INTERNATIONAL EDITION

DRILLING & EXPLORATION WORLD

# DEW

THE COMPLETE ENERGY JOURNAL

Volume 19 Number 11

ISSN - 0971 - 7242

www.dewjournal.com

September 2010

In publication since 1989

Media Supporter

SPE REGIONAL HONOURS AND AWARDS CEREMONY Bahrain

Society of Petroleum Engineers

# DESIGNED FOR A NEW ERA

**Aker Solutions' new deepwater intervention vessel, Skandi Aker is the most advanced, multi-functionality and a first of its kind vessel designed to perform riser based well intervention services along with subsea construction and installation activities at water depths up to 3000 mts. Other existing well intervention vessels are limited to just 800 mts water depth.**

# Tracking the latest advances in Reservoir Simulation

**Tyson Bridger, Product Manager, Roxar, Emerson Process Management**

Reservoir simulation sits at the interface between the geological modeling of an oil or gas reservoir and the economic evaluation of possible production strategies. It is the forecasts generated from these models that play a crucial role for operators as they make economic decisions around reservoirs - whether it is bid valuations, new field development and operational plans, production estimates or divestments. The prizes for effective reservoir simulation are there for all to see - a world where multi-million dollar operational reservoir management decisions are made with an understanding of the full range of opportunities and risks. Reservoir simulation technologies today are making such prizes attainable.

## The Importance of Reservoir Simulation

At a time when operators are looking to optimize production from increasingly marginal assets and make effective decisions over the allocation of capital and resources, the models and analytical processes that define modern-day reservoir simulation have never been more important.

Reservoir simulation sits at the interface between the geological modeling of an oil or gas reservoir and the economic evaluation of possible production strategies. It is the forecasts generated from these models that play a crucial role for operators as they make economic decisions around reservoirs - whether it is bid valuations, new field development and operational plans, production estimates or divestments.

## Technology Advances in Reservoir Simulation

Yet are today's reservoir simulation technologies rising to the challenge? I believe that, to a large extent, the answer is 'Yes'.

Reservoir simulation technologies have come a long way over the last few years. Whereas simulation was previously considered to be a niche skill, dominated by small, highly-specialized teams of engineers, today it is a highly accessible element of the reservoir management workflow.

The rise in computer power and computer-led automation has been partly responsible for this, leading to reservoir simulation taking place on the desktop and greater accessibility and use of such technologies across the entire subsurface community.

With engineers not having to wait in line for the more powerful computers and not having to wait for the simulation team, faster decisions can be made with a greater ability to determine the important 'what-if' scenarios relating to operators' reservoirs.

This rise in computing power has also put an end to the inefficient, manual workflows of the past, characterized all too often by incompatibility with other data sets and third party simulation engines.

Today, with parallel processing and hardware developments, such as 64-bit multi core chips clusters, reservoir simulation tools can calculate more realizations of the same problem, incorporate higher resolution and generate greater detail into the simulation process. Whereas previously, computer limitations meant that geological models had to be scaled-up to a few hundred thousand grid blocks for simulation, today multi-million cell reservoir simulation models are increasingly common. And the benefits are there for all to see - more realizations, greater detail, faster simulation runs, accurate predictions of field performances. and better targeted capital expenditure.

## Challenges Still Remain

Yet, as in any fast changing sector, challenges still remain. Simulation technologies must never stay still!

Such challenges include ease of use and accessibility, cost and flexibility, the need to incorporate real-time data and the limitations of history matching, and the need to increase both 'physical' and 'people' asset productivity.

Ease of use, accessibility and the ability to integrate within existing workflows still remain key challenges. While significant advances have taken place in all these

areas, reservoir simulation remains a complex process and it is incumbent on vendors to guide users through this process, provide the necessary processing tools for effective simulation, and ensure there is integration across the reservoir management workflow.

There are also the issues of cost and flexibility. Not all operators and all regions, for example, require complete detail in their reservoir simulation models and require highly expensive and powerful packages. Whereas it may cost many millions of dollars to build and drill a well in the Gulf of Mexico, for example, in Russia it may cost closer to hundreds of thousands, with many more wells to be drilled.

In these circumstances, many operators are happy to compromise detail in favour of ease of use and cost. Reservoir simulation packages today must be able to cater for these different options and provide whatever returns are considered acceptable on the operators' hardware investments.

Another such challenge is the need to incorporate more and more real-time well and production data into the reservoir model.

Well data, especially in an actively developing field, changes on a daily, hourly, and even minute-by-minute basis – so much so that it can change the reservoir and simulation model significantly. The same is the case for other production data, such as pressure, temperature and flow rates, which can change the simulation model and can be used to update the model and quantify structural and reservoir property uncertainties in real-time.

Advances in reservoir monitoring technologies has ensured that much of this data is now available on a real-time basis, meaning that today's simulation models must have the ability to incorporate such information. Reservoir simulation today is an ongoing part of the production cycle of the reservoir.

Then, there is history matching. Reservoir simulation and history matching today provide many asset teams with a tool to understand the reservoir and predict future performance. The history matching process itself, however, can be very time consuming and frustrating due to an uncertainty about the reservoir and the fact that a history match can often be achieved through various different configurations. How do we know which one is correct? How can operators ensure a much tighter link to the geological model?

Finally, there is the all important need to increase productivity within asset teams and from the reservoirs.

Operators today need to maximize performance of both their physical and 'people' assets with an increased need to do more with less. This is likely to continue into the future with the continued skills shortage in the industry. A 2008 study by Booz Allen Hamilton[1], for example, found that around 50% of professional staff in the industry are between 40 and 50 years old, while barely 15% are junior recruits. The net result is that reservoir simulation must continue to increase productivity across asset teams.

The bottom line today is that users need to adopt the right simulation strategy that is right for their specific circumstances. As well as the latest in speed, detail and realizations, they also need a solution which is accessible, easy to use, cost effective and, above all, works for them.

It was with these challenges in mind that we have developed the latest version of our Roxar Tempest™ reservoir simulation software suite.

### Covering Every Aspect of the Simulation Process

It is important today that users are led through every aspect of the simulation process - from the preparation and analysis of original data to the economic evaluation of results.

That is what we have done with our Roxar Tempest software. At the heart of the software is the MORE engine, which runs fully implicit studies and supports a wide range of advanced options within a single program including black-oil, steam, polymer, dual porosity, equation of state and coal bed methane.

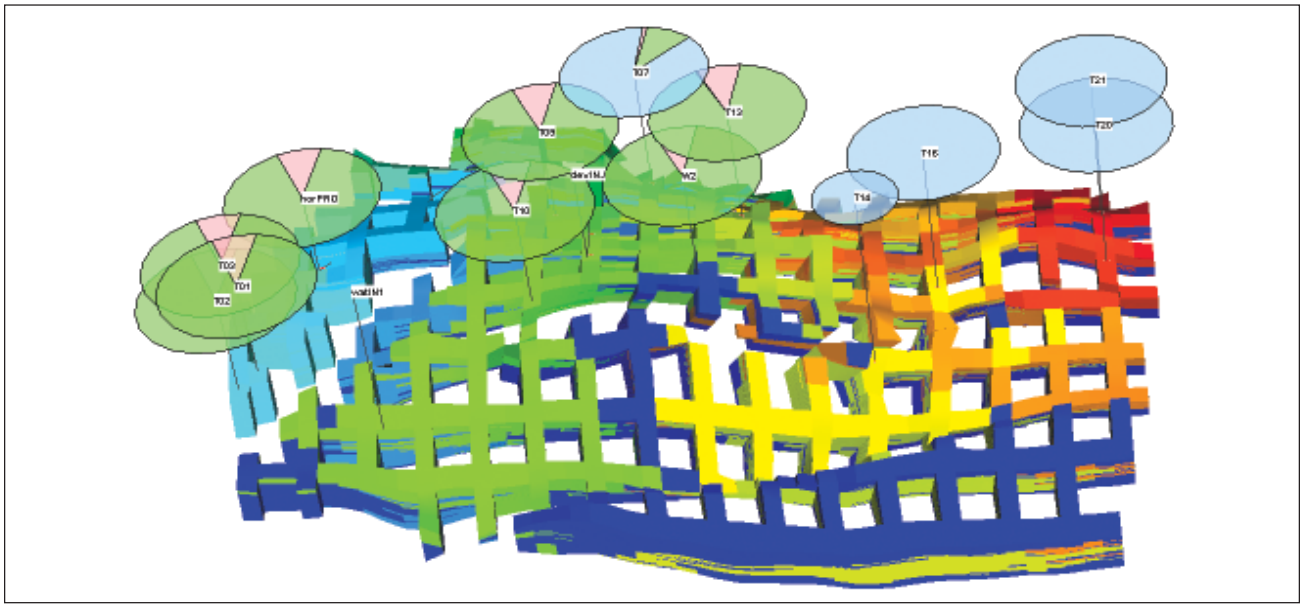
The software provides data preparation and analysis tools; pre-simulation calculations; compositional and black-oil simulation methods; and analytical tools for economic evaluation. All of these powerful functions are presented through a simple, easy to use graphical interface.

### Advanced Simulation Capabilities

The Roxar Tempest 6.6 software also comes with advanced simulation capabilities, providing full parallel simulation on the latest multi-core workstations and clusters, faster simulation runs in greater levels of detail, and increased productivity across asset teams.

A new segmented well approach, for example, allows for a detailed well model which represents the underlying physics more realistically. Fractured wells can also be simulated.

Furthermore, historical measurements may be entered as a table and well trajectories directly as 3D xyz files, with no need for additional pre-processing tools. Jobs can be submitted locally or to remote clusters and the progress monitored interactively.



Tempest 6.6 provides integrated model preparation, black oil, compositional and thermal reservoir simulation with 2D and 3D results viewing -- all in a single package. It is used at hundreds of installations worldwide, modeling fields with thousands of wells and millions of cells.

**"It is important today that users are led through every aspect of the simulation process - from the preparation and analysis of original data to the economic evaluation of results. That is what we have done with our Roxar Tempest software. At the heart of the software is the MORE engine, which runs fully implicit studies and supports a wide range of advanced options within a single program including black-oil, steam, polymer, dual porosity, equation of state and coal bed methane. The software provides data preparation and analysis tools; pre-simulation calculations; compositional and black-oil simulation methods; and analytical tools for economic evaluation. All of these powerful functions are presented through a simple, easy to use graphical interface."**

### Increased Speed and Easy to Use

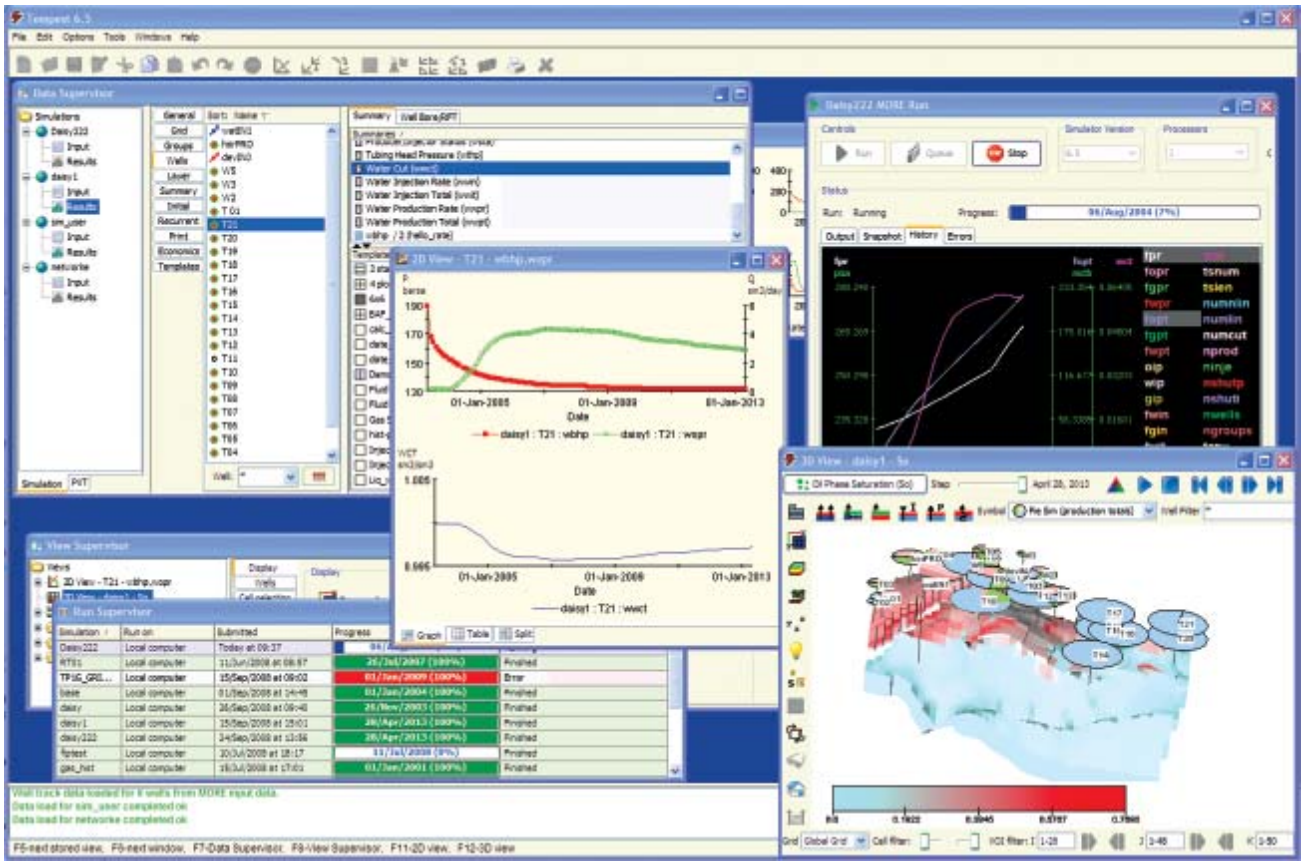
Speed, accessibility and ease of use are also integral to the design of our simulation software. To this end, our new graphical interface helps with the preparation of the simulation input, allows interactive run submissions, and supplies powerful 2D line graphics and 3D visualization of the results.

Our latest reservoir simulation software also includes the View module, a fast and powerful pre and post processing tool for a range of simulators. View provides integrated 3D visualization with powerful 2D line graphs which increases productivity across the asset teams. This ease of use and accessibility also encourages more asset team members to engage in the simulation process.

Multiple simulation runs can be loaded and managed together with observed data. Comparisons between runs and with historical data also greatly speed up history matching and sensitivity studies as well as helping operators understand the model and the underlying physical processes.

The easy to use graphical interface also allows many new features to be tailored to the working practices of the customer. Data may be viewed as a table, or simultaneously as a table and a highly configurable graph. The appearance of almost any item on the graph can be customized with several plots presented on a single graph. "Thumbnail plots" also allow large numbers of wells to be scanned at once. The data may be from the same simulation, different simulations, or from a user-supplied, column-formatted file. This makes it easy to compare the results of different simulation runs, or to compare predicted results with historical data.

The simulation model is also easy to set up and can incorporate well and production data, as mentioned



Tempest View

earlier in this article. A prototype simulation data deck for MORE can be easily created and run, with resulting data – including well and production data - edited inside or outside the Roxar Tempest software environment. Data, such as PVT (Pressure, Volume, Temperature), for example, relative permeability curves, and well lift curves, can all be graphically edited within the model.

In this way, the challenge of incorporating well and production data into the simulation model is met head-on. The Roxar Tempest software provides a modern data input for wells data. Historical measurements may be entered as a table and well trajectories directly as 3D xyz files. And dynamic data is also entered in tables as 'events', which can then be interactively edited, sorted, filtered and viewed on a timeline.

### A Seamless & Structured Workflow

As already mentioned in this article, a seamless, structured and productive workflow is also central to the reservoir simulation process. Roxar Tempest's data-preparation and job-submission features ensure that this is the case.

Jobs can be submitted locally or to remote clusters and the progress monitored interactively, with the results available automatically when the run completes. Simulation results are loaded on demand, keeping the memory requirements low even for very large models.

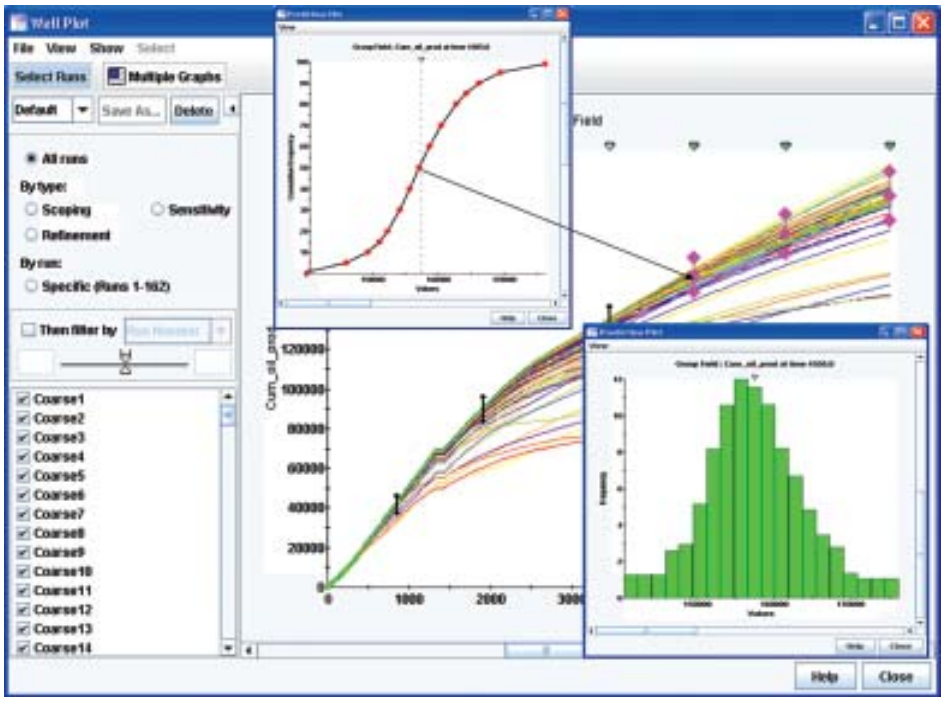
Within the software, users can also work with projects consisting of multiple cases and associated observed data. This offers an efficient way to organize and manage multi-run simulations, such as sensitivity studies. Cases and observed data can readily be added to or removed from existing projects, and within a project, user defined groups and calculator expressions are common across all cases. Comparison plots for all selected cases and observed data can also be created with just the click of the mouse.

Interoperability with other reservoir simulation tools is also important. To this end, the Roxar Tempest 6.6 software provides tools to assist operators display results from other 3rd party simulation engines and also interfaces with Emerson's reservoir modeling and history matching software.

### Real-Time History Matching

Real-time and computer assisted history matching is an important element of reservoir simulation today, ensuring that that the static geological model is synchronised with production data. In this way, computer assisted history allows the engineer to focus on

# Reservoir Simulation




Roxar EnABLE™ 2.3 - a tool for estimating uncertainty in forecasts. Roxar EnABLE™ calibrates simulation models against prior observations by adjusting input data to reproduce or match past performance.

developing an understanding of reservoir mechanisms and their relative impact on production behaviour.

This is the case with our history matching software, Roxar EnABLE™. Roxar EnABLE™ is not a reservoir simulator as such, rather it is a tool for estimating uncertainty in forecasts. It calibrates simulation models against prior observations by adjusting input data to reproduce or match past performance. In this way, geological modeling and simulation are brought closer together.

When used alongside the simulation software, our software history matches numerous geological scenarios to create simulation models that are fully consistent with their underlying geological interpretation (unlike many current 3D model workflows).

Match modifiers are updated intelligently, there is automatic parameter sensitivity analysis, and powerful statistical techniques are used to determine multiple matches of the reservoir to production history and to model the reservoir's uncertainty. The results are then used with the simulator to predict how a field will perform and provide measures of the uncertainty about these predictions. All the benefits of continual geological updating can all now be rolled into the simulation model.

Our latest version of our history matching software – Roxar EnABLE™ 2.3 – also comes with a number of new tools and enhanced interfaces with reservoirs simulators. For example, there is an Estimator Analyzer, which is very useful in performing quick 'What-If' analysis or in choosing a representative uncertainty model. This provides a better understanding of the reservoir and allows for immediate answers without having to run a more time consuming simulation model.

The new software also has improved interfaces for submitting and importing the results of reservoir simulation, highlighting the demand for integration between history matching and simulation. New simulator interfaces include FrontSim, Nexus, PBRS and Acres. In addition, Roxar EnABLE™ 2.3 works even more seamlessly with the Roxar Tempest simulation solution and other mainstream simulators, such as Eclipse. Roxar EnABLE™ 2.3 can read the Roxar Tempest software and Eclipse binary files, making the process faster and avoiding memory storage issues.

### The High Prizes of Successful Reservoir Simulation

The prizes for effective reservoir simulation are there for all to see - a world where multi-million dollar operational reservoir management decisions are made with an understanding of the full range of opportunities and risks.

Reservoir simulation technologies today are making such prizes attainable. dewjournal.com

## about the author

Tyson is currently Product Manager within Emerson's Roxar Software Services division. Prior to joining Emerson, Tyson spent 20 years at Schlumberger, with the last seven years as part of the Petrel portfolio team where he was responsible for the business side of product development, outlining product strategy, business cases and high level functionality requirements. Tyson was born in the UK but grew up in South Africa. He began his career working as part of a land seismic field crew in South Africa.