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# Best Practices & Tools in Reservoir & Production Analysis

A Market Study

*Voice-of-the-Customer<sup>™</sup>*

Study Sponsored By:

Optimization Petroleum Technologies



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## Study Background and Participants

During the first half of 2010, interviews were conducted with U.S. executives and engineers in operating companies, engineering and consulting firms, and academia to identify current practices and tools used in reservoir and production analysis. The study was sponsored by Optimization Petroleum Technologies, a Beijing-based petroleum engineering software firm that recently entered the U.S. market. Advertas, a Houston marketing and public relations for the energy industry, organized and conducted interviews with the following 11 types of participants, to include:

- Six independent Oil & Gas operating companies
- One international engineering consulting firm
- One independent engineering consultant
- Two oilfield services firms
- One academician

Due to the complexity of the topics, a standardized interview guide consisting of 10 questions was used to capture as much detail as possible, and permit a more in-depth exploration of a salient subject. All participant identification remains confidential, and a summary of the information is listed under each question.

*The Purpose: To identify current practices and tools used in reservoir and production analysis.*

## Question 1: Please describe your current and any past experience relative to reservoir analysis and/or production analysis.

- All participants had extensive experience in reservoir and/or production analysis
- Seven participants had extensive experience in their career but were now in management roles managing a team or region
- One participant was a staff engineer at a major oilfield services company whose responsibilities included reservoir analysis
- One participant was a reservoir engineer at a large independent
- Two participants currently taught university courses on reservoir and/or production analysis and were also working in the industry
- At least two participants had published technical papers on the subjects

## Question 2: Elaborate on the types of production (oil, gas) and the area in which your company is developing (offshore, onshore, shale)

- Size- The six independent operators range in size from startups to having assets in excess of a billion dollars.
- Production Type - Operators were primarily gas and NGL's with some oil production.
- Geography -
  - Onshore - in Texas, Oklahoma, and Marcellus Shale in the Appalachian regions
  - Offshore Gulf of Mexico shelf

### Question 3: What Processes are Employed for Reservoir and Production Analysis?

- Integrated (asset) teams - Generally, participants shared that an integrated team approach was best, where geoscientist, reservoir engineers, and production engineers can collaborate. For larger companies where various disciplines exist, teams are typically organized around the asset, i.e. "an asset-team"
- Evaluation processes - For onshore, evaluation processes varied depending on the type of analysis: from prospective undiscovered resources to water flooding for existing wells. Independent operators reported starting their evaluations with volumetric and material balance methods to estimate reserve potential. Other evaluation methods include decline curve (rate/time) analysis, incorporating simple tank models connected to a system model. Typically, the smaller independents rarely used reservoir simulation with the exception of water flood development work. If simulation work was performed, it was outsourced to consultants because they did not have geophysical experts in-house.
- Deepwater evaluation analysis - Deepwater reservoirs impose additional constraints. A representative production model would also include subsea connections and offshore surface facilities. The next step would be constructing a flow model that accounts for conditions imposed by the extreme environment - high pressures, high temperatures, gas hydrates and the potential build-up of wax. Petrel and Eclipse were used for dynamic modeling.
- Consulting-lead study processes – One international consulting firm evaluates data quality before the property can be evaluated. Based on results, they set out a planned work flow with milestones and obtained the data from the client. Typically the lead geologist will work with the client to get the geology done first, and then engineering analysis is conducted. They often use Petrel to build the geologic model but also have an in-house database to store all project data. After the model is built, volumetric calculations are sent to the engineer for production performance of individual wells. To finish the study, the firm then analyzes cash-flow. Software programs for this are Aries, PHDWin, Merak, OFM, and Energy Navigator. Analysis and findings may be reported with a wide range of detail, from an executive summary to descriptive tables, projections and isopach-structure maps. One independent consultant reported using well log data and production history from public and other commercial providers. When doing petrophysics, this consultant looks for zones from old wells that have been underplayed. Fluid dynamics are also carefully evaluated.
- Software used – The above mentioned independent consultant uses ProdEval by Texas Computer Works because it is easy to use and fast. He has also created some of his own software because "all the applications integrate," something which he has not been able to find in commercially available software. According to this consultant it would be "wonderful" if the applications would integrate wellbore simulation, reservoir analysis and production analysis.

*A representative production model would also include subsea connections and offshore surface facilities.*

An operator developing the Marcellus Shale incorporates production data and downhole pressure history with analytical and nodal analysis models. They also do some PVT work. Cores and logs are also carefully analyzed. In smaller independents, the study found that spreadsheets remained the tool of choice for decline curve analysis. In general, survey participants indicated the following gaps in current commercial software:

- No comprehensive, affordable, integrated suite of software spanning all phases of reservoir and production analysis
- Better models and procedures are needed for high pressure and high temperature conditions
- Poor to non-existent data on rock properties

#### **Question 4: How is data shared among groups doing reservoir simulation and production analysis?**

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- Data sharing practices varied widely, from PDF reports to accessing a common database in Oracle.
- Spreadsheets were frequently cited for manually moving data between applications.
- Applications enable collaboration – One independent operator uses TOW, a Landmark product for production accounting that allows team members to download portions of the database on an individual PC. This way, field supervisors can work on different parts of the database at a time, enabling better coordination and collaboration among the team. Another operator places files in a Microsoft SharePoint server to make information available to internal team members and external consultants.

- Regarding work processes, a Chief Technology Officer at a medium-sized independent shared that when exploitation of mature fields occurs, they make sure the team is “over communicating”. When new data is obtained, this information must be disseminated throughout the company. Every morning at 9am, they have a Production Teleconference; the technology and production teams meet to discuss the past day’s production. Given the variety of methods employed to move data between software applications, it is clear that incompatibility among the disparate application introduces potential errors as data is moved, as well as, requiring added time from highly skilled people. One clear conclusion from all the interviews is that teams need to be able to work on different parts of the asset in a way that impacts the entire asset. Example: A subsurface map that is updated can be immediately used by the whole asset team. Ideally, asset teams have a shared database that allows collaboration, including the sharing of images and calculations.

*It is clear that incompatibility among the disparate applications introduces the potential for errors as data is moved, as well as requiring added time from highly skilled people.*

#### **Question 5: How do you design wellbores and well trajectories, and how are the wellbores managed against production?**

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- Design tasks are outsourced to consulting drilling engineers - Some of the smaller independents reported using consultants for wellbore design and the choice of software tools was

left to the engineering or drilling companies involved. Use of Landmark's PLAN software tool was cited by one of the independents. One of the large oilfield services companies interviewed reported working on a comprehensive program to model the wellbore and improve the drilling process.

- Design tasks performed by drilling contractor - For the large independent developing onshore, the drilling engineer works with the drilling contractor to design the well path. At least one third of the drilling by this operator is horizontal in shale plays & tight sands; little work is done in designing well trajectories. The company typically images the data through geologic software, including Geographix and SMT.
- No software is used - The Marcellus Shale operator is doing pad drilling, designs are based on the limitations of the drilling equipment and downhole equipment. They use horizontal drilling, principally in a single direction and do not use software for wellbore design; this operator relies on Measurement-while-Drilling (MWD) services to assure targeted well location.
- Participants also reported using logs to indicate higher permeability areas and understanding the geology to mitigate exploration risk.

*Being able to use production data with reservoir parameters would be very helpful in gauging the results of fracturing.*

## Question 6: Can you suggest some opportunities to improve reservoir simulation and characterization?

- Provide software that's easy to use - An individual consultant reported he would like to see software that does not "require a Ph.D. to use" and went on to explain that the training required by most software tools today is too long. Systems also need to be able to run models quickly, evaluate the results, adjust the model, and re-run frequently.
- Managing large datasets - An executive with the international consulting firm reported having to break up major fields into separate grids (cells) to accommodate the constraints of their modeling tools. It would be useful for reservoir simulators to accommodate large development projects to increase the scope of the analysis, while reducing the time required for the iteration of the model. This would allow more scenarios to be considered and determine the optimum way to produce the field.
- Manage multi-phase flow requirements - An independent producer shared that it would be useful if simulations could be done multiphase, handling gas and liquids rapidly. One of the major simulators he is using can accommodate multiphase, but he reported it to be slow.
- Simpler Tools - The president of a new independent, who was widely published on the subject of reservoir simulation, cautions that reservoir analysis is a technically challenging problem, and if not done correctly, answers from any simulation tool will not be useful. He also expressed that simulation is as much of an art as it is science, and most business managers do not appreciate the level of difficulty involved. The manager of an asset team must

have confidence in the reservoir engineer's skill, which is why so many independents default to simpler methods, such as the decline curve analysis.

- Expand hydraulic fracturing models - The Chief Technology Officer of another independent says that many of the plays domestically are going to unconventional resource plays utilizing hydraulic fracturing. Being able to use production data with reservoir parameters would be very helpful in gauging the results of fracturing. An engineer with a major oilfield services firm suggested better reservoir simulation of unconventional resource plays. He also expressed the need for more user-friendly tools that could yield answers in days, not weeks.
- Improve simulator data loading. A senior reservoir engineer with a large independent stated that data input for the present simulators remains cumbersome. He said: "simulators are complex tools that require a lot of input and, in spite of efforts by all the suppliers to put nice front-ends on these tools, there is still room for improvement." For the most part, he believes that the actual simulation is very good across the industry, but post processing is somewhat "spotty". He would like to see more universal standards for post-processing, so that the output from different packages could be effectively compared. Integration of seismic with production in 4D is also important as it conveys where fluids have moved over time. "There is a lot of dynamics in reservoirs that are not understood, and 4D has the potential to reveal more insights into those dynamics."

*Opportunities exist to integrate flow assurance into production models based on the type of production and associated chemistries employed*

## Question 7: What do you think are some of the opportunities to improve production analysis?

- Utilize Real-time Surveillance - Several independents have systems in place or projects underway where SCADA systems measure and report production at the wellhead. The Chief Technology Officer of one mid-sized independent shared that his company has an active project to implement SCADA systems for their wells in the Gulf of Mexico. In a case where fluids are entering the well, that production data can be used to improve production performance and remotely diagnose problems.
- Utilize Real-time downhole data analysis - A large independent operating in the Marcellus Shale updates production models daily. They are also seeking to capture downhole information to calibrate the production models. To enable this, the vice president of an international consulting firm reported that "in the last few years there have been significant strides in the software". For work domestically, the two primary programs this company uses for production analysis are Aries by Landmark and PHDWin by TRC Consultants. He goes on to say that "Landmark uses an open database system, which makes it easier to import and export. The PHDWin international module is powerful, but requires specialized training to use".
- Integrate flow assurance in operations - According to an operator in the Marcellus Shale, where hydraulic fracturing methods are used, opportunities exist to integrate flow assurance into production models based on the type of production and associated chemistries employed. The models can indicate concentration materials (scale) on the inside of gas pipelines. Another operator interviewed uses a

system called Well Analyzer, by Echometer, that measures well productivity, reservoir pressure, overall efficiency, equipment loading and well performance. The system is based on a combination of measurements, including surface pressure, acoustic liquid level, dynamometer, power and pressure transient response.

- Production analysis software is easier to use and avoids having to import and export data among applications
- Creating type curves that define an expected profile based on other wells in the field
- Performing curve fit analysis and comparing production histories among wells in a field
- Accessing production histories more seamlessly from state records

**Questions 8 and 9: What software tools are used for reservoir simulation and characterization? (#8) What software tools are used for Production Analysis? (#9)**

Table 1 lists the software and providers participants were currently using. While the list is not exhaustive, it illustrates the diversity of tools available. Several participants stated that the variety of software tools was due to (1) the complexity of problems in the industry; and (2) commercially, some of the packages were quite expensive. Essentially, the industry historically bought point solutions for best-in-class products and price reasons.

Software Applications Referenced by Study Participants

Product	Company	Description
Petrel	Schlumberger	Seismic interpretation
Eclipse	Schlumberger	Reservoir simulation
Carte	Merrick Systems	Production trends
Aries/RMS	Halliburton	Reserve economic analysis
ProdEval	Texas Computer Works	Daily field production
PHDWin	TRC Consultants	Economic and decline curve analysis
Plan	Landmark	Designing well paths
TWO/cs	Landmark	Production accounting & allocation
Kingdom	Seismic Micro Technology	Reservoir volumetrics, decline curve and economics
GeoGraphix	Halliburton	Geoscience, engineering and economics
Merlin	Gemini Solutions	Black oil reserve simulator
GEM	Computer Modeling Group	Reservoir simulation
Well Analyzer	Echometer	Production optimization
OGRE	GRE Systems	Economic analysis
Exodus	PetroStudies Consultants	Reservoir simulation
IPM Suite	Petroleum Experts	Integrated production modeling
OpenWorks	Halliburton	Geosciences project database
WinProp	Jehar & Associates	Fluid properties and flow analysis
IRAP RMS	Roxar Software Solutions	3D reservoir geological modelling and integrated simulation
Power Tools	PI Dwigths/ IHS Energy	Economic and reservoir analysis
F.A.S.T RTA	Fekete	Production decline analysis
valuenavigator	Energy Navigator	Capital and reserve asset management
Perform	IHS Energy	Well performance analysis

## Question 10: If the tools and processes are not currently integrated between reservoir and production analysis, what value would an integrated set of tools provide to you?

- Virtually all respondents agreed that there is tremendous value in integrating these two functional domains, especially if financial analysis were included.
- The one academician interviewed offered that “model(s) that integrate with the value chain of the company is the ultimate goal. Such a tool set would assist in determining the changes necessary to improve the value of the field.”
- A manager at a large independent offered that integration would be “very valuable. To assign reserves you need to know how well the well is operating.” This operating company is looking for ways to maximize production and integrate tools that would support that aim, since “the interaction between the reservoir and production group is critical.” The consistency in the data set would ensure that the reservoir and production teams are referencing a consistent set of data about the field.
- A senior manager at another independent offered that “all simulators have history-matching capabilities, but being able to iterate between the simulator and production would be extraordinarily beneficial, especially with fields of 20+ wells.” Also, moving data among applications is cumbersome and can be error-prone. With the data that is integrated between reservoir and production, the staff can focus on analyzing versus moving the data.
- Integration would also afford the opportunity to understand where fluids are moving, where bypass potential exists, and as fluids are being produced, operators could understand how efficiently reserves were recovered. For example, an increase in gases in a well would feed into the reservoir simulator as an input. This could identify the model of the reservoir or the source of the gas. A similar opportunity exists with monitoring water influx, revealing the need to identify the point of the oil/water contact.
- Participants generally acknowledged that an integrated suite would be very valuable from many respects, but would need to scale from a few wells to hundreds of wells, and support third parties working remotely, as well as team members who are geographically scattered.

*Participants generally acknowledge that an integrated suite would be very valuable from many respects...*

**About the study sponsor:  
Optimization Petroleum Technologies  
and PEOffice®**

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Optimization Petroleum Technologies, Inc (OPT) supplies oil and gas reservoir management and production analysis software and technological solutions. OPT sponsored the above study to better understand the needs of the industry, particularly independents seeking an affordable, yet robust, integrated software solution for reservoir and production analysis. The company entered the U.S. market early 2009 with a pilot program based on the PEOffice suite, a complete, integrated petroleum engineering software tool-set. PEOffice provides visualization, evaluation and management of reservoir and production, supporting planning, design and operations. Producers utilize the engineering capabilities of PEOffice for property evaluation, wellbore and facility design, reservoir simulation, well and surface equipment failure diagnosis and production planning. The pilot evaluation program has been very successful, enabling independent producers and consultants to test the PEOffice suite against the tools or spreadsheets currently in use. For more information on OPT or the PEOffice pilot program, see [www.OPTPT.com](http://www.OPTPT.com).



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