Technology Strategy for Shale Plays: Independents vs. Majors--An Analysis and Outlook*

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Abstract

This report examines the strategies for exploring for and developing shale plays as implemented by independents and by major oil and gas companies. It finds explanations for comparative success and failure, and charts an ideal strategy for both established and new / frontier shale plays.

Introduction and Brief Historical Overview

In the 80s and 90s, despite the limitations of technology, companies such as Mitchell Energy persisted in their quest to extract hydrocarbons from ultra low-permeability fine-grained formations, which are called "shale" for the purposes of this report, but which in reality cover a wide spectrum of siliciclastic and carbonate fine-grained rocks.

The early shale play companies applied the horizontal drilling techniques which were being pioneered in the Austin Chalk. They moved them north to the Fort Worth Basin, where they started to horizontally drill the Barnett Shale. They also began to experiment with new completion and stimulation techniques, namely multi-staged hydraulic fracturing, and the use of slickwater fracturing fluid (as well as linear and crosslinked gel), and different sizes of proppants.

Because the price of natural gas was high in the early 2000s, success in drilling, completing, and producing the horizontal wells in the Barnett shale was also economically viable. The high initial production levels of gas combined with high prices worked as a powerful stimulus. The notion that shale plays were homogeneous, laterally extensive "resource plays" with productive extent of hundreds of thousands of acres was a paradigm shift which set off a boom and a new direction that continues to shape oil and gas exploration and production today.

Phase I: Developing a Business and Technology Strategy for Shale Plays

The early influencers and leaders in shale plays were, most notably, medium-sized independents, some of which soon became large independents.

With a large-scale model that was highly attractive to Wall Street, many companies were able to move past proof of concept to drilling, completing, and producing large plays. Majors did not necessarily do well in the early development of shale plays for several reasons:

* late to the party (the independents had the sweet spots already leased)
* were not able to take advantage of the key elements of the independents' strategy
* participated in plays that were not yet tested and/or optimized
* acquired leases in unproductive parts of the play
* slow to respond to new developments
* high operating costs
* implemented all technologies on large scale, with poor results
* teams lacked experience in shale plays or unconventionals

Consequently, the majors who participated relatively early in the development of shale plays had very mixed results.

Shell entered the Mississippian Lime play in Oklahoma and Kansas, but decided to sell the play after only a few years, due to disappointing results and high costs.

BP partnered with Lewis Energy in the Eagle Ford, and while BP seemed to be satisfied with the results, they also announced a desire to contain costs.

Like BP, other majors seemed to succeed when they either partnered with an early-entry, experienced independent shale operator. Statoil purchased Brigham Energy (and retained much of the talent) in the Bakken, BHP Billiton purchased Petrohawk, and retained their CEO for a period of time for knowledge transfer, and other companies likewise entered via acquisition rather than simply leasing prospects.

These examples are not to suggest that all independents experienced success, nor that all majors experienced disappointing results; it is just that scope, breadth and scale of majors' involvement made their entrance (and exit) of shale plays all the more dramatic.

Effective and Efficient Land Positioning

Independent operators tended to specialize in one or two shale plays which they had carefully studied for years. They either owned producing fields where the shale play was a "bypassed pay" zone and consequently held by production, or they were able to swiftly lease vast expanses of a new play without perturbing the market, at least at first.

Barnett Shale: The land situation was something of an exception to the rule, given that so much of the land was under the city of Fort Worth, and it was necessary to include a number of public hearings, which loudly publicized the endeavor. The play had a large number of operating companies, and the experiences of each varied widely as the technology was very much in the experimental stage.

Marcellus Shale: Much of the Marcellus production lies in an area that has long produced from other formations. The Marcellus was, in essence, a bypassed pay zone. Companies such as Range and Cabot, with operations in the area as well as control or access to existing infrastructure had a great initial advantage.

Eagle Ford: This is an example of a very large play which contained areas that were not commonly leased. It was possible to lease entire ranches, which helped a great deal with respect to efficiency. It also required the operating company to have a very good and trusting relationship with the ranch owner, which is something not easily accomplished by a stranger or large, distant, super-major.

Bakken: Companies such as Brigham and Continental were able to obtain leases in the early stages of the play before the true potential was recognized. They were helped in their leasing (while perhaps hampered in obtaining public financing) by the persistently low United States Geological Survey estimates of recoverable reserves, which were, for many years, officially announced to be 4 BBO, while, given the new technologies and new zones such as the Three Forks, they are commonly held to be as high as 48 BBO.

New Financing Approaches

Because of the sheer magnitude of the plays and the potential for vast reserves produced in horizontal wells drilled as parallel laterals, and which could be "mined" for uniform results across the entire play (at least that was the early thinking), the estimates of ultimate reserves and for cash flow were highly attractive to Wall Street. Most independents, however, could not hope to drill this highly capital-intensive play without obtaining funding in innovative ways.

"Aggressive" Means Risk-Tolerant Investors: The super-majors are often constrained by the fact that their major shareholders are large institutional investors who have traditionally looked at companies as capable of producing profits, which translate into dividends and predictable rise in price. On the other hand, the small-cap small companies have been considered very aggressive, which means that the investors are less risk-averse, and welcome the possibility of high returns.

That said, the "high-risk / high-reward" approach sometimes hits a snag when shareholder activists gain control of a company. Sometimes it seems to be the only solution to high debt and low natural gas prices. However, it often results in the ejection of the original visionary leader. The argument is that the visionary leader was good for a "proof of concept" notion and the shareholder activists need to come in and establish a kind of prudent order which means cost-control and uniform operations. This may be a good idea, but, it may not always work. Much depends on the culture of the organization.

Chesapeake Energy: Developed new, aggressive approaches to public financing via equity financing, debt financing, and even financing future production. The prevailing belief was that the high capital costs were well worth the risk, thanks to very attractive projected returns on investment, and also potential returns on stock. Not all financing options rewarded their investors with the hoped-for returns, but that is a different story.

SandRidge Energy: Developed their "Mississippian Trusts" in order to develop the Mississippian Lime play, which is not a shale but a limestone, but considered an "unconventional" in the sense that was viewed as massive, laterally extensive, and ideal for high-density multi-stage laterals. The Trust instruments were securities sold separately from the

Devon: Partnered with international national companies in order to obtain needed capital to develop plays such as the Woodford Shale. The companies investing were not necessarily hoping for a quick return on their investment in terms of selling stock, but were more desirous of obtaining technology exchange and knowledge transfer for developing their own country's shale resources.

PetroHawk: Obtained initial investment funding from various sources in order to develop first "proof of concept" Eagle Ford wells in what was identified as a fairway or sweetspot in the Eagle Ford.

Continental Resources: An innovator in multi-staged hydraulic fracturing and obtaining very high initial production rates in the Bakken, Continental Resources leveraged revenues derived from their oil production (while the oil prices were high) to purchase leases in what was considered a gas-rich area, in their Woodford "SCOOP" play in southern Oklahoma.

The development phase of unconventionals is proving to be just as innovation-dependent as the exploration phase. One can argue that the companies that acquire assets from distressed companies that are suffering from the dual onus/burden of high debt and low natural gas prices tend to be too cautious because their investors expect a steady rate of growth as if achieving "proof of concept" meant smooth sailing. Unfortunately, in the case of unconventionals, a high degree of innovation is necessary as more information is gained about the reservoir.

Implementing New Technology

A quick overview of the new technologies in Phase I, which resulted in the mainstreaming of shale plays can narrow a potentially very long list to that of several "make or break" new technologies, many of which were developed quickly by the independents in conjunction with service companies. Independents tended to use the field as a "living laboratory" and were able to test and evaluate the results of individual wells in early stages, before the operations tempo had to accelerate dramatically as companies sought to drill as quickly as possible to make sure the leases were held by production (HBP) for the leases expired.

Independents had the ability to revise and even completely overhaul their drilling programs and drilling plans if the results of one or two wells indicated that the approach they were using would result in large problems.

Geochemistry to Determine Productive Limits: Direct methods were used to determine TOC and thermal maturity to identify productive limits. In addition, new methods of indirectly calculating / estimating TOC using existing logs (the Passey Method) were used with some degree of success.

Horizontal Drilling / Flexible Geosteering: Being able to drilling horizontally, and to steer the well while drilling required new kinds of bits, drillpipe, and pumps. Small companies were able to experiment on a few wells at the beginning and work out critical issues, rather than having to roll out with a drilling plan involving 50 or 60 simultaneous wells.

Imaging for Proper Identification of Sweet Spots and Staying in the Zone: Mitchell Energy and others developed an approach that integrated geological and geophysical information, and to generate and interpret 3D seismic images that would both reveal zones of enrichment ("sweet spots") both before drilling, and in conjunction with geosteering. Being able to stay in the zone was most critical for formations containing geohazards, including water zones and abnormal pressure.

New Fluids that Minimized Formation Damage: Understanding the behaviors of the clay minerals as well as the other elements of the well were very important in developing fluids that did not clog fractures / fracture zones.

Tools for Real-time Temperature and Pressure Monitoring: Logging While Drilling (LWD) represented a huge breakthrough. High temperature-resistant sensors that transmit real-time information made a great deal of difference.

Induced vs. Natural Fracture Systems: Being able to drill in the zones containing high degrees of natural fracturing could have a significant impact, particularly in gas-productive formation such as the Marcellus and the Haynesville.

Hydraulic Fracturing Fluids and the Hydraulic Fracture Design: Understanding the behaviors of fracturing fluid, and recognizing that while there are some common elements, all plays are different, is a key issue. For example, guar gum was a key additive in early hydraulic fracturing programs in the Barnett. However, how much was enough? And, it was necessary in some cases to add a stabilizer such as zirconium to "cross-link" the gel and create a polymer that could withstand more pressure, and work better with the proppants.

Better Understanding of Rock Behavior: Understanding how a rock will behave, particularly as it applies to pore architecture, conduits, and fractures was the difference between a good flowing well, and on that never flowed, or had a very precipitous decline. Independents made sure that they understood to the best of their ability what was happening to the rocks while drilling, while completing, and also while producing.

The "Living Laboratory" Approach: Instead of adhering to the "factory" model that some operators claim to be following, in reality, they're highly innovative, and they are willing to experiment with different drilling and completion techniques, along with treatments. It means that they will have highly variable results in the early stages because some techniques will be more effective than others. Nevertheless, the lessons learned will be used profitably later.

Team-Based Operations Structure: Distributed Leadership: Teams can be quite small and are interdisciplinary, typically with engineers, geologists, geotechs, and a geophysicist working together. Decisions can be made rapidly, and the team leader has the authority to make a decision quickly without lengthy approval processes.

Emerging Challenges

The first phase of exploration of shale plays resulted in great technological success in determining that it is possible to drill and complete shales so that they produce very high volumes of oil, gas, and liquid-rich gas. The problem is that of decline rates, however, and according to a report by Credit Suisse, the first year decline rates can range from a high of almost 80% in the Mississippian Lime, to around 65% in the Bakken Three Forks. To combat steep decline rates, and to better drain the reservoir, the focus started to turn to the viability of increased density or infill drilling (horizontal wells).

In addition to steep decline rates, other challenges emerged, including escalating costs of massive hydraulic fracturing jobs, the need to optimize drilling pads and infrastructure, a need to better pinpoint sweet spots, and to determine ideal well spacing and cluster density. Determining the productive limits of a play (a "line of death") and also identifying new zones, especial in multiple pays or "stacked" zones.

Phase II: Optimizing Shale Plays

Companies are now in a new phase of developing shale plays, which involves optimizing operations in order to achieve higher initial production rates and to reduce decline rates, and increase recoverable reserves. The key concerns in the second phase, for majors as well as independents involve achieving efficiency and improving the quality of the portfolio of properties.

Goals include

- Retaining acreage
- Rapid cash flow from production
- Learning from experience
- Implementing "game-changer" technology
- Optimize infrastructure
- Reduce the steep curve associated with decline rates
- Explore new ways to increase density in shale plays to increase ultimate recovery rates

General Approach:

The process of shale play development can be summarized in the following way:

Exploration: Identifying the most productive parts of the play (the "sweet spots")

Obtain Acreage (lease or acquire)

Large-scale basin analysis studies

Type sections, logs, seismic, petrophysics, etc.

Appraisal: Plan for both pilot tests and horizontal production wells

Pilot Design: Maximize the science, gather data for ongoing lab studies

Pressure monitoring

Instrumented wells

Logging and coring

Prestimulation pilots/ post-stimulation pilots

Horizontal Wells: Optimize stimulation design, operations

Higher density cluster spacing

Optimizing proppant density

Increase cluster density, add more proppant

Development: Keeping capital costs and production optimization balanced

Capital costs: Efficient use of capital, hedging, good contracts for midstream

Multi-pad drilling operations

New zones in "stacked" plays

- Multiple wells from each location
- Acreage "multiplier"
- Reduced risk and cost

Well placement: Optimizing spacing and siting (includes stacked and infill)

Operations efficiencies: infrastructure, midstream, water /fluids treatment

Well-density optimization (infill drilling / "downspacing")

- 660' between one-mile long wells (80-acre spacing)
- 330' between one-mile long wells (40-acre spacing)
- Determining performance (80% of parent? 60%?)
- Determining fracture interference / fluid behavior / flow paths

Conclusion and a Potential Future

Technology strategies in use in Phase II of the commercialization of shale plays focus on optimizing the reservoir. There will undoubtedly be improvements in the characterization of reservoirs, identification of sweet spots, as well as optimized drilling, completion, and stimulation.

Sea changes could involve changing the way we currently drill, and merging the acidizing and drilling phases for something that could be considered "stimulating while drilling" (or "Stimu-Drill," to coin a phrase), to minimize formation damage and to dramatically reduce costs and also the time to drill and complete a well. The results would be cost savings and higher ultimate recoveries.

Appendix

Shale Play Technology Strategy of Independent Oil and Gas Producers: A Brief Sample Based on Analyst Day Presentations, April 2014

A close evaluation of the presentations made by U.S. independent oil and gas producers at the annual IPAA analyst meetings held in April 2014 in New York reveal what companies view as their most important strategies, most likely to have a positive impact on company and play valuation, as well as their stock prices.

The technology strategies of a representative sampling of independents described above appears here. The companies in this section are not listed in any particular order:

Continental Resources
Bakken
Focus on drilling efficiencies in order to drive growth
191 rigs drilling in the Bakken and Three Forks
2014 plan: 290 net wells (870 gross)
Increased density pilot wells: 330' between laterals (vs. 660 ft between laterals)
660-ft same-zone spacing – use microseismic monitory, 31 new wells
Question: is there interference in the natural and induced fractures?
Question: what is the ultimate recovery of wells drilled in the tighter pattern? Can they recover as much as the original "parent" well?
Mega-pads
"Cost discipline drives excellent margins"

Woodford
SCOOP play

Whiting

Bakken

With six fields in the Bakken (Missouri Breaks, Cassandra, Sanish, Hidden Bench, and others), Whiting has focused on a technology strategy of optimization and also efficiency in midstream.

New objective: Upper Three Forks

Technology Strategy:

Identify the Bakken maturity limit / Bakken pinchout (or "line of death")

Improve hydraulic fracturing distribution

40-stage hydraulic fracturing design

3 perf clusters per stage

120 potential entry points

New style of cemented liner (vs. sliding sleeve)

Niobrara

Integrated midstream

High-density pilots

- 165-ft spacing
- 960 acre DSU

Abraxas

Abraxas opened their 2014 Analyst Day report with a statement that their overall strategy is "focused in execution."

Eagle Ford

Pinpoint sweet spots and acquire 100% working interest

Balanced portfolio

Oil / dry gas / condensate – coupled with hedging

"hidden" gas portfolio: affiliated gas that can be produced when the price warrants it

Bakken

Increased density

Infill drilling with Three Forks zone

Samson

Bakken experience (North Stockyard field since 2008)

"More Is Better"

- More stages

More lateral length
More proppant
Now, planning
Three Forks
Infill drilling
Corner wells
Additional developmental wells

Southwestern Energy
Marcellus experience:
NE Pennsylvania position – now increased density

Fayetteville experience:
In the heart of the play
Early entry -- $320 / acre, 15% royalty, 74% working interest
Planning 460 – 470 horizontal wells in 2014

New Ventures: New Brunswick – 2.5 million acres

Overall strategy includes:
Longer laterals
Reducing well costs
Vertical integration of production
Contiguous acreage position

U.S. Energy (Wyoming):
"Stacked Play" Strategy:
Bakken / Three Forks
Austin Chalk / Eagle Ford / Buda

Now avoiding Federal lands (takes 307 to process permit to drill)
Participate 12.5% in Three Forks

Step-out wells

Denbury
Response to the 80% first year decline rates of most shale and unconventional plays
Targets enhanced recovery
Trying CO_2 flood in Barnett
Estimated recovery with CO_2 flood: 17% of total field reserves

Unit
Owns drill rigs, plus midstream processing + pipelines
- Gas gathering
- Processing plants
- Pipelines

They operate as well. Operating strategy:
- Pad drilling for optimized locations
- Fast movement between locations
- Bigger mud pumps
- Environmentally friendly
- Natural gas-utilization for engines on site

Drilling horizontal wells in conventional, mature fields as well as unconventionals
Strategy for operated wells: focus on stacked plays with 5 – 7 zones

Atlas Energy Partners
Growth by acquisition and geographic diversification
Acquisitions and working interest:
- Carrizo
- Titan
- Equal Energy
- EP Energy

Hedge fund
Mississippi Lime play: acquired sweet spots in play core
- *Hunton* held by production

Midstates
Pennsylvanian sands in Oklahoma and Texas Panhandle (*Cleveland* and *Cottage Grove*)
Apply lessons learned in the *Mississippian Lime* to *Cleveland / Marmaton*
Use 3D seismic to

High-grade locations
Optimize well placement and completion techniques
Investigating Mississippian benches to infill drill for increased density
Expand acreage position

Cimarex
Avalon Shale (Delaware Basin)
Stacked zones:
Second Bone Springs
Third Bone Springs
Wolfcamp
Avalon
Strategy:
Stagger / Stack the pilot wells
Do extra pilot drilling (4 wells / 80-acre spacing)
Upsize fracs (example: TimTam 24 Fee # 1H - 20 stages vs old 12)

Old strategy:
12-stage / 1100 BOPD IP ➔ 200 BOPD after 24 months
20-stage / 1500 BOPD IP ➔ 375 BOPD after 24 months (projected)

(*Cana Woodford*: Testing upsized frac as well)

Upsized *Wolfcamp* frac:

Old strategy:
5,000 ft lateral / 12 stages / 400,000 lbs sand / 100 mesh / 100 b/min

New strategy:
5,000 ft lateral / 20 stages / 6.0 mm lbs of sand / 2.0 mm at 100 mesh / 40-60 Bbl/minute

Pioneer
Shale intervals in Midland Basin
Wolfcamp and *Sprayberry* Shales / silts

Strategy:

Careful geological modeling using paleoecological models & biostratigraphy
Increased density: 100-acre spacing
Infill drilling
Stacked pay
Clearfork
Middle Spraberry Shale
Atoka
Woodford

Key? Better fracs / better acidizing

Halcon
*Bakken / Three Fork*s
Eagle Ford stepout (extending the productive read of the Eagle Ford)

Strategy for *Bakken / Eagle Ford*:
Develop sweet spot of play
1,000 locations, 800 ft laterals
Reduce drilling days / lower frac cost
Optimizing artificial lift
7,000 – 9,000 foot laterals
1,000 or 800 ft spacing
Increase perf cluster density and test proppant types

Tuscaloosa Marine Shale
TMS Well in Mississippi

TMS Strategy:
Identify sweet spots on log using Passey Method
(Determine TOC and maturation by measuring separation on sonic log & resistivity log)
High clay – low swelling factor (low smectite) – design drilling and stim plan

Well Performance Innovations
Longer lats: 7,200 ft +
Lateral placement well-defined using 3D seismic and innovative LWD
Hybrid frac (not just slickwater)

1,600+ lbs proppant / foot
50 ft cluster spacing
Optimize stage size
Stabilize clay using choline chloride
More abrasion-resistant bits
Multi-well pads

Magnum Hunter
Extreme information gathering on pilots
Utica Point / Pleasant focus
Investing in pipeline / gathering system

Carrizo
Utica
Eagle Ford
Niobrara
NE Pennsylvania *Marcellus*
Testing infill economics in 2014
Base on EUR that is 80% of "parent" using 1,000 offsets (frac interference?)

Range Resources
Gas In Place (GIP)
- Pressure
- Temperature
- Porosity
- HC Saturation
- Thermal maturity
- Net thickness

Strategy:
GIP Analysis on all plays
- Stacked pay or new plays:
  - *Utica / Point Pleasant*
  - *Marcellus*
  - *Upper Devonian*

Linn Energy
Granite Wash
Uinta
Jonah Field (Green River) – evaluating new processes for kerogen oil
California
Permian – Midland
Permian Basin
Hugoton Embayment
Salt Creek
Williston Basin

Vanguard
Strategy: Geographically diversified
Jonah Field
Ultra Petroleum
QEP Resources
Shale Play Diversification
Bossier
Haynesville
Marcellus
Utica
Eagle Ford
Fayetteville (core)
Woodford
Barnett (core)
Bakken

Gulfport
Utica / Point Pleasant

Strategy for siting wells:
Thickness
TOC
Thermal Maturity
Overlapping Sweet Spots

Swift Energy
Strategy: Wellbore placement critical for success

Geosteering / staying in the zone
Better detection / better sensors
3D seismic integration with process

Logging horizontal laterals
- Allows selective stimulation of highest quality rock

Grouping clusters within each stage around common fracture gradients
- Results in more efficient fracs

Continuous optimization by assertively pushing engineering and technical limits

3D seismic / proper placement of laterals

Logging well laterals
- Optimized placement of frac stages
- Improved frac performance
- Reduces number of frac stages needed to efficiently complete a well
  - (note – this counters the conventional wisdom of "more is better")

Selected References

Most of the information gathered for this report came from corporate earnings reports released in April 2014. More than 100 oil and gas operating companies were reviewed, including majors and independents.

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