Abstract

BP, a major shareholder of the Atlantic LNG Plant in Trinidad and Tobago, was in search of project modeling and economic forecasting tools to help meet the aggressive commercial gas demands of this asset. This asset consists of 7 production fields that supply oil & gas to the island, with gas being fed through the existing 1, 2 & 3 trains for the next 20 years and projected to feed future LNG trains and downstream gas projects and a proposed gas refinery.

The development & production team collaborated with the resident facilities engineers and the drilling & completions teams to procure facilities cost data, drilling data, and other similarly-structured project planning data. The team was then challenged to formulate a production constraint system that applied strategic and economic analysis of gas supply/demand options, deliverability forecasts, facility capacities, and rig availability.

The team met this challenge through a single decision support tool that accelerated project analysis cycle time by 30%, reduced risk with full-cycle economic options analysis and promoted interdisciplinary teamwork. This tool superseded the use of eight (8) linked Excel workbooks that occupied 17 MB and proved inadequate to meet the team’s performance standards.

In this paper we present an overview of the challenges facing portfolio managers in their attempt to create a dynamic portfolio model for evaluation and optimization of portfolio value taking into account any relationships which may exist between portfolio projects and opportunities. Subsequently, it is demonstrated how the computational toolsuite “PetroVR” (Petroleum Ventures & Risk) managed the scope and complexity of modeling this BP asset. Features that helped search and define scenarios, provided graphic comparisons of model variations and finally helped the development and production team narrow their choice of real options will be discussed.

Introduction

Much has been written about portfolio analysis, portfolio management, and portfolio optimization. The thrust has been to simulate how choices could be made given various alternatives and constraints. The paper will discuss some of the limitations in the traditional portfolio analysis methodology and how the authors believe process shortfalls are hampering more widespread use. We will present how attempting to simulate physical reality by describing complex system interactions helps teams to make choices about sequencing, scheduling and pace of investment, as well as facility sizing, and production routing in BP’s Trinidad & Tobago assets.

The process that BP follows is presented by Maharaj et al., in a separate paper that alludes to the tool used, Figure 1.

Methodology of Development Planning

Integrated gas model from reservoir to export system

Gas Markets

EPC & wells

Costs

PETRO VR Planning Tool

Projects Schedule Field Sequence Production Deliverability Cost profile

Figure 1

We will focus on the integrated planning tool, PetroVR, alluded to in the other paper. The tool has been developed specifically to model oil and gas exploration and production activities. It draws on traditional modeling, project management, system dynamics, simulation, and decision analysis for inspiration to provide the tools necessary to help answer difficult questions.
Traditional Portfolio Modeling and It’s Limitations

When considering traditional portfolio analysis, resolution of project information captured at the portfolio level is often very coarse. Typically, a portfolio manager is fortunate to have basic cash-flow items such as revenue, price assumptions, expenditures, cost recoveries and income taxes available. It is not uncommon to see project or prospect information condensed into one or two cash-flow items for portfolio analysis purposes.

In our experience there are several reasons why companies resort to making such gross simplifications:

1. Lack of Project Standardization
2. Model Performance
3. The failure of Portfolio Managers to appreciate the importance of underlying project complexity models caused by a general lack of communication between project team and portfolio manager

Lack of Project Standardization

We rarely see standardized business modeling policy across a company. In this time of mega-mergers, it is unlikely to improve in the near future. Asset teams typically perform their own evaluations using their own homegrown spreadsheets and, if uncertainty is considered, perform an analysis without a set of specific corporate guidelines. Consequently, some companies have implemented an intermediate step which typically requires project teams to complete standardized spreadsheets created by the portfolio management group. Rarely do we see a direct dynamic link between the project and portfolio business models.

Model Performance

Larger companies may have 100+ opportunities in their portfolio. Investigating the optimal project and working interest mix may require significant computational resources. If project models are condensed to cash flows, simple calculations can be applied to estimate total portfolio uncertainty.

This simplification, however, requires the user to implicitly or explicitly make assumptions concerning project dependency. The aggregated effect of all project dependencies can be described by a single correlation factor, again, with a loss in resolution and accuracy. It is not trivial to arrive at an estimate of the correlation coefficient. In reality, projects will always be correlated to some degree through product price, even though they may be located in different parts of the world. As we will discuss later, other dependencies exist between projects in many cases.

Communicating Model Complexity

Communication between project teams and portfolio analysts is poorly developed in many companies. Project team members often lack understanding of how or even if, the data they provide to the portfolio analyst is used in corporate decision making. On the other hand, the portfolio manager often does not appreciate the underlying assumptions for the project data he or she is receiving.

There is also the obvious issue of control of the business model. If team members provide the portfolio manager with access and control over detailed project information, such as the exact timing of different project phases, they may fear that changes beyond their control will be made and consequently will lack proper quality assurance.

Categorization of a Dynamic Portfolio System

To understand portfolio dynamics, a valid starting point for system analysis is to categorize the areas where interdependencies may occur.

We have compiled a category list based on our experience (Figure 2):

- Subsurface reservoir connectivity and dependency
- Rig availability
- Shared Infrastructure
- Sales Contracts
- Cost and revenue allocation for tax purposes.

![Figure 2](image-url)

The categories reflect the different disciplines most often represented in an asset team. Clearly, geologists, reservoir engineers, drilling engineers, facility engineers as well as negotiators and economists will have to consider dependencies.

Subsurface Reservoir Connectivity and Dependency

There are a wide range of dependencies which can affect the reserve potential. Reservoirs in physical communication obviously cannot be considered in isolation. Also, prospects within the same trend or play may have related rock properties, sealing mechanisms, or other characteristics. Depending on the maturity level of the project and size of the prospect inventory, this may be analyzed by traditional reservoir simulation or probabilistic volumetric calculators. The limitation with both,
however, is that sub-surface uncertainty rarely is reflected consistently in the above-surface development strategy.

**Rig Availability**

Rig availability can have a substantial affect on development schedules in several different circumstances. In some areas on shore, e.g. Russia, the availability of high grade rigs can be very limited. Another example would be seasonality effects in the arctic where drilling is limited to a specific season. In offshore areas, rigs for ultra-deep or extreme arctic conditions may be in short supply.

**Shared Infrastructure**

In some regions, shared infrastructure is a very important issue which is often disregarded or handled in a simplistic manner. For example, the deep water Gulf of Mexico is an area where there are a large number of marginal discoveries with development dependent on other near-by fields, which may be fully, partially, or wholly, 3rd party owned.

Resolving potential bottle-neck problems for existing and future projects, as well as optimizing development pace is not a trivial task. Many factors such as well rates and drilling schedule will influence production potential and optimal capacity.

**Sales Contracts**

“What gas volume can I contractually commit to supply given the production risk and penalties for delivery failure?” To answer such questions, understanding how reserve uncertainty, development pace, and capacity constraints all work together is essential.

**Taxable Entities**

Cost and revenue ring fencing is common in many fiscal regimes. Obviously, accounting for cost and revenue has no direct effect on the project activities and can be performed in the portfolio model. However, there may be significant benefits from designing development activities with tax-optimization in mind.

Typical examples include balancing exploration and development expenditures to stay within a certain tax bracket. Short-term tax planning is standard in many companies; however, rarely have we seen a proactive operational plan that considers minimizing the tax liability.

**Example of a Complex System**

With multiple fields, discoveries and prospects, 600+wells to be drilled, and numerous current and future facility installations, BP’s Trinidad portfolio is indeed a complex interconnected and interdependent system, Figure 3.

![Figure 3](image-url)
diagram is mirrored by the timeline, Figure 5, by providing the context of time and money for the facilities depicted.

![Figure 4](image1.png)

**The Tool**

After dealing with eight (8) linked Excel workbooks that occupied 17 MB of storage space and inadequately addressed the issues, a solution was sought for integrated planning. Systems dynamics models were reviewed along with PetroVR, a hybrid commercial product. PetroVR was chosen primarily due to its hybrid nature. It combined reservoir depletion plans, Figure 4, with Gantt charts, Figure 5, and a process flow diagram, Figure 3, to produce a production constraint and planning system that could be built upon to achieve the required results.

![Figure 5](image2.png)

BP worked with Caesar Systems to enhance the software with the functionality necessary to model the complexity. The production constraint system was the first order of business.

The constraint system allows one to specify which of the downstream facilities a constraint should be applied to, and allows production from other downstream facilities to be excluded from the calculation. The order in which the constraints are applied is user-defined. A crucial part of the constraint system is the actions the system must perform in the future based on constraints. Deferring producers, building new capacity, expanding existing capacity, and drilling additional completions are all examples of the actions the software can take during execution. Thereby, the software executes dynamic models where changes in the design model occur based on rules provided by the user.

**Conclusion**

Limitations in communication, human, and computing resources often lead to over-simplified portfolio models. The result is poor portfolio performance, and consequently a lack of deployment. This is particularly true for regional portfolio models that typically contain complex relationships between the projects and opportunities included in the portfolio.

As an example of the benefits of a single integrated planning tool with complex project dynamics, a business model used at BP Trinidad and Tobago was presented. The model is an essential part of the portfolio planning process at the company. It provides a single system for data gathering and analysis. The system’s capabilities provide insights that would otherwise not be gained. Significant time is saved answering difficult questions, and because several disciplines are using the system concurrently, a better general understanding of the asset exists.
References

