase the productivity of frack stages and fracture propagation; in the medium term, to identify highly predictive geophysical indicators of top-tier well performance; and longer term, to completely transform the well production profile.

Finally, implementation planning needs to consider a range of issues including: the right balance between the ‘Apple’ and ‘Google’ models of innovation; improving cross-functional/business collaboration through changes to reward and recognition systems; filling out the R&D project agenda by setting project-level objectives and prioritizing projects based on asset timing requirements and other factors; and assessing options to bridge internal technology and competency gaps through third-party collaboration.

In our example, the ‘Apple’ approach may be best suited to the short and medium-term objectives of improving frack effectiveness and ‘reinventing geophysics.’ However, dramatically transforming the production profile seems best suited to the ‘Google’ approach of seeking new ideas from non-traditional sources and rapid experimentation with a strong external focus.

One step in the direction of collaborative development in unconventional is the formation of COSIA, Canada’s Oil Sands Innovation Alliance. An alliance of oil sands producers focusing on accelerating the pace of improvement in environmental performance, many observers are keenly observing the progress and results of this initiative.

Once there is clear alignment — on the link between breakthrough technology objectives and critical business objectives; the supporting R&D projects, programs and platforms required; and the actions that need to be taken for effective implementation — companies are in far better shape to shift to new paradigms for innovation in unconventional oil and gas.

As the unconventional growth trend continues, operators should ask themselves: “Do we have the right balance between closed (Apple) and open (Google) innovation models to execute on our business strategy and deliver maximum shareholder value?”

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ABOUT US

Roland Berger Strategy Consultants

Roland Berger Strategy Consultants, founded in 1967, is the only leading global consultancy with German heritage and of European origin. With 2,400 employees working from 36 countries, we have successful operations in all major international markets. Our 50 offices are located in the key global business hubs. The consultancy is an independent partnership owned exclusively by 220 Partners.

Further reading

THE SHALE GAS PHENOMENON

Roland Berger experts highlight the relevance of this resource to the US energy landscape – by 2050, shale gas could make up 50% of total gas produced in the US. Specialists believe its potential can revive production and manufacturing in the US through 4 competitive advantages.

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