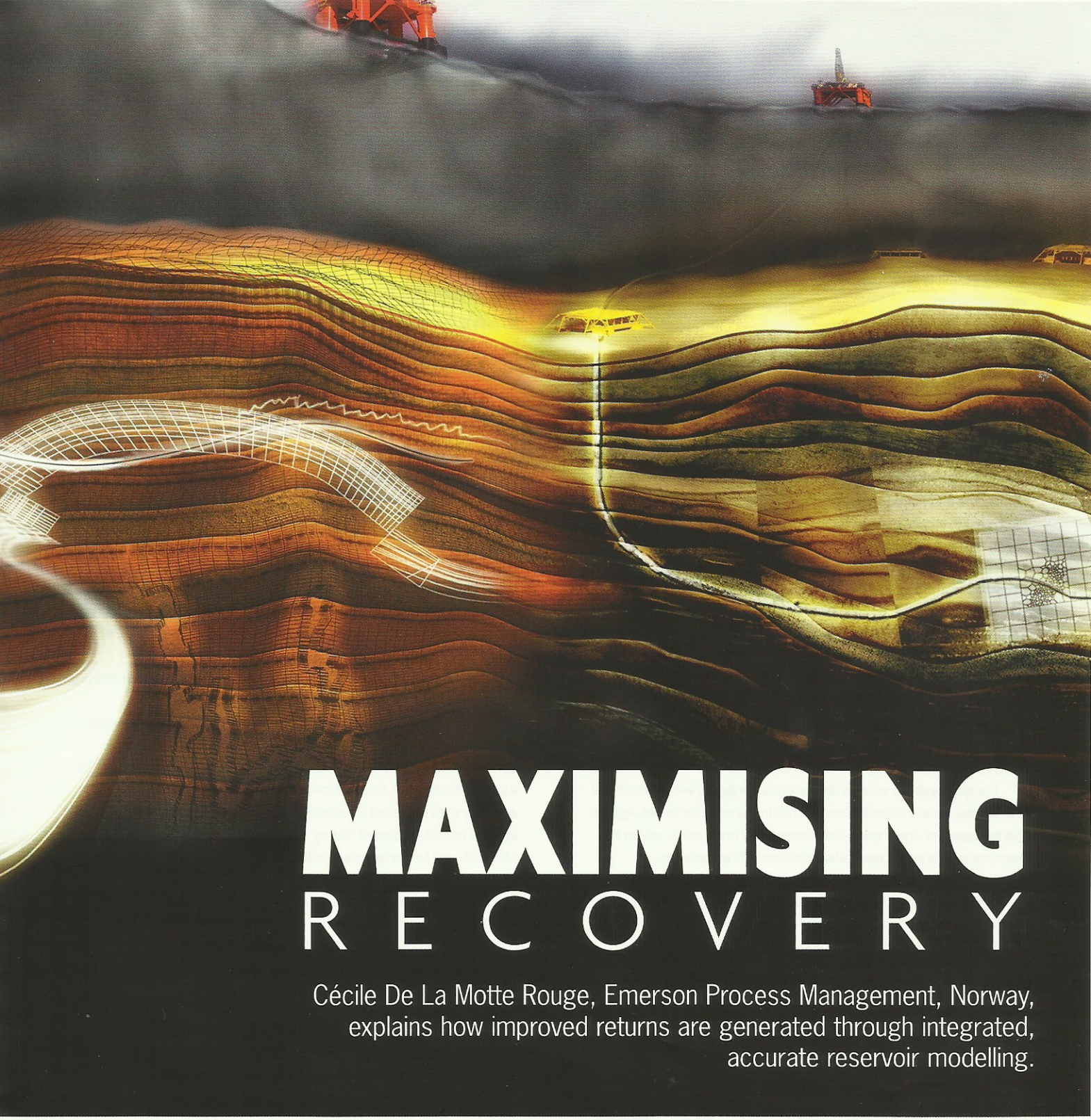

MAXIMISING RECOVERY

Cécile De La Motte Rouge, Emerson Process Management, Norway, explains how improved returns are generated through integrated, accurate reservoir modelling.

The decline in oil and gas prices and operators' growing needs to generate maximum returns from assets has ensured that reservoir modelling remains an important decision-making tool within the reservoir management workflow.

Most operators use 3D reservoir modelling to obtain information on where to drill, what production strategies to adopt and how to maximise oil and gas recovery from both existing and newer fields.

The smallest percentage recovery improvements within a field can have a significant impact on the bottom line (especially if the infrastructure is already in place). Therefore, an accurate and integrated reservoir modelling workflow can make all the difference between a field being commercially viable or not.

Yet in reality, using 3D reservoir models does not always guarantee the best results. This article will look at the key elements behind an accurate and integrated reservoir modelling workflow and why it is so crucial.

Managing uncertainty

The latest studies and developments show the importance of uncertainty quantification, particularly in regard to solid and accurate reservoir models. Being able to generate realistic structural scenarios gives operators the necessary confidence when it comes to reservoir economics and predictions of oil and gas volumes.

Uncertainty quantification is one of the key strategic developments behind Emerson's reservoir modelling software, Roxar RMS. The software

includes tightly integrated structural modelling tools that enable users to quantify uncertainty more effectively across the prospect lifecycle.

Uncertainty management decision-making is enhanced through a closer integration between structural modelling and 3D gridding tools as well as horizon uncertainty models tools that allow users to incorporate realistic uncertainties into the horizon model.

The latest release also includes a grid adjustment tool that supports the calculation of residuals between the grid and well picks. This enables the grid to be adjusted to exactly match the well picks and leads to greater flexibility in well data conditioning and improved well targeting and placement.

Model-driven interpretation

The new uncertainty quantification tools within the software also build upon Emerson's model-driven interpretation workflow that allows users to build models directly from the geophysical data.

Model-driven interpretation involves a geologically consistent structural model being created (and updated) every time the interpreter makes a measurement of a subsurface feature. Uncertainty information is collected and paired with an interpreted geologic feature (horizon, fault, etc.) to create an uncertainty envelope.

In this way, users can set and collect uncertainty information associated with an interpretation; easily and reversibly test geologic hypotheses; and add more detail to the model as and when required.

Quantifying GRV uncertainty in a Middle East field

In one offshore Middle East example, the operator used the model driven interpretation approach to quantify gross rock volume model-driven GRV uncertainty.

The reservoir in question was in the appraisal/early development stage. It had nine wells unevenly distributed across the field, not all of which had penetrated the bottom of the reservoir.

The quality of the seismic data was also only fair, with limited well and seismic data and limited confidence in the velocity model. Against this background, there was a need to quantify uncertainty within the reservoir model and in particular calculate GRV uncertainty.

Figure 1 illustrates the fault uncertainty envelopes generated through model-driven interpretation. The uncertainty along the faults can be provided during interpretation for each point or can be kept constant and defined manually on both the hanging wall and the footwall side during the structural modelling workflow.

The next stage of the workflow was the creation of a 3D grid, out of which multiple realisations were generated to quantify GRV ranges. This generated the P10, P50 and P90 GRV values as well as indicating which horizons, velocity models or fluid contacts are affecting the GRV calculation.

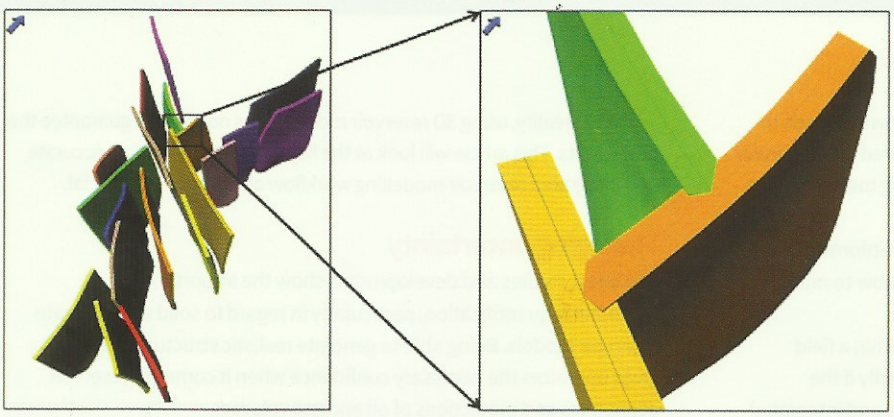

Figure 1. *Fault uncertainty envelopes generated through model-driven interpretation.*

The result for the Middle East operator was improved GRV uncertainty, valuable input into field appraisal and development plans, and reduced risk.

Evergreen model updates

Accurate reservoir models though are not enough. What if a very precise model cannot be updated? Or that it takes so much time to update the model that it ends up being rebuilt from the beginning? How can value be generated from rapid, incoming and fast changing data?

In such cases, rapid model updates, workflow automation and the efficient updating of the whole workflow from seismic to simulation, including the model's structure, are vital.

To this end, a multi-realisation 'evergreen ensemble'-based workflow was developed. In such a workflow, the modelling process is highly automated and flexible enough to incorporate new data, concepts or applications as soon as they become available and at any time.

Increased collaboration

Too often in the past, there have been limited incentives for asset managers working within individual domains in the reservoir modelling workflow to talk to each other – that is unless inconsistencies occur. Furthermore, by this stage, so much time will have been spent creating the model that major fixes and time will often be required to address such inconsistencies.

With an integrated framework, however, any discrepancies can be identified and fixed earlier in the process with all domains aware of the bigger picture and the modelling project's overall goals.

This integrated and collaborative approach represents the underlying principles behind the new evergreen ensemble-based workflow.

As part of the new approach, all asset members share a common workflow where each specialist can see the direct influence of their domain on the end result and can contribute in the same timeframe to a shared framework, from seismic to simulation. This leads to greater accuracy with the latest information from new wells always incorporated into the model, improved history matching (through Tempest ENABLE), and better targeted drilling campaigns – whether greenfields, brownfields or fields moving between the two phases.

What is done in one domain can also be automatically tested and there is a shared responsibility for the tasks, with asset members collaborating in choosing the correct parameters. This also allows for uncertainties to be added where they apply and further propagated throughout the workflow to where they matter.

The automated workflow subsequently generates an ensemble of multiple models that can be created rapidly, with all models then going forward to simulation without choices having to be made on the most appropriate model. The result is improved information for field development planning, well placement and as input to economic analysis.

Creating an open platform

An open and flexible platform for workflow integration, data sharing and model updating is another key element of successful reservoir management.

To this end, the company has developed an 'extensibility' solution based on the application programming interface (API), resulting in a software platform for building geoscience, reservoir engineering and oilfield technology applications.

The new platform provides extensibility to RMS and interoperability with other

software applications. This ensures the preservation of vital reservoir information across multiple-stage workflows.

It also improves data management and workflow integration, enabling operators to integrate their own IP and specific applications and ensure maximum flexibility.

Integrated production management

However, integration does not stop after reservoir modelling and simulation. Operators today are looking for an integrated workflow from seismic interpretation and reservoir modelling right through to reservoir simulation and production optimisation.

They are also looking to combine data from their predictive reservoir models with their production modelling and field instrumentation. Through this, they can monitor production continuously and use field information for operational decisions and for forecasting future reservoir performance.

It is with these issues in mind that in July 2015 Emerson acquired Norwegian company Yggdrasil, a provider of flow assurance and production optimisation software.

The incorporation of Yggdrasil's production management solutions within the Roxar Software Solutions portfolio helps operators get the most out of their reservoir. It is targeted at reservoir and production engineers, providing them with access to a wide variety of thermo-hydraulic calculations within one single application.

The new flow assurance and production modelling solution also enables operators to calculate single well or flowline performance of mono and multiphase flow systems; generate life of field simulations; simulate well and flow line behaviour; and put in place virtual metering for the allocation of production to wells.

The new software also integrates data from a variety of databases, connects to proxy reservoir models and reservoir simulator processes, and models flow behaviour from the reservoir to the surface. The hardware outputs generated, for example, can be easily linked with the Tempest MORE simulator.

The result is that operators are able to align their modelling, uncertainty quantification and simulation data with production via an integrated production modelling system.

They can also optimise their field development and production plans, and increase oil and gas recovery in challenging environments.

Other developments

Technology and innovation are essential to operators when it comes to getting the most out of their reservoirs and increasing profitability.

Emerson's future development strategy is embracing a host of innovations, strengthening Roxar software's interoperability, performance and usability. This will include advances to the Roxar Tempest reservoir engineering software, the testing of multiple realisations, and improved uncertainty quantification on volumes and cumulative production.

Helping operators unlock their assets

In today's cost conscious environment, operators are looking to recover more from their fields and in as effective a way as possible. Reservoir modelling is a key means towards achieving this.

Emerson and its latest integrated reservoir management software solutions are enabling operators to quantify uncertainty and ushering in a world of rapid model updating; generating integrated and open workflows from seismic interpretation right through to simulation and production; and instilling the latest in integrated production management advances.

The integration of reservoir modelling and its influence across the prospect lifecycle has never been more important – particularly in today's tough economic climate.