A Modern Approach to E&P Asset Valuation, Development, and Decision Making

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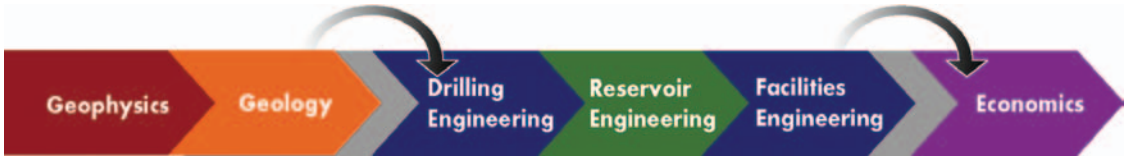

Fig. 1—Traditionally, each technical domain evaluates an oil and gas asset from its unique perspective, then hands off results "over the wall" to the next specialist in a linear sequence—an inefficient and often slow process.

The development of an oil and gas asset can be one of the most capital-intensive endeavors in the modern business world. The largest energy industry projects may require more than U.S. $15 billion in capital spending. While oil and gas assets normally have long economic lives, they have been characterized historically by low rates of return in comparison with endeavors in other industries. According to a recent report by Goldman Sachs, major oil company properties have an average life span of 21 years, but pay only 10% cash return on capital invested.

This level of performance can be attributed to two major challenges faced by nearly all recent E&P projects. First, most include substantial elements of risk and uncertainty, in terms both of commodity prices and estimates of subsurface hydrocarbon reserves and performance. Highly publicized write-downs of booked reserves illustrate the difficulties E&P companies face in this area.

The second major challenge is that conventional tools and techniques are unable to model all components of the production system simultaneously—from the subsurface upward through the wells, pipelines, and other surface facilities—across the entire productive life of an asset. Hence, engineers can create and evaluate no more than a handful of potential development scenarios, thus often resulting in suboptimal decisions. Traditionally, E&P companies resort to modeling each component of an asset—the subsurface, surface facilities, and economic outcomes—individually. At the end of this long, tedious process, they combine all the results, hoping they will represent the behavior of a fully integrated asset, which is rather questionable. Alternatively, they may simplify an integrated asset model to a point at which it can be evaluated as a single entity, which makes an accurate representation of predicted vs. actual returns somewhat risky. Both of these approaches evolved 30 to 40 years ago within major oil companies. They were strongly influenced by the hierarchical corporate structures of those days, as well as the limited computational and storage capabilities available at the time.

Because most oil and gas companies have been evolving rapidly toward asset-centered organizations, and because dramatic advancements have been made in cost-effective computational power and storage, the methodologies and tools for E&P asset valuation and decision making must be revolutionized to keep pace. Otherwise, the energy industry could squander its most precious resources at a time when global demand is going nowhere but up.

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Multidomain Scenario Analysis and Optimization

Over the past 5 years, new methodologies and software technologies that enable multidomain asset risk analysis, scenario analysis, and optimization have been developed, field-tested, and proved to be far more reliable than previous approaches. Collectively, these new tools and methods form a decision management system (DMS) and are based on the premise that all E&P asset decision-making processes really have two fundamental goals:

- To identify possible outcomes and key risks for a particular development project.
- To select the optimal development scenario based on a company's particular business drivers.

In practice, these goals are anything but simple to achieve. In traditional approaches, each technical domain—geology and geophysics, reservoir engineering, drilling operations, facilities/network design, and the commercial department—evaluates the asset from its unique perspective, then hands off to the next domain in succession. Depending on the company, there may be a reasonable level of integration between some domains, but others inevitably require specialists to toss their results "over the wall" **(Fig. 1).**

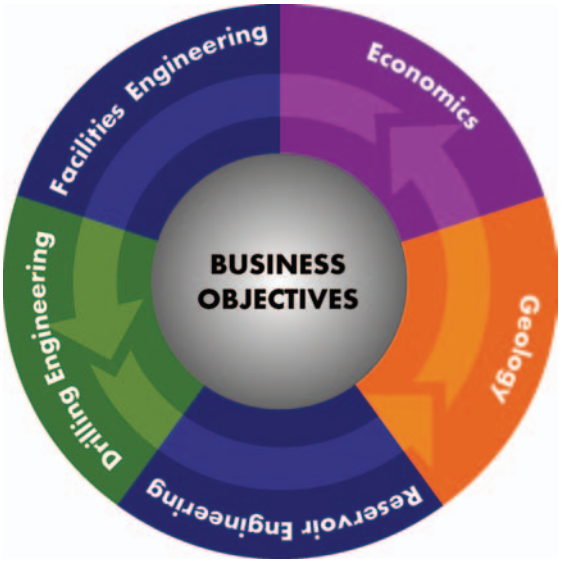

Fig. 2—The DMS approach takes a holistic view of the asset, centered around achieving key business objectives.

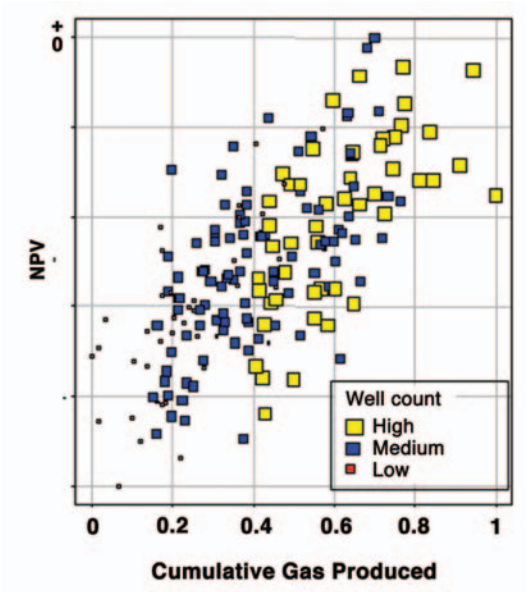

Fig. 3—Uncertainty in the depth of an oil/water contact would yield three different drilling scenarios, based on high, medium, and low well counts (figure from SPE 90961).

While such a workflow can generate excellent results *within* a domain, moving from one to another is time consuming, requiring months or even years to complete. Thus, collaboration between professionals is quite limited. As a result, little modeling of the asset as a whole entity ever takes place. When it does occur, it is generally very late in the evaluation cycle. The total number of scenarios that can be evaluated in this manner is small. There is almost no way to utilize modern optimization tools, which would help identify those development scenarios—in many cases, *nonintuitive* scenarios—that would maximize performance measures critical to corporate success.

The DMS approach, by contrast, takes a holistic view of the asset from the beginning of any multidomain evaluation. This process brings together all the different disciplines early in the development planning process, when changes can be made more easily, instead of running sequentially through the old organizational silos. A true DMS, therefore, requires technologies that integrate surface, subsurface, and economic elements simultaneously **(Fig. 2).**

DMS evaluations can be completed in days to months, rather than months to years. They generate fully integrated surface-to-subsurface asset models, with economics, that can be updated easily as new information or interpretations become available. And they support tools such as optimization. DMS approaches are both scalable and segmentable. They are scalable in that the most appropriate production prediction tool for the situation—whether material-balance, decline-curve, or full-physics reservoir simulation—can be used. They are segmentable in that not every domain must be included in the loop, if it is not required. For example, economics and facilities evaluation can be omitted from a reserves assessment, as can full geologic modeling in mature or homogeneous fields.

How DMS Works

Technologies that support a DMS workflow must be designed to bring the appropriate E&P applications into a computational loop. This loop represents a generic integrated workflow. The nature of the particular development challenge determines which workflow is appropriate for the asset in question. The cross-functional asset team will need to create more than one scenario for each domain in which commercially significant uncertainties can be identified and enter those possibilities into DMS software. The system runs each application in the loop, passing results from one to the next, storing each resulting run in a database. Each run represents one possible outcome for the field, thus achieving the first of the two basic asset decision-making goals cited above.

An example of a subsurface attribute with commercially significant uncertainty would be an oil/water contact with an equal chance of being encountered anywhere between 4,500 and 4,550 ft subsea depth. An example scenario associated with this uncertainty would be three different drilling well counts—high, medium, and low. DMS software would run each of the appropriate applications in the loop, substituting different values for the oil/water contact and using the three different drilling scenarios. This approach would provide detailed information regarding the impact of different asset elements and their relationships. For example, **Fig. 3** shows the effect of different well-count scenarios on net present value (NPV) and gas production for a particular field.

A DMS can also help identify scenarios that optimize certain corporate business drivers, as noted in the second basic decision-making goal cited above. This process also employs the concept of a computational loop, but the purpose now is to find an optimal solution based on criteria set out in an "optimization statement"—for example: "maximize NPV while minimizing well count." The system would run the loop, substituting different scenarios, using mathematical optimization to identify the solution that best meets these criteria.

The most common DMS workflows today involve running scenario analysis and optimization technologies in conjunction with certain industry standard E&P applications. Workflows are stored in a DMS engine for use at any time. A typical integrated workflow for oil reservoirs of moderate to high complexity would include

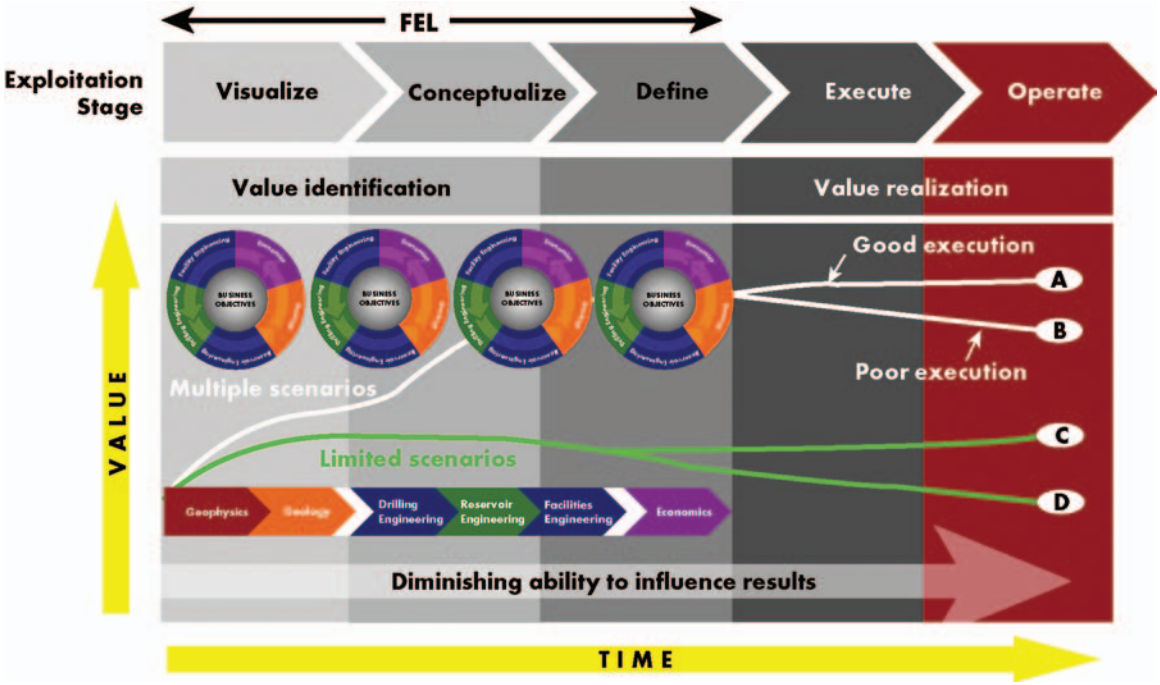

Fig. 4—Using front-end loading with DMS, companies can realize more value by performing multidisciplinary analyses early in the life of a project, generating multiple economically viable scenarios.

applications for simulation of both the reservoir and surface facilities as well as spreadsheets for economics.

Potential Benefits

The DMS approach identifies significant risks and probable outcomes; it selects optimal development scenarios based on key business drivers. This methodology is underpinned by new, differentiating technologies that support collaborative asset modeling to evaluate multiple scenarios rapidly under conditions of uncertainty. Recent projects that used the DMS approach have shown that three types of benefits generally occur:

- Reduction of field-development planning cycle time, from successful discovery to first oil.
- Identification of key project risk factors and accurate estimation of their economic significance. For example, one company recently postponed a U.S. $1 billion investment in a liquefied natural gas project pending further investigation because of reservoir uncertainties.
- Improvement of overall project economics through rigorous evaluation and optimization of a full range of development scenarios.

The concept of "front-end loading" **(Fig. 4),** commonly practiced in many industries, including E&P, is worth reiterating. In essence, considerably more value can be realized by analyzing and understanding all components as early as possible in any large project. Further into the process, the ability to influence the final outcome diminishes rapidly.

A typical exploitation project, for example, progresses over time from the visualization stage through conceptualization, definition, execution, and finally to operation. The project can achieve maximum value only if it is supported by good scenario development and evaluation in the visualization and conceptualization phases and identification of the optimal scenario in the definition phase. Actual value realized later in the project depends solely on the quality of execution and subsequent operations. With poor scenario definition up front, the optimal scenario cannot be identified effectively. Even with excellent execution, such a project will never achieve its maximum potential value.

Current approaches to E&P asset development often wait until too late in the process to bring together all of the business elements of the asset and determine the economic value of the few scenarios under consideration. For many companies, the attempt to investigate multiple scenarios in traditional, sequential workflows may take years from discovery to first oil.

Conclusion

Because E&P companies come in all sizes with many different business models, no approach to asset decision making can be "shrink-wrapped" for generic deployment. Each company's risk tolerance, decision-making apparatus, and level of integration between technical and commercial disciplines may differ widely from those of other companies. But certain basic principles apply across the entire industry. Multidomain teams must:

- Understand all probable outcomes for an asset under conditions of uncertainty.
- Investigate multiple development scenarios to understand which may be optimal in meeting the company's business goals for that asset.
- Consider as many scenarios as possible, early in the project life, to ensure maximizing value and impact on the final economics.

A multiscenario DMS provides a methodology and technology to apply these principles rigorously in the shortest period of time. As the E&P industry continues to strive for excellence in development, recovery, and production growth, this approach can help companies maximize the value of their properties. JPT