

Engineering Workflows Herald a New Era for Upstream Production

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Over the last decade, a number of industries have improved their operations through workflow management—the management and improvement of data and activities through specific business, scientific, or engineering processes. Workflow management most commonly has been associated with business or back-office processes, where workflow-management systems have enabled improvements to productivity in tasks such as invoice processing, authority-for-expenditure management, and technical help-desk operations.

In recent years, several industries have begun focusing on scientific and engineering workflows that differ in many ways from business workflows. A new generation of software tools is emerging to manage engineering workflows in the upstream production domain. These tools will enable many of the promises of the “digital oil field” and are part of the answer to industry challenges such as the “graying” of the workforce, the increasing complexity of assets, and the need to optimize production operations.

Types of Workflows

Business workflows are the most common type employed by companies. The management of business workflows dates back to the 1970s, when workflows were purely paper based. As workflow management evolved to modern information technology systems, many industries re-engineered their business processes for increased efficiencies and lowered transaction costs for optimal performance. Workflow-management software became commonly used to implement improved workflows and integrate business processes that spanned multiple workers and multiple information technology systems.

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Scientific workflows gained wide acceptance in the field of bioinformatics in the early 2000s. Scientific and engineering workflows differ from business workflows. For example, where business workflows tend to deal with discrete transactions, engineering and scientific workflows tend to deal with large data quantities, multiple data sources in multiple formats, and multiple interconnected tools. New software tools can be used to standardize engineering workflows by bringing together data from disparate systems and consolidating separate engineering capabilities within a single platform.

New workflows are needed for production operations. The aging of the oilfield workforce means experience will be lost when older workers retire, and new workers will need to accomplish the same work with less learned knowledge. The automation of engineering processes allows fewer workers to manage the same assets and allows knowledge to be transferred in the form of documented workflows. The increasing complexity of operations requires the management of larger data sets for ongoing operations, more precise decision making, and the opportunity for optimization through controls. New engineering workflows are needed to meet all these challenges, and they must be implemented predictably across multiple assets.

That will change engineering and operations in the upstream production arena. Engineering workflow systems can enable new capabilities for production surveillance through the use of automation and integration of modeling tools with multiple data sources, such as Merrick Systems' workflows.

Modeling—Framing the Problem

The discipline of engineering is based on modeling. To be able to forecast the behavior of a complex system requires the existence of models that describe the interaction and performance of the system's component parts. Only then can these parts be safely integrated, defining the overall system performance.

In the case of upstream production, the system components include the reservoir, the well, and the production network, the modeling of each being in itself a unique and highly specialized discipline, as much an art form as a science. As with any art form, however, modeling is a time-consuming process, both for creation and maintenance. The effort involved is what has traditionally limited its use for surveillance to a small minority of high-value assets, for which there is a critical need to gain maximum insight into performance. The next step change in asset performance will result from the introduction of modeling

into the production-surveillance and -optimization workflow. Before this can occur, however, two challenges need to be addressed:

- The high effort required for model creation and maintenance.
- The need for real-time, unattended model updating and execution.

The Well-Modeling Workflow

The traditional well-modeling workflow has three phases: data gathering, model construction, and history matching. In our experience, a disproportionate amount of time is typically expended during the data-gathering phase. For this reason, our main objective in developing a modeling workflow was to streamline the data-gathering process and to assist with constructing the model.

Typically, the data needed to construct a model are stored in any number of disparate sources, with varying degrees of integration. Wellbore diagrams; well files; petrophysical, production, and reservoir-pressure data; and other forms of information were located in different systems and recorded at different frequencies. To gather the required data, an engineer has to be familiar with all of these separate data sources and must visit each one before modeling begins.

The first challenge in designing a modeling workflow was to integrate all of the necessary information into a single report to which an engineer could quickly refer to build a model. This could be achieved only by using a tool that is capable of connecting to and consuming data from the relevant data sources, independently of the database type, database design, or data frequency. Using this "virtual data set" enables the generation of a complete report, or electronic well file, that contains information such as petrophysical, production, and pressure data, as well as recorded events and hyperlinks to external documents, logs, Excel spreadsheets, and models. After data gathering, engineers construct the model by entering the relevant parameters into a modeling application.

Model-Based Well-Surveillance-by-Exception Workflow

The traditional approach to production surveillance has been to notify engineers of exceptions that occur when measurements deviate from a constant expected value. While this technique is sufficient for operating assets in a reactive manner, it does not take into account the dynamic and changing nature of the field or allow for proactive intervention. Achievement of these goals falls under the scope of what is commonly known as the digital oil field of the future.

The oil field is, by its very nature, a dynamic system. Recognizing that surveillance by constant value will always fail to take this into account, real-time optimization can be achieved only by bringing models into the surveillance workflow. Comparisons can then be made between model-based prediction and actual performance so that exceptions are generated based on user-defined algorithms.

Requirements for real-world application of this workflow necessitate the following:

- Models must be in place for all wells on model-based surveillance.
- The dynamic portion of each model must be updated automatically, and the model must execute unattended.

The solution to the first is the well-modeling workflow. The second requires integration of multifrequency data sources with third-party applications.

Conclusion

Engineering workflows are already in place in the oil industry. These workflows have developed over time and are often undocumented and manual. Documenting existing workflows and developing new workflows to meet the new challenges of production operations will allow increases in productivity from both the industry's workers and the asset base. Analyzing and implementing engineering workflows through information technology are part of the transition to the digital oil field. New surveillance workflows that incorporate reservoir models and real-time data sources are an example of what can be accomplished. A new generation of engineering tools will allow these workflows to be managed across global operations. **JPT**

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