

# Rapid model updating allows right-time decision-making

*Today's 3-D geological models not only provide the tools for incorporating accurate characterizations of reservoir heterogeneity, but also enable multiple scenarios to be quickly built and analyzed to help quantify the inherent reservoir uncertainty.*

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The last few years have seen 3-D geological models become the standard approach to reservoir characterization for field development planning and reservoir management. It remains, however, a highly time-consuming process to build history matched static and dynamic models from the raw data and to update the model based upon newly acquired data.

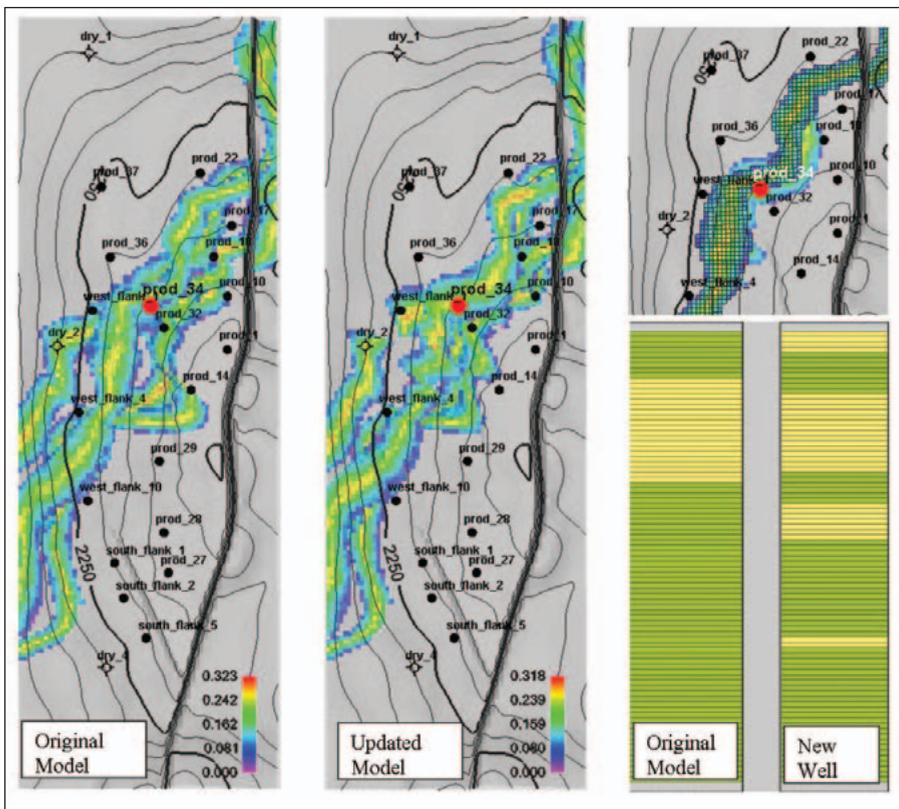
Such is the effort required that static reservoir models and history matches are often only updated intermittently. The process from drilling a new well through to the updating of the static model and history-matching of the new model can take a year or longer.

At a time when increasing amounts of field data are available and there are fewer skilled people to undertake this work, there is a real need to reduce the decision-making cycle time.

**The growing importance of the structural model**

One of the most significant recent developments in reservoir modeling is the evolution of structural modeling from a long and cumbersome niche process to a major productivity enhancement opportunity.

Local updating of the structural model is carried out directly onto the 3-D grid, based on new structural horizons or a



*Figure 1. This figure shows a local update example using channel sands. In the example, the original model (left) is updated based upon new well data (well shown in red). The updated model, with the adjusted channel objects, is shown in the center. The updates for the uppermost observed channel can be seen in the upper right image, where the original channel is shown with grid lines. The channel colors represent the porosity distribution.*

difference map. This allows for the rapid local updating of the gridded structural model without the need to rebuild the structural framework. More significantly, it also retains the existing property models, allowing for them also to be updated.

If the difference between the model and the observed reservoir structure is significant, it may be an indication of some underlying problem with the original interpretation, such as depth conver-

sion or well correlation. In this case, the structural model needs to be updated based on the new interpretation.

The speed of this new structural model technique — along with a streamlined workflow and an intuitive graphical user interface — reduces cycle time from months to weeks. And not only is the initial procedure less time-consuming, but all the edits, optimized defaults, and connections infor-

mation are stored for future use should the model require updating, which makes the prospect of rebuilding the model a far less daunting prospect.

## Updating local property models

A powerful alternative to an updating of the full reservoir model is local property model updating. Roxar has developed a methodology to update the geological model based on new data or interpretations. The method applies to both object- and indicator (pixel)-based facies modeling as well as petrophysical properties such as porosity and permeability.

In object modeling, the new updating algorithm makes minimal changes to the existing model while conditioning it to the new well data. This is achieved by attempting to make existing objects match the new, mismatched data. Only in cases where this is impossible are new objects generated, helping ensure the final volume fraction is as close as possible to the original.

The local updating of the object is divided into five steps. The first three steps identify observations that conflict with existing objects. The next step identifies observations not conditioned by existing objects. The final step assigns all unconditioned observations to existing objects, if possible.

For each object with conflicts or newly assigned observations, the next stage is to simulate local changes in existing objects such that well conditionings are fulfilled. If the object fails to cover an assigned unconditioned observation, the observation is reassigned. If the object does not manage to avoid a conflicting observation, it is removed, and all its observations are reassigned to other objects.

## Indicator modeling

Indicator facies models can similarly be updated. In addition to being used to update existing indicator models, this approach can be used to update any discrete parameter to new well observations. It could, for example, be used to update an object-based model.

The user has the option of either specifying the region or area where the update is to be made or allowing the region to be calculated automatically by the update algorithm based upon the well observations, original model, and variogram range.

The algorithm ensures an accurate match, not just to the new well data, but also the statistics of the existing model, including smooth integration into the existing realization.

## Petrophysical modeling

Petrophysical property models such as porosity and permeability can also be locally updated with or without the associated facies model. As with indicator modeling, the update region can either be automatically calculated or can be user-defined. The user has the option of choosing the original and updated facies models as input.

To generate the updated model, the model is initially rerun using the existing and new data to produce a new petrophysical simulation. Other model settings typically remain unchanged, but can be updated if required.

## Real-time updating

These new workflows can also be applied in real time to provide geosteering workflows within the 3-D reservoir model. Real-time geosteering capabilities in the 3-D reservoir modeling workflow reduce the seemingly inevitable delays between the analysis and integration of real-time drilling data and the updating of geological models.

Real-time logging-while-drilling data can be monitored within the model on the desktop live from the wellsite using the industry-standard WITSML (wellsite information transfer standard markup language) data feeds.

In this way, the reservoir model can be compared to the reservoir data and updated in real time. It would be impossible to make these updates and associated decisions in real time without the ability to update the model locally, as rerunning the whole model would be too slow.

A high-resolution geological model around the well bore allows forward modeling of real-time log data, enabling well-site geologists to see what log responses to expect. There are also links to the target and trajectory planning process, allowing “look ahead” trajectories and targets to be updated in real time.

## The big-loop workflow

This approach of updating the static model locally can also be combined with dynamic models to create a “big loop” workflow of reservoir management — a single, updatable workflow that carries uncertainties and details in the geologic model through to simulation.

The big-loop workflow uses Roxar’s assisted history-matching tool EnABLE to build history-matched geological models. Multiple geological scenarios are analyzed, with the inputs to the geological model updated based on the correctness of fit to the historical production data. This ultimately results in models that not only fit the static data and geological knowledge, but the dynamic data as well.

## Past and present

Reservoir modeling has moved a long way in the last few years. In the past, updating static and dynamic reservoir models was tortuously slow and was carried out only intermittently. Tools and algorithms are now available to locally update the structural model, facies distributions, and petrophysical models.

Together with real-time geosteering capabilities and a single, updatable big-loop workflow that includes both static and dynamic models, reservoir engineers now have the tools to make crucial real-time reservoir management decisions based on the latest available information.

At a time when the industry is looking for reservoir management solutions that can optimize production from increasingly marginal assets and lead to better decision-making over the allocation of capital and resources, the timing could not have been better. **ERP**