Much ado about nothing?

Has integrated 3D reservoir modelling really changed the way we work, or has it been just "much ado about nothing"?

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Only a few years ago, the buzz phrase in the industry was "The Shared Earth Model", and a lot of emphasis was put on "the benefit of the integrated asset teams". According to everyone from CEO's to humble geologists, we were all going to find and produce more hydrocarbons with focused teams taking advantage of the latest technology. Now the question is, did anything change? And did we take advantage of all the new tools that we bought?

Lars Edward Kjellesvik was for 11 years a key participant in the development of Irap RMS and Roxar Software Solutions, as well as the predecessors. For the last year and a half he has worked as an independent consultant advising on reservoir modelling and management for small independents and international supermajors alike.

From 2D maps to 3D modelling

One of the most significant development in reservoir modelling and management over the last 15 years has been the development of integrated reservoir modelling tools, such as Irap RMS, Petrel and Earth Decision. We have used these tools to revolutionise the way we model, visualise and understand the geology of hydrocarbon reservoirs, in order to make more informed decisions. But moving geology from 2D maps to detailed 3D models does not really create an integrated reservoir model. It just gives better geological understanding.

Unfortunately, however, we have not yet been able to take full advantage of the most valuable contribution the integrated reservoir modelling tools offer to the E&P industry: the integrated reservoir model itself.

It is fair to say that the latest releases of integrated reservoir modelling applications provide an adequate technology for the main elements of a reservoir model, such as structural framework, petrophysical properties, initial fluid distribution, dynamic properties and simulation. They also provide workflow management tools and allow integration of third party technology if required. This means that these tools facilitate the construction and maintenance of integrated reservoir models by integrated asset teams.

Defining the reservoir model

At this stage it is useful to step back and quickly look at what a reservoir model actually is. My definition is as follows:

"A reservoir model is a consistent representation of all available relevant data and knowledge of a reservoir, built for the purpose of calculating the volume of hydrocarbons and optimizing recovery from the reservoir".

Reservoir management is therefore about providing input to the reservoir model and acting on decision-support information from the model.

Based on this, the reservoir model can take many shapes and forms, depending on the available data and the reservoir management decisions that we need to make. The reservoir model required for exploration would, for example, be different from the one required for an IOR project. The only common factor is the procedure for designing the reservoir model.

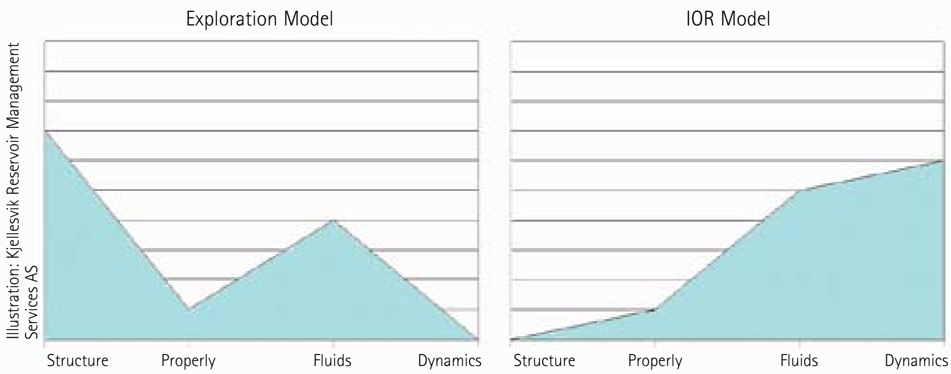
Designing the reservoir model

In my experience, the reservoir model is in most cases still created in the classical way; starting with interpreting seismic data, then building the structural framework, populating petrophysical properties, upscaling the model and finally creating the simulation. Each modelling stage is done in relative isolation, using dedicated software tailored to each task. After each stage the geoscientist or engineer exports the model from his or her software, and then the next stage commences.

This procedure is repeated regardless of the purpose for building the model. Far too often the result is that the majority of the time allocated for the study is consumed before the fault modelling is completed, leaving little or no time for what could be critical items towards the end of the process. Time can also be wasted on parts of the modelling that in the end may prove to be of little importance to the purpose of the model itself. It is therefore necessary to spend more time on the design of the reservoir model.

In order to build the best possible reservoir model we need to answer the following questions (in this order):

1. Which reservoir management decisions do we need to make?
2. Which variables from the reservoir model give us the best decision support information?
3. Which elements of the reservoir model critically influence these variables?
4. How can we be sure that these elements are properly incorporated in the model?



An alternative reservoir model built to investigate the value of well stimulation will look very different from the exploration model.

These questions need to be answered by the entire asset team together to ensure that all aspects are properly investigated.

As a result of this process, we should have a fairly good understanding of where we need to focus our resources and efforts, resulting in a reservoir model that gives robust answers to our challenges.

Even though the resulting model itself will be built by, for instance, the geologist or the engineer, it is critical that the asset team takes joint ownership of the model. After all, the result of, for instance, the petrophysical analysis, is going to end up in the properties model, which should make it as interesting to the petrophysicist as to the geologist. Similarly, the fault seal analysis undertaken by the structural geologist will end up determining the flow pattern in the simulation model, so this should have been jointly investigated with the reservoir engineer.

"Could have been more"

In summary, I am afraid that a lot of the potential rewards of integrated 3D reservoir modelling are lost between moving data between specialised software packages, through lack of time to properly design the reservoir model and as a result of poor cross discipline communication. The software developers have provided or are in the process of providing the tools, but the industry has not taken advantage of them yet.

So in the end it can be said that integrated 3D modelling has been "much ado about something – but it could have been much more"

Detailed knowledge of the fluvial sandstones in the Pyrenees (The Ainsa Basin) is important input for modelling of the Snorre field Triassic reservoir in the North Sea.

One software package

The main challenge with integrated reservoir modeling is that it requires excellent communications between the disciplines, both the individuals and their data. Ideally, the entire modelling procedure should be performed in one software package with all relevant data loaded for QC purposes. This would, for instance, allow the impact of changes in the seismic interpretation on ultimate recovery to be easily tested.

The benefits of building an integrated 3D reservoir model within one software package are obvious:

- No time is lost in importing and exporting data between applications
- A fully integrated model invites the entire asset team to sit together during the entire modelling process, and not only for formalised reviews
- Workflow management tools are available to automate model updates through the entire workflow
- QC is significantly improved by having seismic data, petrophysical data, the geological data and the simulation model together
- Communication is greatly improved
- It is easier to do proper model updates rather than "engineering fixes"

So why is it that the reservoir engineers, geophysicists and petrophysicists do not want to drop their specialist software and join the geologists in the brave new world of integrated 3D reservoir modelling?

The strongest reason is obviously that any tool with a development history focused on delivering what a specific profession needs will have functionality that a "wider" application can never get. Also in some instances regulatory requirements prohibit changes and in many cases partners or time constraints could restrict changes of software.

I consider, however, that the majority of the reservoir modelling work that is being done could be handled by the integrated reservoir modelling applications - and that the benefits greatly outweigh the disadvantages.

We do not expect to ever get to the point where one package can ever deliver specialist functionality for all disciplines, so there will always be a need to do part of the modelling outside the chosen integrated reservoir modelling tool, but the benefits must be significant enough to justify the cost of going outside the optimal workflow.