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Rapid Well Modeling Tool for High Frequency Drilling

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With the advancement in drilling technologies, oil extraction from unconventional O&G sources like shale has become a trend. In unconventional O&G extraction, drilling engineers drill horizontal wells at regularly spaced close intervals to increase the coverage of reservoir area/source rock area. Normally the decline curves of these wells are sharp, because of which new wells get drilled regularly while the old one gets closed. In such a scenario, the number of drilled wells can run into hundreds in a short span of time. This is referred to as high frequency drilling. Currently there is no effective way of modeling wells to catch up with the drilling rate, as the manual process of well modeling is time consuming. Hence, there is a need for a tool that integrates the data from myriad sources, provides a way to perform data quality check, and most importantly automates the well modeling process. A Rapid Well Modeling tool such as this can keep pace with high frequency drilling, which is highly relevant at unconventional well sites.

Need for a Rapid Modeling tool

Modeling a well requires a variety of information that needs to be sourced from multiple sources and third-party systems, enterprise-owned data lakes, application databases etc. Hence it becomes a challenge to collate data from different sources, fine tune it and perform a quality check before creating a valid well model. It typically takes two to three days for an engineer to manually model, which makes it important to have an automated well modeling solution which can collate data, generate a well model, run analysis on the model and save it to be shared.

The purpose of Rapid Well Modeling is to have a unifying tool that can bring together data pertaining to a well from myriad sources, take an engineer's input and help in rapid generation of a well model, even for unconventional well sites. A well-designed rapid modeling tool can bring down the time taken to generate a well model from days to minutes.

Bringing together SORs

A well model is a collection of information from different data sources, or SORs. A simple well model must have the following information to make it complete:

Well Summary: This section will have the name of the well, details like type of lift used and fluid type etc. The engineer can fill this information.

Deviation Survey: This contains information about the deviations of the well bore and data like depths and angle of deviation. This information can come from different SORs like a .csv file or an organization owned data lake.

Equipment Information: It is also equally important to know about the equipment used in a specific well. This information can come from SORs like a .csv file or various in-house/third party systems.

Geo-Thermal Information: This section has details about the geo-thermal nature.

Well Tests: It is also important to capture all until the latest well test of the well being modeled. This information is needed in running the analysis in the modeling tool and can come from SORs.

Vertical Lift and Inflow Performance: This information is needed to get the operating point of the well. This can come from well test and some information must be entered by the engineer as well and rest can come from a .csv file maintained by the business unit.

PVT Information: This is the Pressure-Volume-Temperature information about the fluid.

Lift Methods and Details: Not all wells flow naturally as some need artificial methods like Gas Lift, ESP or SRP to bring out oil from the reservoir. Hence, it becomes an intrinsic character of the well model and needs to be captured as well. This information too can come from SORs.

It can be clearly observed that for a valid well model to be generated, it needs information from myriad sources along with the engineer's entered values. Hence, it becomes important to have a solution that can collate data and capture information as engineers input and feed it to the modeling tool. The Rapid Well Modeling too helps achieve this and also helps engineers perform a data quality check on the screen itself before initiating the model generation.

Modularized well modeling, data saving and model saving capabilities

Due to the nature of high frequency drilling a lot of the data required may not be available during the time of model generation. It thus becomes important to understand that the inherent nature of a Rapid Well Modeling tool must be "independence between these sections or modules", so that absence/ inapplicability of any module due to the current state of the well; should not impact the modeling process. The tool must have the ability to send and receive information between each of these modules to generate a well model with integrity.

The modularization of the section becomes important. Users must be able to save the state of the tool itself, so he/she can revisit anytime in future and can add modules to it as per the requirement. The tool should save the state; such that the tool itself can be shared and must also save the well model generated to a version control tool to retain the versions of well model over time. As the data comes from myriad sources, the fundamental capability of such a tool must be the ability to connect to different SORs seamlessly and bring in data.

Thus, users can use this as one stop destination to view data from different SORs, perform data manipulation, data quality check etc. Only after being satisfied by the data quality and well model integrity can kick-start the well model generation process and get it done in a matter of few minutes.

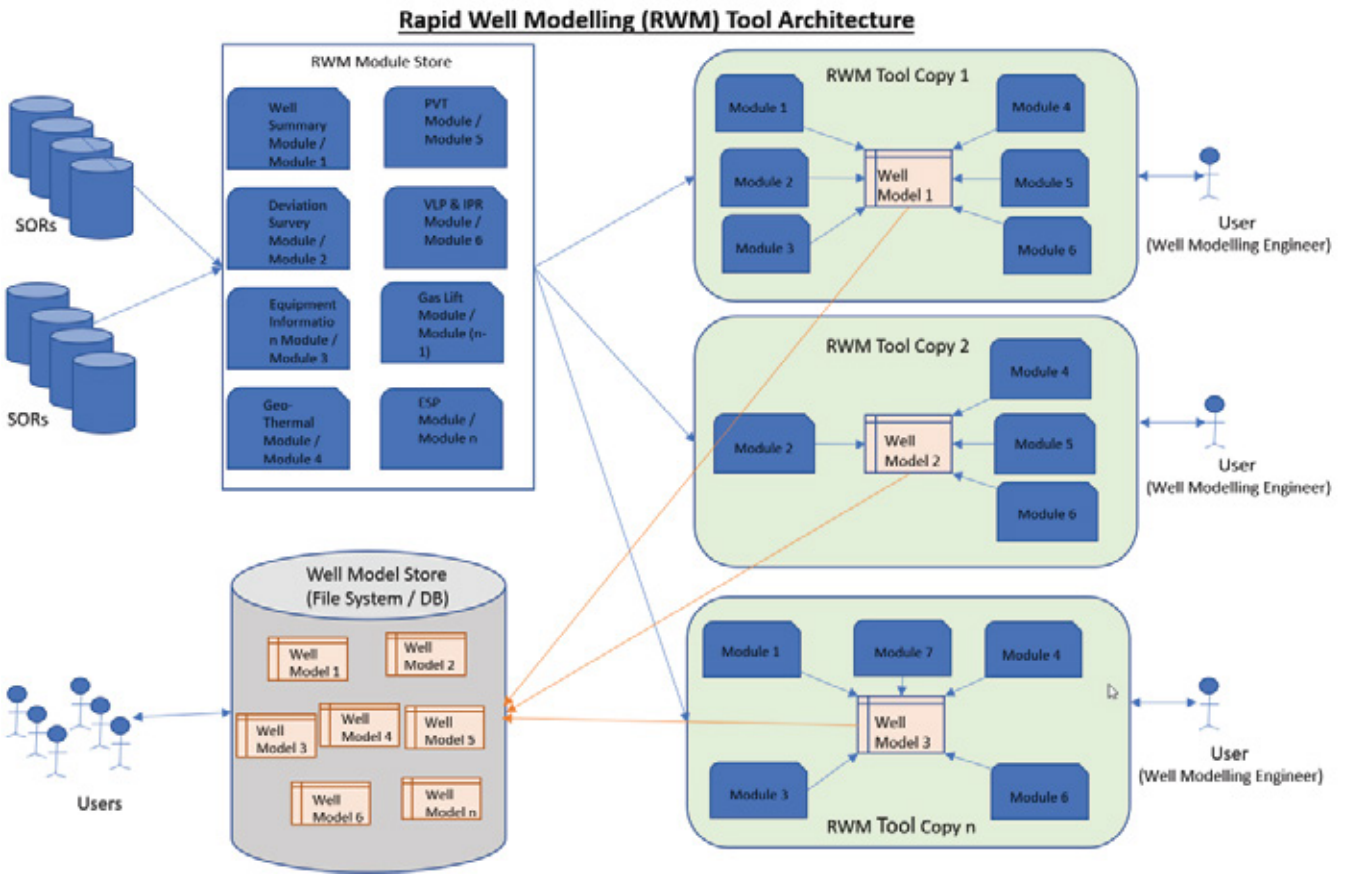
Well Model Data structure sharing

The tool should allow users to bring in or take out the modules from a module store as shown in the architecture diagram later, as and when needed. But at the same time when generating a model, the tool should inform about any missing information and generate a well model error free. The tool should allow users to bring in new modules later and update any previously created well model.

While providing flexibility regarding usage of modules, it also becomes important that, the tool saves the information and state at which it is at any point in time. So that the tool itself could be shared among engineers and anyone receiving it, should be able to take up and continue the work where it was stopped by previous user and on completion; successfully generate a well model with integrity. This could be achieved when the well model is saved as a data structure either externally or internally to the tool. This would allow easy accessing, reading, modifying, saving, and sharing of the well model.

Architecture of Rapid Well Modeling

The architecture diagram shows how we can achieve the above-mentioned capabilities. The module store is a collection of modules that can connect to a SOR to grab data and make data available for quality check. Each individual user may get a copy of the configured module from the module store and use it locally by mixing and matching the modules that meets his requirements. The copy of the tool which has the collection of modules required can be shared and saved with the current state of data; and on completion it can be saved to a version control tool as well.



Advantages of Rapid Well Model Generation

The advantage of such a model generation tool is that it provides ease in terms of generating well model, modifying, and sharing it. Also provides a huge cost saving due to the reduced model generation time, ability to perform data quality checks and so on.

Let's compare a scenario with Rapid Well Modeling implementation with one where it has not been implemented:

Without Rapid Well Modeling	With Rapid Well Modeling
High cost of operations.	Direct cost saving in the form of time saved of more than eight hours per model per engineer, and indirect cost saving as engineers can use the time for more productive tasks.
Manual consolidation of data and generating a model takes several days.	Consolidated data generation is done in minutes.
Low efficiency and output of petroleum engineers.	Petroleum engineer can focus on higher value tasks such as analysis etc.
Consolidating data manually from multiple different sources of records is cumbersome.	The tool makes data consolidation much easier. With just the click of a button an engineer gets all the relevant data in one place.
Inefficient data quality checks	With data consolidated at a single point, it's a more efficient way to perform data quality checks before generating the well model.
Checking the data integrity and well model integrity manually is an intensive process.	Data integrity and well model integrity check is much easier, and any required corrections could be made easily as well.
Sharing the workload among engineers is much harder.	Models can be shared easily making collaboration easier.

Conclusion

A Rapid Well Modeling tool along with all its advantages, is an essential tool in an engineer's toolbox; as it frees them up, and allows them to focus on meaningful tasks like running calibrations and analysis of the well models rather than spending days on generating one. Although the tool finds special application at unconventional well sites where wells are drilled at rapid frequency; however, this neither restricts the usage of the tool for a conventional well site nor taking the advantage of such a tool.

About the Authors

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Vishnu Subash, is a lead developer in Digital Oilfield (DOF) project and is based out of Houston, Texas. He has been associated with LTI for last 9 years and has been working with Oil & Gas domain industry in their Digital Transformation Journey. He has completed his graduation in the stream of Electronics & Telecommunication Engineering from Mumbai University and then post-graduation in Software Systems with specialization in Data Analytics from BITS, Pilani.

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