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## Next Step of Modeling Technologies: Live Model

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### Abstract

Many experts admit a big gap between reservoir simulation and daily management of oil and gas fields. Because only a limited number of specialists can use the results of modeling and models get out of date quickly. The necessity to reduce access and update time has driven to development of a Live Model concept. It will reduce the gap between modeling and practical oil and gas field management.

The targets of Live Model concept are:

- use models as interactive means of teaching;
- make models available to everyone, everywhere, anytime;
- build updating and monitoring tools for models.

In accordance with Live Model concept we developed web-system which enables to perform model monitoring and analysis of reservoir simulation results. Using this tool any specialist by means of a web-browser can do the following:

- make analysis of dynamics well data;
- make maps, streamlines visualization;
- estimate the quality of the models history matching;
- create and calculate a simple model.

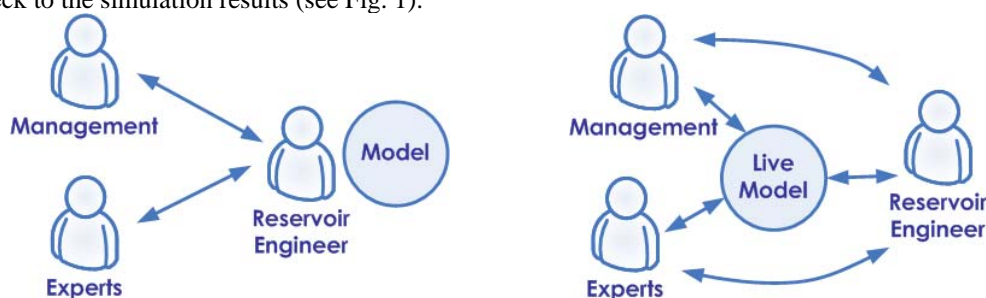
This web-system can act as an integral part of corporate information-engineering portal. Then we have opportunity to use dynamic production data, which is stored in corporate database, and automatically update Live Models. The interaction of web-system for models monitoring and analysis with the corporate database and models accessibility helps the oil and gas companies to use modeling results in the process of decision-making more efficiently. Another crucial factor is the opportunity to employ Live Models as training aids, which significantly reduces learning curve and increases the quality of training.

### Introduction

Oil and gas field reservoir simulation plays a key role in:

- the understanding of physical processes observed in the formation and in wells;
- the working out of a strategy at initial stages of field development;
- exercising control over the oil and gas fields at later stages of field development.

However in daily base fields performance monitoring and management we face with the several factors which prevent an efficient using of reservoir simulation. First of all, only a limited number of specialists can use the results of modeling and have an access to these models. In most cases only model creator has an access to models he created. So, reservoir engineer became a bottle-neck to the simulation results (see Fig. 1).



**Fig.1 – Reservoir engineer is a bottle neck in model access (left panel). Live Model concept solves model access problem (right panel).**



Secondly, these models get out of date quickly or cannot keep pace with the required level of management flexibility and responsiveness. In this case model-aided proactive management becomes impossible and mainly turns into a mere reflection of the ongoing processes. Mainly because the time period required for decision-making by the company's experts and managers is much less than the time needed for a model construction and updating. So, we get the answers "the day after the fair". In case of reservoir simulation managers don't have a proper access to the models (line 1 on Fig.2) and models are not updated with enough rate (line 2 on Fig.2).

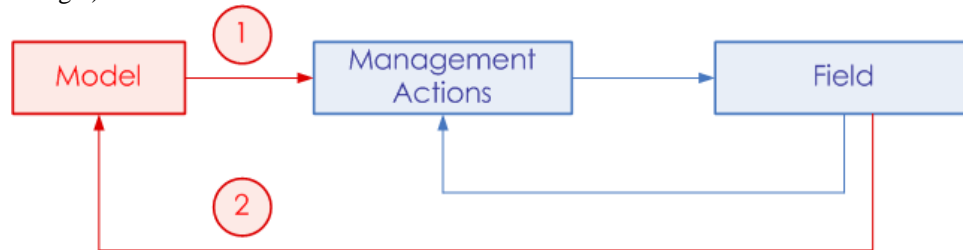


Fig. 2 – Single-loop and double-loop field management.

We developed and implemented Live Model concept to overcome these difficulties and to increase added value of reservoir simulation. The following objectives were set at creation of the Live Model concept:

- to provide online interactive tools for mastering skills in reservoir simulation;
- to implement workflow and process in place for automatic models updating;
- to deliver easy access to models and simulation results.

How we can solve these issues by one shoot? In last decade web based services have been proved as the best dissemination tools and put human collaboration on the new level. Web based solution has been selected as the most suitable platform for reaching these goals and creating Live Model as an interactive service. The great benefit of this approach is that user can deal with simulation by standard web browser and without any specific software installed on his computer.

All methodics described in the artical have been implemented and successfully tested in WebSim system. WebSim can be used as independent system as well part of information and engineering company web portal [1].

### Education using Live Model

We have employed interactive education tools in order to make reservoir simulation technologies widely available. If you want to understand the problem you need to study standard patterns (or in the other words typical situations). This strategy trains your intuition and allows act correctly in practical cases. We have pointed out key pattern problems of reservoir simulation, such as simple model creation using standard waterflooding patterns and study of water breakthrough mechanisms.

Step by step web based wizard helps to consider both of these aspects. Simple model creation wizard consists of following steps:

- choose one of standard waterflooding pattern (5-spot, 7-spot, inverted 7-spot, line-drive direct, line-drive staggered, etc);
- definition of size and dimension of model;
- definition of properties (permeability, initial water saturation, etc);
- definition of well types, parameters and schedule;
- definition of simulation period;
- calculation of relative permeabilities using standard correlations
- calculation of PVT using standard correlations

User can choose default values on each wizard step that simplifies model creation and makes reservoir simulation technologies widely available. Moreover, user does not need to operate with simulator keywords. The source text of model is available for edit by the same wizard after model creation.

Then one can calculate model on the server side (using 3-phase 3-dimensional finite difference black oil simulator). Log of calculation are displayed on the user browser online. User can view different results of calculation:

- graphs of rates, totals, watercut and pressures for field and for each well;
- table view of rates, totals, watercut and pressures
- grids of oil and water saturation, pressure for each time step
- streamlines, which visualize fluids flows in reservoir.

User can compare models in table or graph views. It gives better understanding of influence of different model parameters on water breakthrough, fluid rates, etc.

Foregoing procedure takes only five minutes and does not require any additional software besides standard web browser. At the same time user controls each step of model creation that helps to understand all features of reservoir simulation. All



specialists have free access to such reservoir simulation service (creation, calculation and visualization of models) at [www.live-model.com](http://www.live-model.com) just now. Users from more than twenty countries have taken advantages of this service for the last few months.

We approve WebSim at own training center. Also WebSim were presented to professors of leading universities. They have confirmed that using of interactive wizards helps students to improve their professional skills. We plan to increase number of wizards, make set of E-exercises, and make all models available after university graduation or after course completion. E-exercises will include the analysis of key techniques of reservoir modeling and interactive review tests, which give grade of modeling skills.

### Field Reservoir Simulation with Live Model

The process of creating and history matching of reservoir models take most time of a reservoir engineer. During these activities an engineer uses mostly standalone applications due to the huge amount of data processing. So, what can reservoir engineer benefit from Live Model concept to make his work and simulation model he built more valuable and long time played? We consider the following benefits as the most interesting from reservoir engineer prospect:

- visualization of real fields simulation results in the unified view for different simulators;
- automatic update of dynamic data in models based on new data from the corporative database;
- experience exchange in models history-matching proccess.

In many companies reservoir engineers use different commercial simulators as well as in-house. So it can be challenging to analyze results of reservoir simulation model which were built couple years ago in simulator which is not currently using in the company. For this reason WebSim has been developed with ability to explore the simulation results regardless of which simulator was used for running this model. WebSim provides basic visualization of production profiles (plots and table views) and maps of pressure and saturation distribution.

Advanced postprocessing techniques can be used for extracting more value from the simulation results. For example, information about fluid flows between grid blocks and rates for each well connection can be used for building streamlines even for convential finite difference simulator. By the next step drainage areas for all wells in the model can be visualized and residual reservers per well calculated. Advance postprocessing gives a great apporunity to the engineer to do this without switching between different software packages and converting models from different formats. For history-matching purposes cross-plots for different parameters (actual vs calculated) misfit bubble maps are sharp tools for identifying the margins and the place of mismatch in your model. Special analytical maps such as oil residual thicknesses can be visualized for finding unswept zone and planning infill drilling. These maps are very helpful for field managers.

Another aspect of Live Model is an automation of dynamic data update process. It is possible if web based system is integrated with corporative database with actual production and completion data. As far as new data came to the database engineer runs a special script which forms a new time step data for each models in repository with respect to the simulator keyword format. After that all updated models are running for a new time step simulation (see Fig. 3).

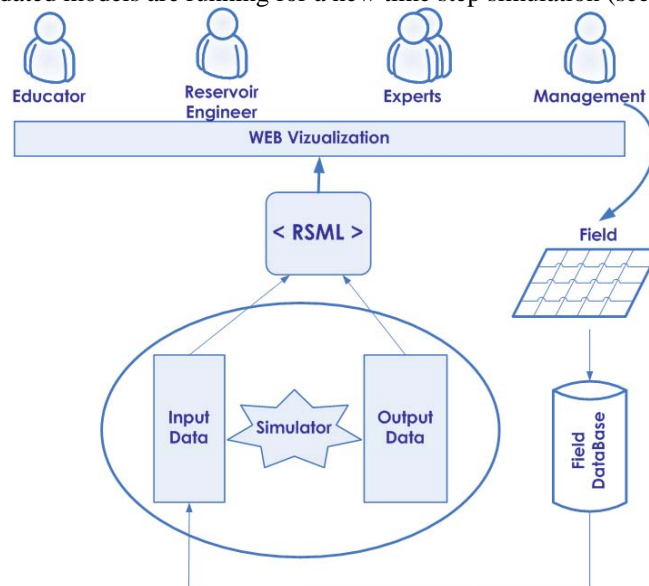


Fig.3 – Frontline access and automatic update of Live Model

We would like to emphasize that this approach minimizes the human element and at the same time saves human resources. It takes less than an hour to update a model by regular way, but in enterprise-wide level automation of models updating and script runs substantially reduce manpower. The list of alerting alarms appear on the special web page in case of mismatch in the certain range of calculated and historical data after all models simulated. It helps to monitor and keep models updated.

Reservoir engineer will need additional tuning for some models and even if models updating automation procedure is in place. Models repository with online access can accelerate history-matchnig process and make more effective dissemination of company wide stored knowledge of reservoir simulation by:



- experience exchange between reservoir engineers;
- storage of history matching of each model;
- usage of previous history matched models as the best practices.

Beside that, senior experts in the company, who supervise models creating and history-matching process, can access to it online via web browser. Standard and custom reports are powerful instruments in presenting simulation results and information exchange between senior expert and reservoir engineer. Reservoir engineer can create a custom report by placing specific plots, graphs and maps, and send his question and the link to the expert. So, the expert will be focusing on the specific problem at the same time being able to explore any information in the model. This essentially save time of expertise and decreases the lack of communication.

In the same way on-line touch on the model is helpful when model is created by the service company, probably outside of the customer office. In this case the customer is able to track the trend of developments in history-matching process and to add necessary specifications and comments on-line.

### Live Model brings new ideas

At the present time Live Model concept are supported for the different formats of reservoir models: RSOOffice, 3DSL, Eclipse. In order to simplify support of new simulators and to make Live Model concept more popular we suggest to develop universal (multi-purpose) XML based language. This XML based language (RSML – Reservoir Simulation Markup Language, [www.rsml.org](http://www.rsml.org)) will describe input and output information of different types of reservoir simulators. It is significant that there are many XML based standards in oil and gas industry [2]. Note that RSML does not conflict and does not compete with current standards, but supplements with it.

One can use RSML as an intermediate step for transformation between different model formats. It is notably simplify creation of converters between model formats and decrease they quantity. For example in this case one needs to develop 12 converters for 6 simulators (6 into RSML and 6 from RSML). At same time one needs 25 converters to transfer every simulator format to all others. In addition RSML could be used as guiding line for new simulators (see Fig. 4).

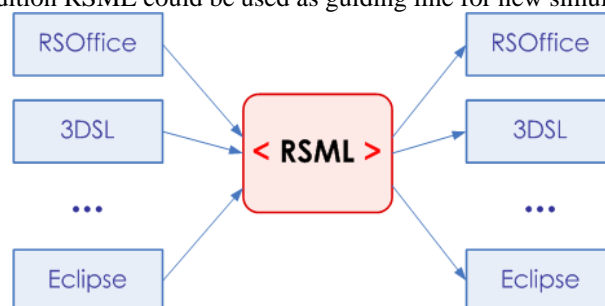


Fig. 4 – Scheme of models transformation using RSML – Reservoir Simulation Markup Language.

Another application for RSML is unified format for output reservoir simulation data. It allows to show reservoir simulation results in uniform user interface (independently from type of simulator). We have employed successfully this concept in WebSim. Also it will allow many companies to be more independent in new simulators implementation. In point of fact this procedure will be analog of well known Plug&Play technology.

### Conclusion

The Live Model concept may be applied not only for complex 3-D hydrodynamic models. It can be effectively used for models of any class of complexity - from material balance calculation to waterflood sector models.

Live Models are interactive services, which bring the process of modeling to an absolutely new level by increasing significantly the rate of feedback and feedforward throughout the entire system of oil and gas field development management. However, one should keep in mind, that the Live Model concept requires not only up-to-date technical solutions but also the transformation of workflows and organizational changes, the deeper integration of modeling into the company's management system. Besides, it is not only the process of modeling should be adopted to users' needs: users should also make efforts to master modeling skills.

Only in this case is it possible to achieve a synergetic effect, which will narrow the gap between modeling and management and bring their efficiency to a higher level.

### References

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