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How Forward Modeling and Predictive Geology Can Contribute to Shorten the Pre-Fid Development Sequence

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Abstract

From exploration to abandonment, the oil and gas industry follows a structured lifecycle that organizes the planning, the key milestones and the terminology of outcomes for all decision-making phases. When focusing on both the exploration stage and the field development part of the sequence, a high-level overview of the main phases can distinguish successively i) the Prospect Study, that rapidly assesses the economic value of a block and prepares its exploration; ii) the Preliminary Study, after initial discovery, which aims to demonstrate the development potential and defines the appraisal strategy; iii) the Conceptual Study, for selecting the optimal development concept among several scenarios; iv) the Pre-Project Study, aiming to reduce uncertainties and to prepare for detailed engineering; v) the FEED (Front-End Engineering Design) to finalize detailed engineering, cost estimates, risks, and execution plans; vi) the FID (Final Investment Decision) for taking the investment decision, committing resources and launching the project.

This entire sequence requires several years of effort, and each of the phases, except the prospect study, systematically relies on a model that integrates a growing amount of data over the course of the project.

The trouble is that from one phase to the next, the model is often rebuilt to incorporate new data and new knowledge about the field. These steps of reinterpreting and integrating newly acquired information justify rebuilding the models from one phase to the next, but they contribute significantly to the length of the cycles. A major challenge in current research is to reduce the duration of the cycles to meet the need for cost reduction resulting from economic conditions and the energy transition. Of course, boosting decision-making reliability by developing increasingly predictive models is also part of the equation. The Live Earth Model (LEM) is a concept that aims to provide solutions to these objectives of shortening cycles and ensuring model robustness. It fits perfectly into the field development process, particularly in the planning, execution, and operation phases. The LEM is a dynamic and continuously updated representation of a field's subsurface (and surface) systems and combines, for the subsurface, geological and geophysical data, reservoir, production, and operational data in near real-time.

However, as it is currently designed, the LEM suffers from certain drawbacks that are difficult to overcome without questioning a set of its core principles. First, the LEM is not necessarily the same model from the conceptual phase to the final investment decision, even though it may evolve from the same foundational model. While during the Conceptual Study the model is simplified and built with limited data to focus on scenario screening and uncertainty ranges, the models built for the Preliminary & FEED Phases are refined

with new data and require more detailed static and dynamic modeling. Lastly, for the FID, more mature models are used to generate production forecasts, reserves, and economic metrics. This potential change from one phase to another illustrates the dependence of model construction on the volume of constraining data in the model, and therefore demonstrates the dependence of model quality and predictive capability on this same volume of data. The use of geostatistics, a data-based technique for modeling reservoir properties, largely explains this situation.

The new approach we're proposing is significantly different in that it uses forward modeling to build a single reservoir model, from the Prospect Study to the FID. This integration is now achieved in a single package that enables predictive simulation of sedimentation, diagenesis, fracturing, and the resulting petrophysical properties. The use of universal, regional, and local knowledge makes it possible to achieve this objective of a unique model. As data is acquired to calibrate the model, uncertainty regarding the construction parameters is reduced, and the principles of causality rapidly lead to a reliable model independent from large volumes of data. The robustness of the boundary conditions thus allows only a single model to be built up to the FID, thereby contributing to the reduction of cycles. Forward modeling thus offers solutions that are inaccessible to data-based techniques and models.