5 Benefits Operators Expect from Their Reservoir Models

Creating the perfect reservoir model and how can it improve your decision-making

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ABSTRACT

This paper illustrates how, through a model driven interpretation workflow, operators can squeeze maximum value from their reservoir models and realize: 1) a more complete representation of the data; 2) early estimates of reservoir volumes; 3) risk estimates for drilling decisions; 4) enhanced productivity; and 5) improved decision-making across the reservoir management lifecycle.

Introduction: Making Reservoir Modeling Work for You

Reservoir modeling is the best platform for examining and understanding subsurface geology and generating vital information on the commercial production of hydrocarbons whether it´s applied offshore/onshore or on conventional/unconventional fields.

Despite the fact that a model driven interpretation workflow is frequently the key difference between success and failure for complex projects (see inset), many companies still don´t model their reservoirs. Reasons include cost, lack of confidence in the technology, limited understanding of the value, or even lack of expertise.

With global oil and gas recovery rates averaging only about 35% (Rigzone, August 2012), reservoir modeling and its ability to optimize recovery is the critical defining workflow within the E&P industry today. It provides the tools and skills that operators need right now to increase the production and profitability of their reservoirs.

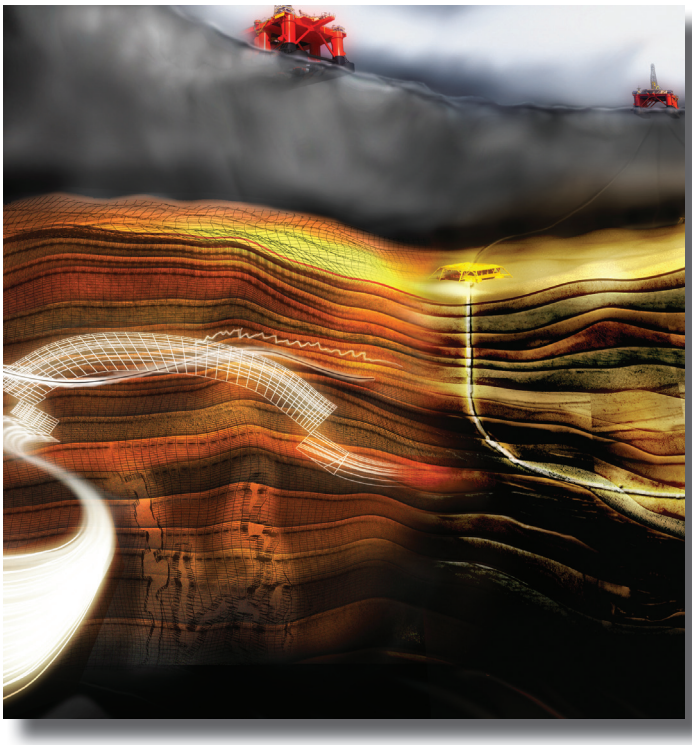
With the right reservoir model, operators can achieve:

- The best possible representation of all available data;
- Estimates of reservoir volumes and recovery;
- Risk estimates for drilling decisions;
- Enhanced productivity via a platform for cross-domain collaboration; and
- Improved decision making over the whole lifecycle of the reservoir.

In this paper, we present the current status of reservoir modeling including workflows and technology bottlenecks. Then, we describe innovative new workflows that:

- Bring uncertainty management and quantification of geologic risk to the interpretation phase;
- Provide responsive and risked reservoir modeling;
- Enhance productivity throughout the prospect lifecycle; and
- Provide a forum for cross-diciplinary discussions on reservoir management.

These workflows will play a key role in helping clients achieve the 60-70% recovery factors they demand in the next decade.



The reservoir model focuses decision making - and enables operators to increase recovery factors.

Reservoir Modeling Today

With predictions that an increase of just 1% in global oil & gas recovery rates would replace three years of global energy consumption (Oil & Gas Journal, 2008), the potential financial benefits of reservoir modeling and its ability to improve reservoir management decision-making are huge. Yet, the question remains:

About the Authors: Tyson Bridger is Software Product Manager, Garrett Leahy Technical Product Manager and Tone Kråkenes Chief Geoscientist at RSS. Together, they represent decades of experience in the industry and are continuing to push the boundaries of reservoir modeling.

About Roxar Software Solutions: Roxar Software Solutions (RSS) is a global leader in 3D reservoir geological modeling, reservoir simulation and history matching. Its software enables operators to better understand their reservoirs and the underlying seismic data, realize the full potential of their assets, and increase oil & gas recovery rates.

What do operators expect out of their reservoir models, and what makes a successful model?

With our broad perspective on the needs of our industry clients, we identify three key elements. **An effective reservoir model:**

1. **Represents the data** – the model should be a realistic depiction of the geometry and properties that impact fluid flow and volumes as determined from all available data, be it seismic images, property logs, regional geology, or even production data. This means an accurate representation of the structural framework – the faults and geologic horizons in the reservoir – and an accurate tracking of heterogeneities, lithologies and how the different flow properties are distributed in the reservoir.
2. **Answers the right questions** – the reservoir model is a tool for decision-making support. The operator should be able to use the model to make predictions and hypotheses that are tested via a drilling campaign. This requires tight integration of data and the ability for interpreters, modelers, reservoir engineers, and drillers to work together towards common objectives.
3. **Describes key risks** – the model is the place to capture and use the uncertainties and risks that affect reservoir management decisions. Experience shows that an increased awareness of risks, particularly early in the interpretation and model building phases, leads operators to improved results throughout the reservoir lifecycle.

Rising to the Challenge

So, given the huge potential benefits of reservoir modeling, are today's solutions rising to the challenge?

The answer is mixed. While reservoir modeling has improved hugely over the last few years, limitations do still exist. For one, as the industry moves into more and more complex tectonics, reservoir modeling packages will continue to evolve to capture these geometries.

We identify **four major challenges** that modeling tools will need to overcome to provide the best value to operators:
A fit-for-purpose reservoir model represents the data, describes key risks, and provides operators with the answers they need to manage a field.

"Model Driven Interpretation allows geocientists to unlock the value of the geologic model in ways never possible before"

1. **Over-dependence on single models** – conventional industry workflows in geosciences still remain geared towards producing a single model or scenario, even though it is widely accepted that multiple scenarios fit the data. The result is that many alternative hypotheses are discarded and not carried through to decision-making.
2. **Disjointed and time-consuming workflows** – at many companies, workflows are segmented and 'siloed'. Geophysicists interpret thousands of points at seismic scale, and geomodelers do the best they can to fit the model to the interpretation. Iteration and quality control is time consuming and resource intensive. Too often data is ignored, or, in the case of poor seismic data, interpretations may be estimated and the data quality forgotten.
3. **Inherent ambiguity of the data** – physical limitations in seismic acquisition technology result in only a portion of the earth response being captured in a seismic image. These band-limitations result in uncertain estimates of horizon or fault locations. Many configurations or scenarios are therefore possible, but cannot be distinguished by the data alone.
4. **Uncertainties in static reservoir properties** – the static reservoir properties (for example, the structure or interpretation, depth conversion, fault model, or facies distributions) are the largest contributors to the commerciality of a prospect. These factors must be integrated to obtain risked estimates for decision support and, yes, it is currently difficult to quantify these uncertainties.

In summary – reservoir modeling today must up its game to meet the challenges of the future: multiple models, responsive workflows, capturing the limitations of the data, and quantifying geologic risk early will play important roles to increase reservoir recovery factors and commercial success.

A New Approach - A New Workflow

Against this backdrop, Roxar and its flagship reservoir modeling package RMS introduce a new milestone in reservoir modeling for 2013: **Model Driven Interpretation**. This innovative solution unites the geophysicist and geologist on a common platform, allowing geoscientists to unlock the value of the geologic model in ways never possible before.

A fit-for-purpose reservoir model represents the data, describes key risks, and provides operators with the answers they need to manage a field.

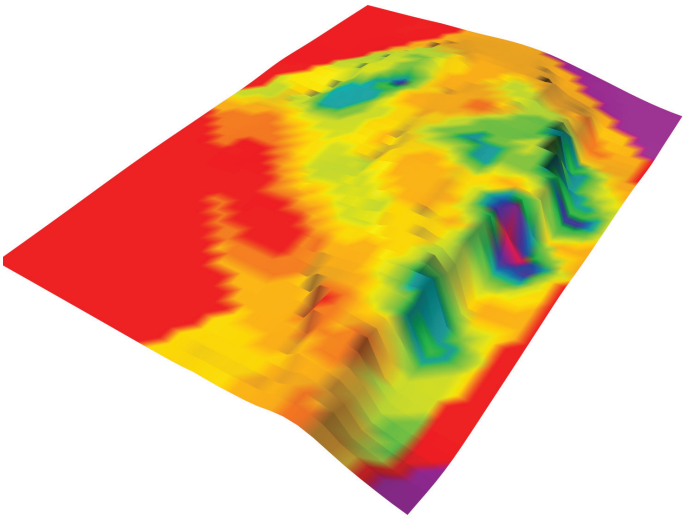
Capture uncertainty during interpretation – Rather than creating one model with thousands of individual measurements, modelers create thousands of models by estimating uncertainty in their measurements. RMS 2013 can then generate statistically significant ensembles of models based on these probability distributions.

This provides immediate value to geoscientists. For example, uncertainty maps can be used to investigate key risks in the prospect, or areas can be quickly identified for more study. The possibilities are wide and varied, but the fact remains that by capturing uncertainty at the beginning of the geoscience workflow, operators gain the best possible picture of their subsurface risks.

The model is the interpretation – Instead of a serial workflow for interpretation and geomodeling, model-driven interpretation allows geoscientists to guide and update a 3D, geolocially consistent structural model directly from the data. This allows clients to focus their efforts directly where the model needs detail – those challenging, complex geometries so common in reservoirs today.

Furthermore, model driven interpretation provides a forum for cross-disciplinary interactions: geophysicists, with a strong understanding of the complexities of seismic data can work together with geologists, with their understanding of the lithologies and facies while the critical static reservoir properties are described.

Unlocking the full range of models – RMS also brings exciting new tools to market for analyzing the full range of structural uncertainties. Geoscientists can create suites of model realizations that satisfy many external constraints (see inset), from well picks and zone logs to velocity uncertainty and horizon or fault positional uncertainty. These model realizations allow operators to sample and quantify uncertainty in their subsurface parameters further down the value chain.



Understanding risk, via for example uncertainty surface maps, helps operators make the complex decisions required to optimize production.

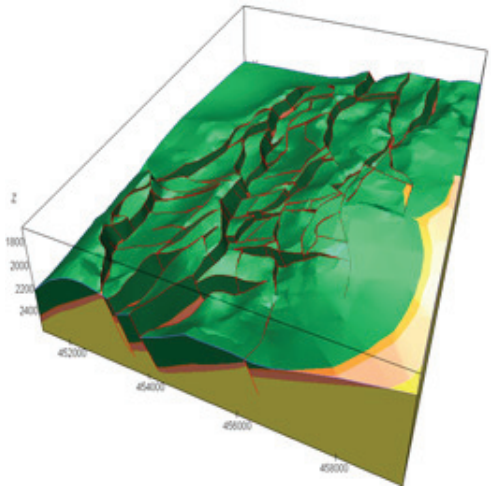
Where do these tools lead?

These tools lead directly to commercial decision-making support.

For example, histograms and distributions of static reservoir volumes can be quickly constructed and analyzed (see inset), resulting in probability estimates that can be directly used in financial modeling.

Or, estimates of potential drilling challenges can be used to guide well planning.

Or, key risk factors can be identified, and hypotheses constructed to be tested by the next drilling campaign.
The whole process takes place within a highly intuitive, agile, and responsive modeling environment, empowering the modeler to rapidly map the key features of the reservoir and react immediately to new data without compartmentalized workflows or bottlenecks.



Complex structures require state-of-the-art software to represent the data.

Reservoir Modeling Delivers!

To conclude, let's revisit the five key elements operators expect from their reservoir models today – and whether they are being delivered. The answer is a resounding **Yes.**

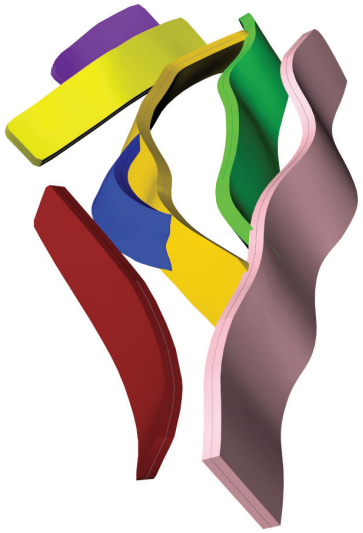
Can your reservoir modeling workflow generate a more complete representation of the data – no matter what the data quality?
Yes. By capturing uncertainty and building models directly from the data, model driven interpretation generates a more complete representation of the data in less time. Model driven interpretation does not allow poor data quality to be swept under the rug, or cause unnecessary delays – the uncertainty stays with the interpretation throughout the modeling workflow.

"Reservoir modeling today must up its game to meet the challenges of the future"

Can your reservoir modeling workflow generate early estimates of reservoir volumes? **Yes.** By increasing productivity and streamlining workflows, model driven interpretation empowers geoscientists to quickly build risked models of static reservoir volumes, providing the best possible estimates to support commercial decisions.

Can your reservoir modeling workflow generate risk estimates for drilling decisions? **Yes**. By combining interpretation uncertainty with state-of-the-art structural uncertainty modules, clients can make risked predictions of horizon or fault positions. When combined with logging-while-drilling data and precision steering, real-time risked hazard avoidance becomes a reality.

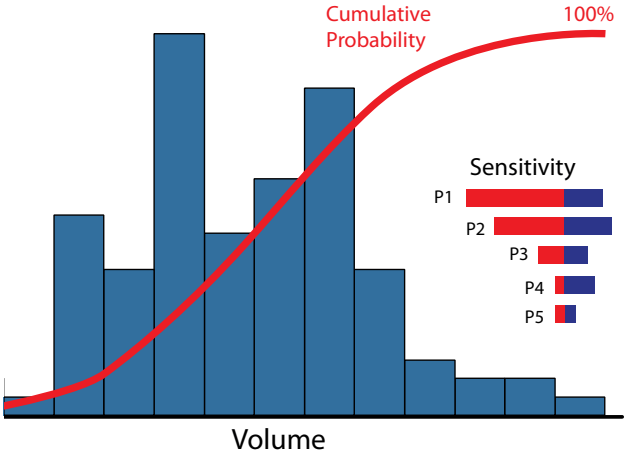
Can your reservoir modeling workflow maximize the value of your geoscience resources? **Yes.** Lean asset teams and short decision-making timescales can be overcome with the enhanced usability and fully integrated reservoir modeling solutions of RMS.



Quantifying uncertainty in fault interpretations allows multiple realizations of reservoir models, helping geoscientists understand the limitations of the data.

"The reservoir model is the key difference between success and failure for complex projects"

Can your reservoir modeling workflow improve your decision making? **Yes.** RMS places the model and risk analysis at the center of the decision-making process – whether it be bid valuations, new field development and operational plans, drilling programs, or production estimates or divestments. The right decisions get made for the right reasons.



Multiple realizations of possible structural models allows operators to statistically analyze outcomes via distributions and cumulative probability – and examine the sensitivity of the results to key parameters (P1-5).

As operators move into more complex tectonic settings and more commercially complex prospects, it's clear that the boundaries and power of reservoir modeling are evolving fast. Can you keep up?

To find out more about RMS 2013 and Model Driven Interpretation, contact Roxar Software Solutions today.

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