Efficient Economic Evaluations for Dynamic Field Development Planning

Streamlined field economics workflow — enabling life cycle planning and decision analysis

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Summary

Field-level economic evaluations are needed at various stages throughout an E&P asset's life cycle to support decisions regarding exploration opportunities, development planning and producing field optimization. Schlumberger provides excellent integrated tools for conducting these key workflows in a timely manner, giving you the ability to not only account for inherent risks and uncertainty, but also apply common and changing evaluation criteria to multiple projects. This paper reviews the ability of the FloMatic™ field development business planning tool, Merak Peep™ economic evaluation model and decline analysis software and Merak Decision Tool Kit™ decision analysis and risk management tool (formerly Decision Tree) to provide the efficiency and technology necessary for performing rapid field-level economic evaluations by multidisciplined teams challenged with the field development planning workflow.

Introduction

To support financial decisions, field-level economic evaluations must incorporate multiple "what-if" scenarios for the numerous strategies under consideration, whether by using formal decision analysis or discrete evaluations.

Similarly, due to vast subsurface uncertainty, multiple field development scenarios are often required to offer alternative strategies. This will involve describing and running numerous field scenarios for each major strategy analyzed, dependant on the complexity of the field.

Without an integrated workflow and supporting software, field-level economic evaluations can be onerous. Many of the scenarios involve a change in the number, timing, type and size of wells, while considering corresponding pipeline systems and processing facilities. This leads to an arduous workflow between asset team members using multiple software applications to prepare each field development strategy. In most cases, the software is not linked and much of the data transfer is manual. Of additional concern is the duplication of effort involved each time an asset team member makes needed changes to even one of the variables for which they are responsible.

Many companies face this inefficiency in field-level economic evaluations. They lack the software tools to schedule out different development strategies, integrate them with the related production and costs, and retain all related data in a visual and accessible format that can be easily modified and linked to fiscal terms. When all major project elements are in common integrated software, the economic assessment of alternatives and the impact of uncertain variables can be quickly evaluated.

Key workflow enablers

The key to success is the ability to easily schedule different field-level scenarios with the required detail on timing, production streams, costs and facility constraints. Then, integrate these complex scenarios with correct fiscal terms to plot the results in a meaningful format to derive insightful and quality decisions associated with each strategy.

The following presents an improved workflow for field development economic evaluations using the FloMatic, Peep and Decision Tool Kit software. In this workflow, FloMatic serves as the initial project planning software used to incorporate important development elements. Each development scenario is scheduled and defined in FloMatic and exported to Peep to

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create an accurate economic case. The Peep case links to the Decision Tool Kit to offer complete probabilistic analysis or multiple "what-if" scenario evaluations and plots. Tornado Diagrams (sensitivity plots), Decision Trees, Monte Carlo Simulations and Cumulative Probability Curves can all be generated in a seamless and timely manner. More importantly, once built, revisions are made in a matter of minutes by utilizing all three integrated software products.

Field development planning workflow

This phase of asset decision-making has the widest scope and largest level of investment, thus requiring a high level of input from multiple members on the asset team. An exhaustive number of uncertainties in key variables (both subsurface and cost-related) and a variety of development strategies must be considered. This results in a need to run numerous hypothetical cases.

As you would expect, the economic evaluation time necessary for development planning normally ranges from months to years and involves significant resources and costs. This integrated workflow will significantly reduce your efforts and eliminate the tendency to compromise a thorough analysis of all desired strategies for lack of time or resources.

The field development workflow (Figure 1) typically begins when the exploration group makes a discovery that appears viable for development. The questions asset teams focus on in this phase include:

- What is the optimum field development plan?
- Is more appraisal necessary, and if so, what should it focus on?
- Should flexibility be built into the development, and if so how?

Step 1 – Frame the problem – plan the evaluation.

The field development workflow begins with the project team "framing" or planning the evaluation of their discovery. They identify the development decisions to be made, key uncertainties associated with those development decisions and potential appraisal and flexibility options to consider, as seen in Figure 2.

From the framing sessions, the team knows which initial development decisions they want to focus on and which uncertainties they want to incorporate into their evaluations. They outline the scenarios needed for each development strategy and decide how best to construct them. Selected uncertainties, such as reserves, production and scheduling are built as separate FloMatic cases, while cost-only uncertainties are addressed using the scalar feature within Decision Tool Kit to understand their impact on the evaluation.

Step 2 – Build field development cases in FloMatic.

Looking over the list of development cases needed, the team decides which cases to build in FloMatic from "scratch", or which to include by copying and editing previously built cases. In Gantt chart format (see Figure 3), required development cases are built in FloMatic with various team members either independently contributing their input data, or providing the data to a central source.

The reservoir engineer can describe the production streams in FloMatic or input a forecast from a simulation model. The drilling engineer inputs well data, cost and timing, as seen in Figure 4.

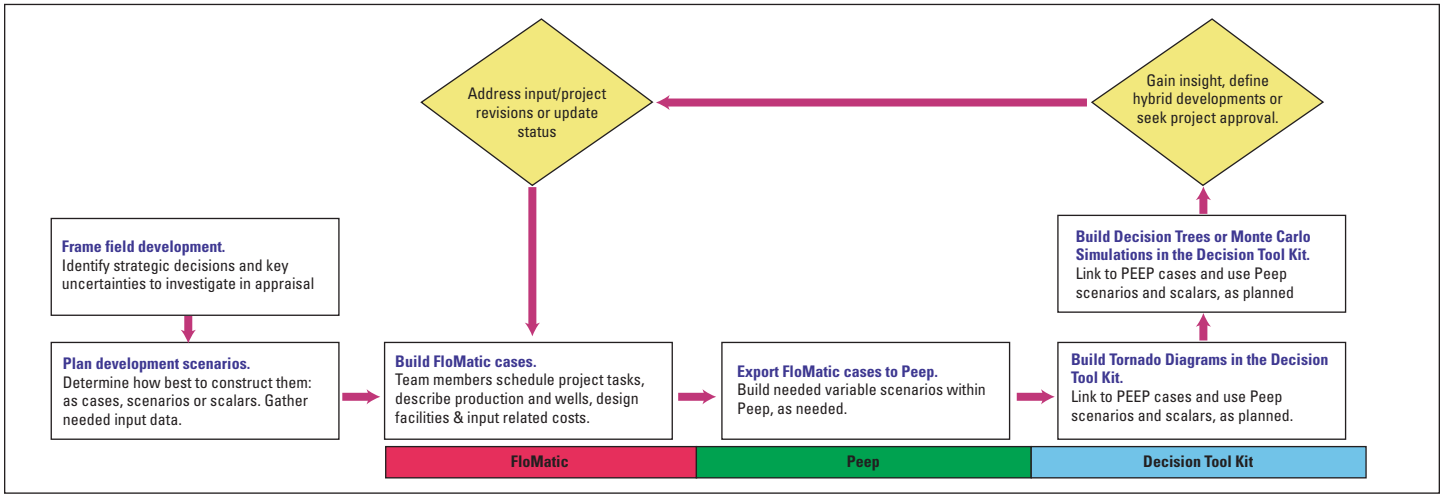

Figure 1. Improved field development economics workflow

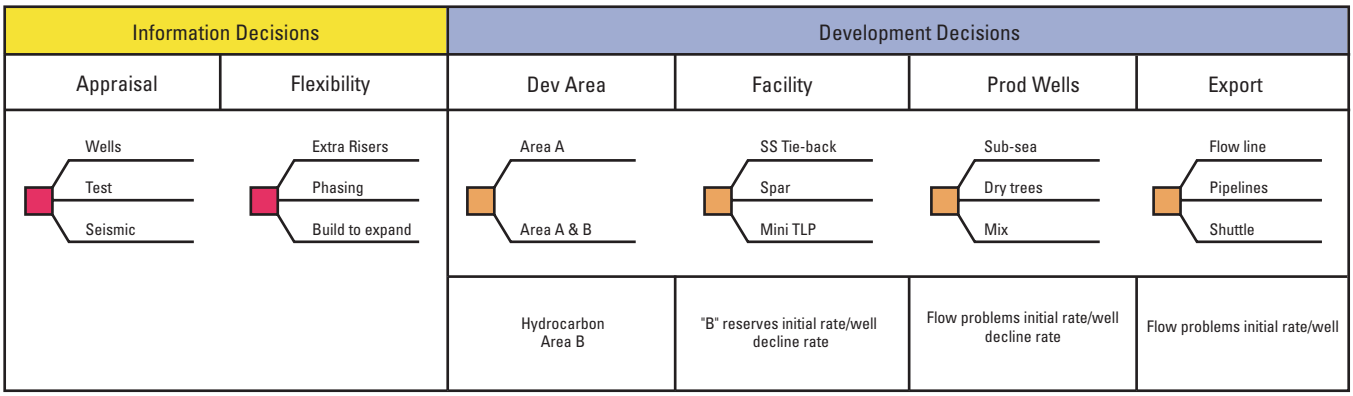

Figure 2. Field appraisal & development decisions example

For pipelines and production facilities, the facilities engineers have two data entry tools in FloMatic. Using the Gantt chart format, shown in Figure 3, they schedule the required infrastructure needed to accommodate that case's development plan, with the associated installation and cost information calculated using the FloMatic customizable costing models.

Another powerful feature of FloMatic allows the facilities engineer to construct the surface network (see Figure 5) to model pressure, temperature and flow design. This introduces engineering into the planning process to discern if the number of wells and projected flow rates can indeed be produced through the facilities described and, if not, adjust the plan accordingly.

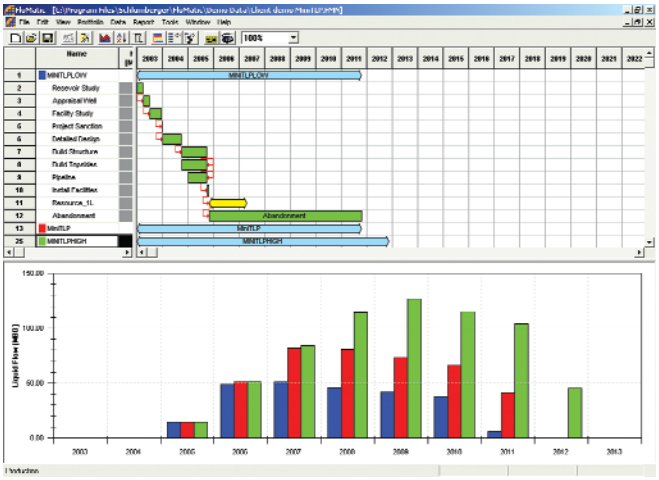

Figure 3. FloMatic case — Gantt Chart view

Step 3 – Export FloMatic cases to Peep.

Once the FloMatic cases are built, they are exported to Peep, one FloMatic case converts to one Peep case.

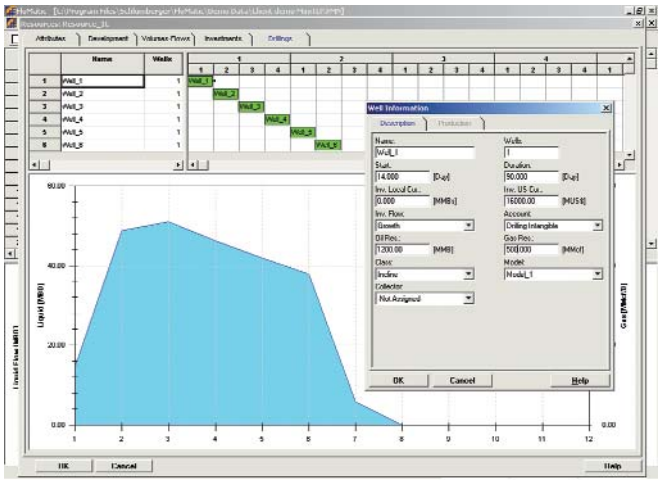

Figure 4. Production & well information entry in FloMatic

FloMatic exports the forecasted production, capital investments and operating costs directly to the applicable Peep variables. The FloMatic to Peep export file can easily be customized by the user to accommodate specific Peep economic models. Once any desired modifications to the Peep cases are made, the risk tab within Peep allows quick and insightful analysis of all parameters that affect the case.

Step 4 – Build tornado diagrams using Decision Tool Kit.

The team builds tornado diagrams for each development strategy, as seen in Figure 6. Tornado diagrams depict sensitivity to changes in input range and, like decision trees, provide insight on how uncertainty in selected variables can impact a particular development plan's value. The team builds the tornado diagrams within the linking Peep cases and describing each variable's uncertainty range by either using a scalar or scenario function.

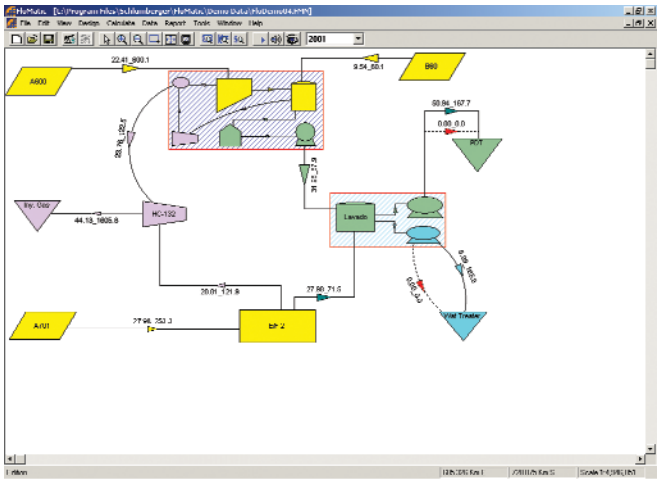

Figure 5. FloMatic surface facilities entry

Step 5 – Build decision trees using the Decision Tool Kit.

Based on the tornado plots, the team selects the key uncertainties they want to include in the decision trees. Decision trees are able to illustrate the impact of multiple variables on a development strategy, as well as calculate a risk-weighted value measure. The team constructs the decision trees by linking the Peep cases to Decision Tool Kit. The key uncertainties from your decision tree are linked to Peep through the scalar or scenario functions or through separate Peep cases. Figure 7 represents a typical decision tree.

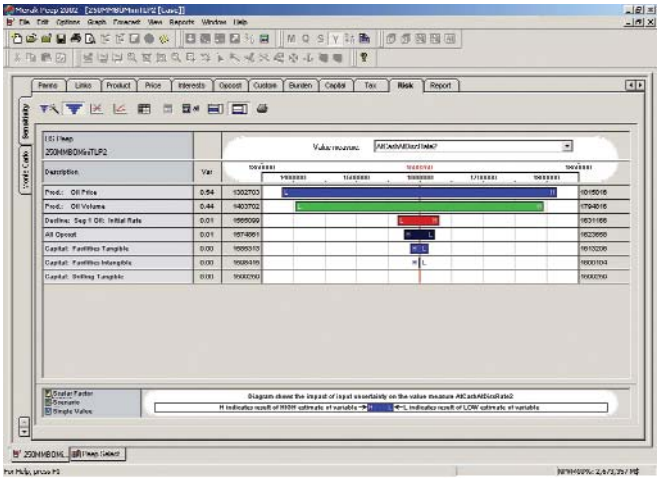

Figure 6. Decision Tool Kit Tornado Diagram

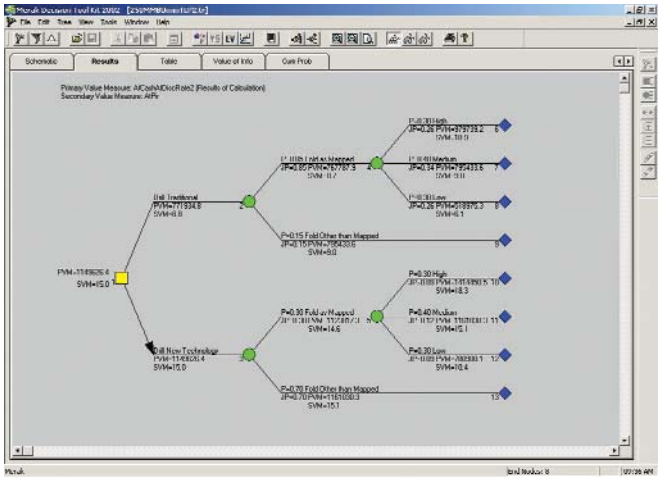

Figure 7. Decision Tool Kit Decision Tree

Step 6 – Perform Monte Carlo simulations, if desired.

At this point, some teams may decide to run full stochastic economics, using Decision Tool Kit's Visual Monte Carlo simulation, on one or more of the development strategies under consideration. A Monte Carlo simulation is similar to a decision tree in that it provides insight on the impact of multiple variables on the asset value. It differs from a decision tree in that the variable uncertainty is described with a distribution that can be sampled thousands of times as opposed to a decision tree that uses a small number of discrete points. Figure 8 represents field development with differing risks and dependencies due to the geologic outcome, rig delays and many other variables that can be modeled using visual Monte Carlo in Decision Too Kit.

Step 7 – Evaluate hybrid strategies, revise or decide.

At this point, the team has gained insight on numerous development strategies and the impact of multiple variables on the value of the opportunity. They discuss this insight with management who decide if a decision can be made, or if some hybrid development plan needs to be evaluated.

The good news for revisions is that this workflow links all three software applications, allowing all previous work to be automatically updated. That means when common design inputs are modified, such as well planning, construction, production forecasts, you can quickly make those changes in FloMatic, export them to Peep, run Decision Tool Kit and completely update all economic evaluations with minimal time and effort.

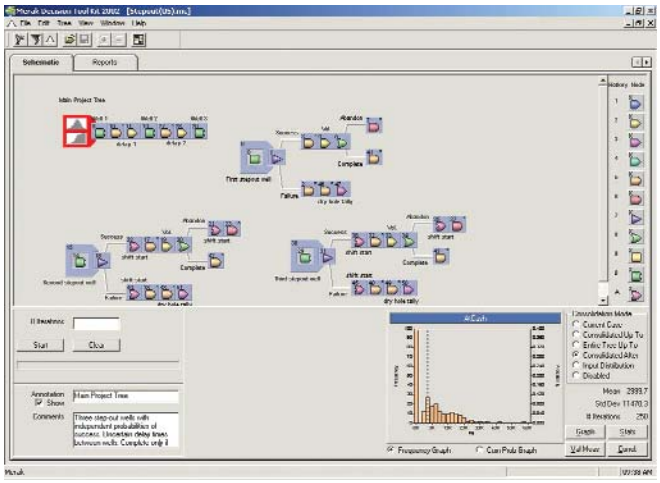

Figure 8. Decision Tool Kit Visual Monte Carlo

Exploration and Production economic workflows

Two other field-level economic evaluation workflows are common in the life cycle of an asset: exploration prospect valuations and producing field optimization. These economic evaluation workflows are essentially the same as described for field development planning. The main differences are not in the workflow methodology, but in the questions the evaluations address, the types of options considered and the number of field-level economic scenarios needed to gain insight and make decisions.

Exploration prospect valuations

This workflow tends to consider far fewer development scenarios in pre-drill economics than discovery economics. Typically, exploration teams will evaluate three different development plans for the high, medium and low possible reserves sizes. To do this, they may evaluate a few different development plans for each reserves size, dependant on the company and the complexity of development opportunity.

Critical in this workflow is the ability for the asset teams to ensure that as much bias as possible is removed from the uncertainty estimation process. Once estimates have been checked against historical data to discern what is realistically feasible, reserves estimates can be linked to economic software and other planning tools to evaluate the viability of various development strategies.

Conclusions

Field development planning has a wide scope and large level of investment, thereby requiring a high level of input from multiple teams within your organization. By using FloMatic, Peep and Decision Tool Kit, you can completely examine the numerous development strategies with their specific exhaustive number of uncertainties in key variables. This integrated workflow will yield accurate information on future cash flows, taxation implications and return on investment for an improved decision making process.