

Knowledge Integration: Going Beyond Data Integration

By Jeff Nelson and Victor Koosh, Caesar Systems

Forecasts indicate that about \$21.4 trillion will be invested in energy infrastructure over the next 30 years to meet global energy demand, the bulk of which will be upstream. From look-back analysis there are many cases where large scale projects either under-performed or outspent their forecasts. Privately, E&P experts concede that as much as 20% of capital investments are less than effectively employed. Not that the capital has been “lost,” but rather, look-back analysis reveals that a sizable percentage of capital expenditures are underutilized, overspent or mis-directed. Such a large variance in actual versus forecast suggests a “gap” of misdirected capital that could approach trillions of dollars as E&P CapEx accelerates into the next decade and beyond.

The reasons for such variances are numerous, some controllable and some exogenous. One of the principal reasons for decision uncertainty can be found in the collaborative process and tools that multidisciplinary teams typically employ in the analysis and planning of major E&P investments. Large capital E&P investments are hydrocarbon value chains, extending from reservoir to market. An effective decision analysis platform should enable this future value chain to be modeled and fully understood long before any major investment is undertaken. An integrated, business-wide simulation platform is needed that enables scenarios to be rapidly evaluated, decision tradeoffs identified and additional options exposed. The problem with most major projects is that this process is being supported by a variety of spreadsheets and disparate software applications, limiting the frequency of updates, evaluation of decision tradeoffs and the ability to identify both risks and opportunities.

Benefits that can accrue to the planning process are otherwise missed with slower data integration methods. When analyzing and planning an E&P value chain, there are specific capabilities needed to ensure an agile, flexible process that clearly exposes risk and opportunities. A single, integrated knowledge platform that contains a business-wide model of the prospective value chain will be able to:



Jeff Nelson



Victor Koosh

- Generate and evaluate multiple project scenarios, considering all key uncertainties and their dependencies from reservoir to market;
- Test management decisions over time against possible scenarios; and
- Identify and focus on the significant factors that influence project outcomes in order to maximize capital efficiency and project value.

Knowledge Integration and Capital Decision Quality

The energy industry has invested heavily in IT data integration over the past decade to enable collaboration and data sharing among disciplines, asset teams and decision makers. E&P companies now experience an over-abundance of data from a variety of sources, such as collaboration platforms, visualization rooms and field surveillance systems. In contrast, multidisciplinary teams charged with evaluating prospective capital investments still principally lack the ability to effectively integrate knowledge from various disciplines to evaluate competing decisions or tradeoffs affecting the financial outcome of a planned development. The data integration that is done in the early phases of the lifecycle of an asset is often accomplished through spreadsheets.

A higher level of business integration among disciplines is required that goes beyond data integration, not

limited to separate spreadsheets and disparate software applications. In sharp contrast to data integration, knowledge integration incorporates the learning of various disciplines into a common model.

A knowledge model is the value output or understanding from a given discipline in the analysis and planning process, i.e., reservoir simulator data or cost estimator information. Knowledge integration therefore allows synthesis of multiple knowledge models into a common model, which can incorporate complex, significant dependencies among uncertain variables.

Based on advanced business simulation software, a knowledge integration environment presents model-based, virtual laboratories for rapid evaluation of multiple project options and scenarios. Inputs from multiple disciplines can be evaluated collectively and simultaneously within a consistent platform using common, shared models. Given the expected CapEx investment in E&P projects, much of it in higher-risk ventures (unconventional, arctic, ultra-deepwater), the value for transitioning from limited data integration techniques to knowledge integration could be worth billions or even trillions of dollars to E&P players.

Data Integration vs. Knowledge Integration

When it comes to the process and disciplines involved in making strategic capital-intensive decisions, data integration alone falls short. Capital decisions regarding whether or not to drill a new well or how to develop an entirely new field require contributions from multiple disciplines, such as exploration, drilling, reservoir, facilities, commercial, economics and other functions. Incorporating and leveraging this variety of information sources is crucial to obtaining an integrated, business-wide assessment of alternatives and risk.

Spreadsheets remain the default tool used for analyzing these complex, interdependent decisions, which provide only data-level integration between and among disciplines. It becomes very difficult to effectively model the dependencies between variables and uncertainties of the various disciplines using spreadsheets alone. When other tools are employed in conjunction with unrelated spreadsheets, the data integration problem is compounded, adding cost, time and uncertainty to the project planning process. More significantly, data integration using spreadsheets tends to entrain the prevailing assumptions, limiting the scope of the analysis and allowing opportunities or risks to be missed altogether.

Obtaining a complete, integrated, business-wide view of alternatives, and their financial and operational impact, requires true knowledge integration. Knowledge integration can be achieved through integrative business simulation software that incorporates comprehensive analytical models

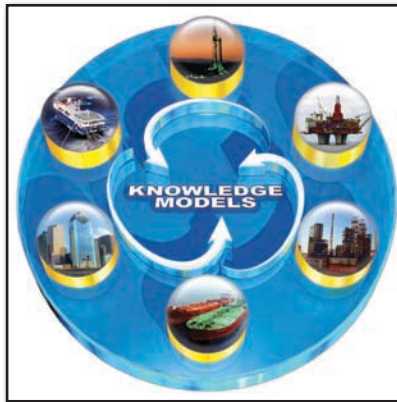


Figure 1. Knowledge integration enables business-wide simulation of the hydrocarbon value chain.

reflecting environmental, engineering and financial data and associated dependencies. It is this level of inclusive, business-wide decision analysis that will take capital planning to a higher level of effectiveness and efficiency.

Case Study: Super Major Gains \$1 Billion NPV

An offshore joint development by two super majors is located in depths ranging from 5,000 ft (1,525 m) to greater than 7,500 ft (2,288 m). The development includes multiple, independent fields consisting of 50

lease blocks over several square miles. Considered individually, the independent fields initially appeared to offer a marginal return with respect to corporate financial hurdles; consequently, management had decided to divest. The asset team, however, had reason to believe that the entire development, including all fields, could have a net present value (NPV) more than sufficient to meet investment criteria.

The asset team had utilized a set of complex spreadsheets and other tools that required extensive data integration to construct the analytical models of the project. The number of requisite spreadsheets proliferated and the cost of maintaining the models entrained in these spreadsheets rose accordingly. More significantly, the time to run scenarios and evaluate alternatives expanded as well. The asset team also found that the models were not sufficiently robust and flexible to assess alternatives and decision tradeoffs. Their spreadsheet-based models lacked the ability to integrate knowledge models from the various disciplines involved in the planning process. This limitation impaired team members from seeing the impact of decisions by each discipline on the total performance of the value chain. The development manager realized that more of an asset-focused scenario builder was needed that would provide a structured, integrated workspace where geoscientists, engineers, planners, economists and other disciplines could collaborate. Real knowledge integration was needed over the spreadsheet-level data integration they had at the time.

Having surveyed the market for business-wide simulation tools, the asset team selected Petroleum Ventures and Risk (PetroVR) software from Caesar Systems. Using PetroVR, an integrated asset-wide model was quickly built that replaced spreadsheets with a single, comprehensive platform that could integrate input from all disciplines. The advanced modeling and collaboration platform enabled the rapid assessment of a wide range of differing scenarios.

The project was recast within PetroVR and a revised business-wide simulation provided sensitivity analysis for NPV versus platform expansions, workover costs, subsurface performance and construction schedule. The range

of uncertainties and risk also became more apparent. An enhanced schedule of project phases resulted that identified specific ways to increase NPV of the investment as well as other metrics. The tool was successfully employed by the asset team to identify tradeoffs and determine the point at which the highest value of the planned asset could be realized at an acceptable level of risk.

As a consequence of the revised analysis and better understanding of the whole value chain, management elected to retain the asset and move forward with development. Figure 2 offers a three-year “look back” of actual performance as compared to originally expected values using deterministic spreadsheet methods, where NPV is shown along the Y axis. The red bars indicate the possible ranges of NPV, determined using the integrated model, while the green star on the far right bar shows the actual NPV achieved. At least \$1 billion in value was gained over original projections!

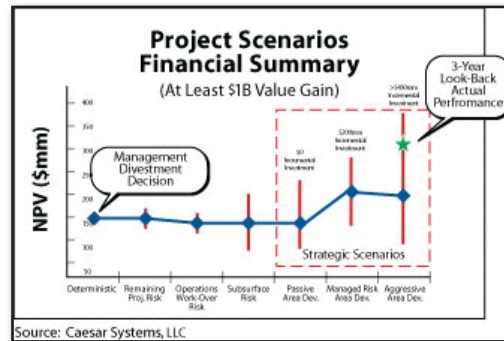


Figure 2. Forecast of NPV vs. actual for major offshore development – \$1 billion in value gained through knowledge integration.

Knowledge Integration Manages Uncertainty

Over the past decade the energy industry has adopted a variety of techniques in the quantification and modeling of uncertainty. Most oil and gas companies have incorporated probabilistic modeling and statistical simulation (Monte Carlo) in their investment analyses. Often, such probabilistic distributions are run on pre-defined ranges and expected values, which are entrained in spreadsheets. While these techniques are useful, statistical simulation alone still leaves a gap when compared to an integrated, business-wide simulation that accounts for the interaction among multiple disciplines simultaneously. In contrast to probability distributions around expected values, an integrative, business-wide simulation will reveal decision tradeoffs, opportunities and sources of risk to the project. Management is equipped with insights and can act on new information as it becomes apparent through the iterative evaluation of the asset.

Procedural risks are also encountered where Monte Carlo simulation and other statistical modeling techniques are based on spreadsheet financial models. There is a tendency for organizations to become overly dependent on a few individuals who understand these complex models. This adds organizational risk to the planning process, which can be avoided by a single decision-analysis platform.

Transitioning

A business-wide simulation tool, such as PetroVR, provides a single, comprehensive decision analysis platform that can simultaneously model the complex dependencies among

multiple disciplines. While such tools are applicable across the lifecycle of the hydrocarbon assets, from exploration decisions to abandonment, the greatest value is realized when analyzing complex, interdependent project development options such as rig availability, project schedule and the price of hydrocarbons under which management

decisions would change. This point occurs during appraisal and into development and concept selection when input from geoscience, reservoir engineering, facilities engineering, drilling, petroleum economics and other functions are important to obtaining an integrated, business-wide assessment of alternatives. It is during these phases of hydrocarbon development that major capital decisions are made.

Knowledge integration that is enabled by a single decision analysis platform offers the advantage of

standardized business processes supported by knowledge capture, retention and transfer. Creating such an integrated decision process provides better utilization of staff, a key consideration given the growing demand for talent in the oil and gas industry. In the case of PetroVR, the business-wide simulation software enables an integrated work process among multiple disciplines, which may otherwise remain “discipline silos.”

Having adopted PetroVR, managers at Shell have found that the evolution from compartmental technical modeling to integrative business modeling is also about instilling a thought process. Data provided by each discipline can be visualized and easily audited, something that is much more difficult with multiple linked spreadsheets.

The quality and confidence in decisions is increased as development teams are equipped with an understanding of the entire value chain from reservoir to market. Collaboration is enabled and process efficiency is gained as the time to evaluate assumptions is dramatically reduced, and individual disciplines see the impact of their assumptions on the whole plan and on other disciplines.

www.caesarsystems.com

PetroVR is a value-chain modeling platform that can simulate dependencies among many parameters, provide a complete view of the trade-offs and outcomes of investment decisions, and enable stakeholders to:

- Dramatically improve ROI of their project portfolio;
- Evaluate a greater number of scenarios;
- Discover sources of risk, gaps and potential cost/schedule overruns; and
- Increase decision-making speed by up to 50%.