Information Management in the Shale

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Abstract

With the rise in the development of Unconventional Resources (Shale plays, coal bed methane, and oil sands), many upstream companies find themselves working in ways very different than when they pursue conventional assets. These differences range from the need for a much tighter integration between the various functions (Geoscience, Engineering, Production, Land, EH&S, etc.) to the business operating at speeds previously unseen in the Energy sector. While these companies’ business units are working through the issues of how to work differently to be successful, their Information Management functions face similar challenges. Many Data Management solutions implemented to support conventional Exploration and Production are being stretched in supporting these unconventional efforts. This paper will explore the similarities and differences of the information needs of Unconventional and Conventional plays, the capabilities and challenges put upon the existing information systems and processes, and what new solutions are needed to be successful.
Conventional versus Unconventional

In a conventional play, three things need to be present for success: a hydrocarbon charge, the presence of a reservoir, and a trapping mechanism. Geoscientists evaluate plays within basins to find those areas where there is a high degree of probability that all three factors are present. Working with the Land department, the desired acreage is pursued through lease sales and license rounds, after which the prospects are high graded and the best ones drilled. Future production is forecast based upon past and current production. At each step of the way, each function within the company does its job and passes the results on to the next function in the chain. When companies are pursuing a strategy based on conventional plays, a comprehensive first quartile data management program is desired but not critical for the business’ success. The functional nature of the work as well as the rate at which prospects are evaluated and wells drilled leaves time to manage the data and data handovers as each prospect works its way through the well lifecycle.

In the unconventional world, all three factors (charge, reservoir, and trap) are combined, as the shale plays all three roles. The hydrocarbons are generated and preserved within the shale without a traditional trapping mechanism. Unlike conventional exploration, finding the hydrocarbons in shale plays is not the difficult part but rather the challenge lies in finding the “sweet spots” within the shale. The focus shifts from the mapping of structural and stratigraphic traps to modeling the mineralogy and fractures within the shale. The race for acreage makes early entry into the shale plays and the identification of the sweet spots critical. In these unconventional plays, instead of a company’s wells being numbered in the dozens per year, they’re being counted by the hundreds. In the Bakken, some companies spud a new well every other day. Success in the unconventional space is dependent upon a model-based approach, with the fractures (length, pattern, density), well design, mineralogy, production data and patterns, and so on all being considered and evaluated in concert with each other.
The type of source, reservoir and trapping mechanism isn’t the only difference however. The sheer amount of acreage that needs to be considered in the shale plays dwarfs the conventional prospect. In figure 2, we see the areal extent of the larger assets in the Gulf of Mexico side-by-side with the areal extent of some of the major shale plays. This sets the stage for a type of work that will demand the management of amounts of data that is magnitudes greater than in the conventional world.

<table>
<thead>
<tr>
<th>Conventional</th>
<th>Unconventional</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Charge</td>
<td>- Shale plays all three roles: Charge, Reservoir, Trap/Seal</td>
</tr>
<tr>
<td>- Reservoir</td>
<td>- High Volume / Lower Cost</td>
</tr>
<tr>
<td>- Trap/Seal</td>
<td>Development requires an contemporaneous integrated approach</td>
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Prospects move along the Value Chain
Exploration – Development – Production

Challenge is finding the hydrocarbons

Challenge is finding the “Sweet Spots”

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**Major Gulf of Mexico Assets:**
- Mars-Ursa 126 mi²
- Neptune 72 mi²
- Thunderhorse 72 mi²
- K2 63 mi²

Sizes are based upon the number of blocks under which the asset lies (BOEM)

**Major Shale Plays**
- Marcellus 54,000 mi²
- Bakken* 24,000 mi²
- Eagle Ford 20,000 mi²
- Bazhenov** 2,300,000 mi²

*Size for North Dakota portion of Bakken
** Western Siberia

Figure 2
The Rise of the Shale

Over the last decade a number of factors made the development of shale oil in North America a very attractive option.

- The price of crude oil rose to levels that could sustain the capital investment in such a play.
- The turmoil in the Middle East sent upstream companies looking for more stable environments in which to operate.
- Drilling and particularly Completions technologies allowed for especially long horizontal wells, fracking on a large scale and multi-lateral completions, all of which could bring the volumes of hydrocarbon necessary to make such an operation economically feasible.

Over a span of less than ten years, drilling activities as measured by the active rig count and following on from that, the production from the shale plays went to previously unseen levels.

Onshore U.S. Rig Count

*Data from Baker Hughes*
The production from the Bakken Shale is just one example of how production from these resources have increased exponentially over the past decade, both in absolute volumes and as a percentage of the total North Dakota production.

*Data from North Dakota Industrial Commission

This sudden and drastic increase put a strain on all aspects of the operation. With the business operating at such a pace, sustainable success is not possible without well-defined data and information management capabilities being implemented.

**Information Challenges**

As a result of the aforementioned changes, there are a number of data and information challenges that, for operating and service companies, will determine their success or failure. Among these challenges are:

- The Speed of the Business
- Finding the sweet spot
- Logistics
- Integration
- Advanced Analytics

![Annual Bakken Production](chart1.png)

![Bakken Production % of ND Production](chart2.png)
The Speed of the Business

In the Unconventional space, the business is operating at previously unseen speeds and as a result, a strain is being put on all aspects of the operation and the need for timely, accurate information is more critical than ever. Wells are being spudded every day, companies are running rig lines that can be numbered in the dozens, production wells can number in the thousands. Unlike conventional operations, the unconventional space more resembles a factory-like operation than a traditional oil play. Opportunities exist for improving operating efficiencies through programs such as LEAN and Six Sigma. In addition, the existing conventional software and processes require re-thinking. The old way of doing things just won’t work at this pace of business.

This speed of business means that Land is the driver of the business, not geology or reservoir engineering. Early entry into capturing the necessary acreage can mean the difference between paying $500/acre versus $25,000/acre. Multiply that by hundreds of thousands of acres and the importance of being one of the first companies into a new play becomes apparent.

This fast pace generally means safety related problems as well, both for employees and contractors alike. Over the last several decades oil companies have made significant investments to decrease safety related issues. The entry into shale has meant that many companies had to re-think their current safety policies, procedures and systems. Monitoring the operations, and the personnel involved in the operations, becomes critical in ensuring that everyone goes home every night.

Finding the Sweet Spot

As was previously mentioned, finding the hydrocarbons isn’t the problem in the shale plays as these are formations that cover tens of thousands of square miles. Rather, finding the optimal locations within the shale, or the sweet spots, is the challenge. While understanding the mineralogy is an important
component of subsurface work, whether it’s conventional or unconventional, it’s critical in the shale in order to optimize production volumes. In order to develop the clay model for the shale, specialty wireline logs, such as spectral gamma ray curves are needed. These are not normally present in a regular log suite, so the collection of this data needs to be carefully planned. A spatial analysis of the distribution of the specialty curves and core data is needed to ensure that all of the shale will be represented in the model, but only the number of curves necessary to building that model will be collected.

Understanding the thermal maturity of the shale can also make or break the commerciality of the play. Access to good geochemical data will help differentiate between the prospects for a wet gas and a dry gas. With the current low price for natural gas, identifying the wet gas may be the difference between a successful and unsuccessful operation. In some parts of the Marcellus, for example, a wet gas will bring prices as much as seventy-five percent more than a dry gas.

The integrated use of seismic, core analysis, dipole sonic logs and microseismic helps one to understand the regional fracture trends in the shale. Drilling along the azimuth of these regional trends has shown to improve production significantly over drilling in directions that are not coincident with these regional trends.

All of this data, be it logs, cores, seismic, geochemical, real-time WITSML and similar data objects need to be readily available in a useable format and in a place where it can be regularly updated and modified with new information. Finding the sweet spot in the shale is the equivalent of finding that precious conventional location that has all three factors: charge, reservoir and seal.

Integration

The speed of the business in the shale mandates the integration of all aspects of the data. In most companies, this usually means merging data from the
production and accounting worlds. For the unconventional play, this level of integration falls woefully short. Because of the model-based nature of successful unconventional developments, the integration of data must transcend the entire value chain.

With the number of wells, drilled footage, and production all on the rise, a fully integrated information solution is required to sustain operations.

This includes:

- Access to timely and accurate land holding and expirations
- Supply chain issues for rigs, pipe, tubing, water, and other materials
- Product and by-product distribution issues
- Access to real-time drilling and completions data
- Rig Scheduling – requires re-thinking – first come / first serve
This means that the Accounting, Supply Chain, Drilling, Land, Subsurface and Production systems all need to be fully integrated. Most current systems are not integrated: drilling schedules are passed around in an Excel spreadsheet, the Supply Chain system is standalone and doesn’t talk to anything other than the accounting system, work is done on property whose leases have already expired, or wells are drilled just to hold acreage. All of this can lead to suboptimal operations. With some companies drilling over 1000 wells a year in shale plays, success hinges on efficient operations and cost control. In such an operation, the difference between $10,500,000 per well and $11,000,000 per well over an entire year’s operations is half a billion dollars!

This higher level of integration of systems and processes is the new assembly line. The same LEAN and Six Sigma processes used so successfully in the manufacturing sector have a real, and needed, use in the operation of unconventional fields. All of this is due to:

- Expanded Data Coverage
  - New data sources, e.g. Land, Production
- Challenging Integration
  - Faster, higher data volumes and real-time
- Just In-Time Management
  - Big Data, Predictive – similar to the manufacturing process

But taking these factors into account by themselves is not sufficient. There needs to be feedback loops for continuous improvement. With each frack job, every well failure, all of the analysis needs to force the processes to evolve into something more efficient, more effective, or hopefully, both.
In order to have the level of integration that’s necessary for success, a solid, yet flexible, data governance program must be in place. Governance is a term that borders on overuse, however data governance is lacking in many companies. Implementing data governance does not mean creating a data-focused bureaucracy, rather translating business needs into adhered-to data management processes.

- Governance means defining roles and responsibilities for collecting and managing data.
- Governance means applying data standards that transcend the individual disciplines.
- Governance is important understand what data will be needed to make critical business decisions.

This information can then be used to architect the fully integrated systems needed to optimize the operations.
Advanced Analytics

Once the data is managed and integrated, the business can take the efficiency of the operations to the next level through the use of analytics.

- Analysis of drill bits, motor reliability and mud composition, reducing trips and thereby reducing costs.
- Analysis of multi-stage frack jobs to determine what works best for that particular area and what does not.
- Geosteering (staying in the formation while drilling improves results)
- Anti-Collision work requires accurate positional information for the well being drilled in addition to the existing boreholes.
- Advanced analytics to analyze and optimize the *entire* well lifecycle.

This analysis needs to be done across the entire value chain, and not just through traditional methods. The sheer volume of data requires systems capable of performing these multivariate analyses in a timely manner. There are many more data points, and the existing systems do not easily scale. New technologies need to be tested and utilized.

This analytics should not be restricted to the traditional tabular methods. Water and traffic management is a major issue in a shale play. The transport of water and other needed resources to the well site, as well as the movement of the product and by-products of the production operations from the well site, present major logistic challenges. Studies show that a spatial analysis of traffic patterns, and the implementation of the results of those analyses, can increase efficiencies by 10 to 30 percent!
Combining the subsurface knowledge with an analysis of the land holdings will minimize the need to drill wells in sub-optimal locations just to hold the acreage. Stop light maps make excellent analytical tools for areas covering large expanses.

Many of the unconventional plays are in old mature areas. Wells in plays such as the Utica and the Marcellus Shales predate the invention of the well log. An important factor in performing analytics on the data is having access to, and an understanding of, the terminology on old data will add a wealth of knowledge about unconventional plays in old field areas.
Summary

Unconventional resources are playing an ever increasing part in the global energy picture. Success in the unconventional space depends upon efficient, integrated operations, all of which are dependent upon readily available integrated data and information:

- **Governance**: Having the business needs translated into adhered-to data management processes by defining the roles and responsibilities for collecting and managing the data as well as the standards which will be applied to the data.

- **Integration**: The Unconventional play is no longer a play based on the sum of the parts. It’s a way of doing business that’s fully integrated, an integration whose success is totally dependent upon the ability to correlate the data across all of the functions.

- **Advanced Analytics**: The Shale play is producing data at large qualities. In many cases these data streams require us to re-think our past analytical strategies. Reports and queries will not serve these plays well, given the amount of rigs involved. Managing by exception, similar to the automotive or airline industry, will become the rule, not the exception.

- **Perspective**: In order for the Shale plays to be as successful as possible, information must be viewed not as point-source data, but rather, as pieces in a much larger puzzle. A puzzle which makes much more sense when viewed collectively instead of individually.
About the Presenter & Co-author:

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Fred is a Senior Principal and Upstream Subject Matter Expert with Noah Consulting. Prior to joining Noah in the summer of 2012, Fred retired from Hess Corporation where he worked for nearly 23 years with postings in Tulsa, London and Houston, his most recent position being that of Senior Manager for Global Data Management. He’s been a PPDM Board member for five years and is currently serving as the Chairman of the Board of the Association. Fred has a B.S. in Geology from Notre Dame and an M.S. in Geology from Old Dominion. Previous positions included time with Phillips Petroleum as well as the Defense Mapping Agency (a predecessor to the Geospatial Intelligence Agency). In 2011, Fred was a recipient of the Upstream Data Management Cornerstone Award at the 15th International Conference on Petroleum Data Integration, Data and Information Management, and has presented papers at the PPDM and PNEC Conferences as well as the Keynote at the 2011 TGS GeoForum in Houston.

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