Risk and Uncertainty Management
<table>
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<tr>
<th>Integrated Project Uncertainty</th>
<th>Decision Risk Management</th>
<th>Portfolio Optimisation</th>
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RPS Energy
Risks versus Rewards

All Oil and Gas projects have significant uncertainties, at least some of which lead to significant risks. There is growing evidence of a direct relationship between consistent, accurate assessment of uncertainties and risks and the creation of value.

**Ultimate Value**

Our deliverable is an approach that allows you to manage risk and uncertainty effectively in order to help maximise the value of your assets.
Base Value

an individual asset level the industry norm is an approach that assesses the “standalone” value of each asset. Sometimes this also includes an assessment of uncertainty to base inputs (costs, prices, production rates, etc). The value of the portfolio is assessed by arithmetically summing the “Base Values” of all the assets.

Options Value

In order to realise the Ultimate Value of your assets, we use a combination of judgement (gained through long and diverse experience), and workshop facilitation skills to access the expertise, knowledge and experience in your own asset teams (see: Decision Risk Management, p.5). Proven processes are used to help identify and assess the likely impact of uncertainties on each of your assets and future strategies. Depending on circumstances, it may be preferable to focus on analysing a single asset in great detail (see: Integrated Project Uncertainty, p.6,7), or it may be more productive to analyse the total portfolio, with each asset assessed in less detail (see: Portfolio Optimisation, p.8). The key deliverable at this stage is a list of all of the factors that introduce uncertainty into the project and an assessment of their impact. The potential uncertainties considered might include, for example:

For a prospect

- Mapping and stratigraphy, leading to:
  - GRV
  - N/G
  - Porosity
  - Hydrocarbon saturation

For a development project

- Hydrocarbons in place
- Reservoir flow performance
- Reservoir drive mechanism
- Well productivity
- Watercut development
- Capex/Opex
- Commercial parameters
- Facility/infrastructure constraints
- Environmental regulations

We then devise strategies to capture upside, and to mitigate downside, uncertainties and risks, resulting in an objective, robust Options Value assessment.
All organisations have to make decisions, and conventional approaches are adequate for straightforward issues. However, the following complexities can make identifying the best strategy difficult:

- Significant investment
- Conflicting objectives
- A diverse range of interest groups
- Significant risks and uncertainties
- Constraints

Our Decision Risk Management (DRM) service employs a range of tools and methods to help clients structure and optimise decision making. DRM helps to choose between alternative courses of action in a rational and consistent way and is applied to both strategic decision making and operational risk management.

Through workshops and individual discussions involving client specialists, the DRM team structures the issues and business processes. Quantitative models can also be built which identify the decision options that optimise the selected value measures.

The benefits of our DRM approach include:

- Ensuring that expert opinions are fully understood
- Identifying the best strategy
- Enabling all interest groups to reach agreement
- Providing an audit trail for future assessments

### Simplified Decision Tree

<table>
<thead>
<tr>
<th>Appraisal Wells?</th>
<th>Measured reserves</th>
<th>Sanction project</th>
<th>Field development strategy</th>
<th>Actual reserves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes / No</td>
<td>High / Low / Best</td>
<td>Yes / No</td>
<td>FPSO / Sub sea tie-back / New Platform</td>
<td>High / Best / Low / NPV</td>
</tr>
</tbody>
</table>

### Which Appraisal Strategy

- **Is the reduction in Expected Value**
- **Worth the risk reduction?**

![Graph showing the probability of NPV less than a certain value versus net present value of development.](chart.png)
With the high cost of new Oil and Gas investments and the desire to realise value by reducing the cycle time between discovery and first production, there needs to be a project framework with which the decisions on whether to appraise or plan for mitigations can be made effectively. Since these decisions are necessarily multi-disciplined, understanding the trade-off between resolving further subsurface uncertainty by appraisal, and designing facility flexibility, requires an integrated systematic approach.
This involves the following steps:

1. Determine the variable of interest
   The variable of interest is the one that would be most instructive in providing a decision concerning the development – it could be reserves or costs but where we wish to provide a high-level check on the potential for field development, a commercial measure such as pre-tax NPV allows an early perspective on what uncertainties will drive further work on the development.

2. Determine the key Uncertainties
   Create a list of the key uncertainties affecting the development of the field as perceived by the technical team(s) today. Uncertainties overlooked at this stage will not be evaluated and hence will not be managed further along in the process.

3. Determine the likely range of values for the key uncertainties
   The next step is to facilitate estimation of the likely range of values that the uncertainties may take.

4. Determine the probability that the key uncertainties will take certain ranges of values
   Work in social sciences has uncovered strategies to improve our ability to estimate probabilities. This has led to well tried methods to provide probability estimates, including a pre-calibration exercises and a structured facilitated discussion.

5. Determine the impact on the variable of interest of changes in the key uncertainties
   The variable of interest can often be associated with most of the key uncertainties in a simple way.

6. Calculate what variables are most important
   The approach connects the impact of a change in a key uncertainty with the probability of that change and calculates some very simple statistics. It should be understood that until this calculation takes place it is nearly impossible to judge which uncertainties will be the major drivers, since a large impact with an associated small probability could be as important as a more modest impact and a larger probability. Once calculated, the key uncertainties can be ranked, as in a league table, where those uncertainties that provide the most uncertainty to the variable of interest will be at the top and those that have little effect at the bottom. From experience more than 80% of the total uncertainty will be contained in the top 4 or 5 uncertainties.

7. Manage the uncertainties by further appraisal or mitigating strategies
   Once those few uncertainties that affect the overall uncertainty in the project are identified, further tools can be used to clarify the optimum appraisal strategy or development of facility, or drilling approaches to mitigate them.

### Finding What is Important

**What is the key uncertainty?**

**Volume**
- BRV
- Model
- Sw

**Reserve**
- Swr
- Ksw
- Kh

**Value**
- Oil Disc.
- Plateau
- Height
- Gas Handling

Knowing what makes a difference allows efficient use of scarce resources.
The value of a portfolio of projects is maximised by implementing management strategies based on an appreciation of the effects of interactions between projects, in the context of practical constraints. These constraints may relate to resources (people, finance, equipment) or self-imposed constraints and targets, such as contractual commitments, internal aspirations, or even quotas.

Full probabilistic portfolio optimisation can identify “better” ways of managing a portfolio of assets and can be used to generate a predicted range of possible portfolio performance, against a range of metrics. This indicates strengths and weaknesses, allowing options for portfolio enhancement through specific management actions. Both the Base Value and Options Value can be further enhanced by the strategic overview provided by the Portfolio Effect.
Recent Project Examples

- Preparation of company guidelines for managing risk and uncertainty to make better field development decisions (Middle Eastern National Oil Company)
- Optimisation, in terms of project selection, timing and equity levels, for the entire portfolio of a West African country
- Advice on best practice procedures to address risk and uncertainty in preparation of production forecasts for business planning and reporting to the investment community (Large Independent Oil Company)

Uncertainty studies conducted in the mid-nineties (before production began) on four North Sea fields have been re-examined on the basis of the actual outcomes a decade or more later.

Due to the combination of low oil prices and lower ultimate recoveries than earlier developments, the fields had estimated marginal economic value at the time. Consequently development approval was contingent upon extensive uncertainty analysis aimed at providing assurances that downside outcomes would not lead to economic loss.

The overall trends shown in the figure between the point of economic sanction and now are that:

- There is a movement from static volume uncertainties to dynamic uncertainties of wells and the facility. Many of the factors that relate to static reservoir description have had their range of uncertainty decreased as a result of data that accumulates as the natural result of field development and production (well penetrations, production rates and volumes).
- The hydrocarbon volumetric uncertainty has diminished by about a half on average between sanction and the current status of these fields.
- The connectivity of the reservoirs remains a major uncertainty, even though all the fields have passed the halfway mark in their field life.
- The factors relating to field dynamic behaviour have increased in importance as the fields have matured; thus further appraisal and facility flexibilities could be planned earlier to improve the economics in later field life.

Taking a Calculated Risk
(Bailey, Caust, Lamb, Simpson and Rose, Oilfield Review, Autumn 2000, pp. 20-35)

Engineers, mathematicians and other experts have devised many tools to help us understand uncertainty and to evaluate and mitigate risk. The oil industry is permeated by uncertainty and encounters risk at every turn, yet many oilfield decision makers, perhaps most, give the new techniques a wide berth.
Risk and Uncertainty Management Team

Graeme Simpson
Graeme Simpson has BSc and PhD degrees in Geology from the University of Sheffield, England, and an MBA from the Cranfield School of Management. He worked for Esso/Exxon for 22 years, before joining the University of Aberdeen, Scotland, in 1997, as the Schlumberger Professor of Energy Industry Management, specialising in Portfolio Optimisation. He returned to industry in 2000, working for Gaffney, Cline & Associates for 6 years before joining RPS Energy in London UK, where he is currently a Director, with particular responsibility for resource assessments, valuations, portfolio optimisation and strategic advice. Graeme is an Honorary Professor in Petroleum Geology at the University of Aberdeen.

Peter Smith
Peter Smith has BSc in Physics and a PhD in Chemical Engineering. He has over 23 years experience as a consultant to the Oil & Gas industry as well as a substantial track record of working within integrated teams on a wide range of projects. Major decisions that he has worked on include oil and gas field development options, refurbishment of large scale processing facilities and asset integrity management. In particular, his expertise and skills include: risk management; workshop facilitation; petroleum recovery techniques, including gas injection, depressurisation, gravity drainage, gas condensates and waterflooding; production technology, including subsea well hook-up, commissioning and start-up, hydraulic fracturing, chemical well treatments, corrosion management, sand management and produced water management; cost optimisation.

Laurence Wickens
Laurence Wickens has a BA, MSc and DPhil in Physics. He has over 20 years experience as a consultant to the Oil & Gas industry as well as a substantial track record in the nuclear industry. He helps companies to analyse their decision options to reveal the underlying value measures, cash flows, benefits and risks and identify the best course of action. This experience includes a substantial track record of working within integrated teams on a wide range of projects. Major decisions that he has worked on include oil and gas field development options, refurbishment of large scale processing facilities and asset integrity management. In particular, his expertise and skills include: risk management; workshop facilitation; petroleum recovery techniques, including gas injection, depressurisation, gravity drainage, gas condensates and waterflooding; production technology, including subsea well hook-up, commissioning and start-up, hydraulic fracturing, chemical well treatments, corrosion management, sand management and produced water management; cost optimisation.

Pete Naylor
Pete Naylor has a BSc in Physics and a PhD in Chemical Engineering. He has over 23 years experience as a consultant to the Oil & Gas industry and has also worked in the nuclear and water industries. He specialises in helping companies to analyse their decision options to reflect the underlying value measures, cash flows, benefits and risks and identify the best course of action. This experience includes a substantial track record of working within integrated teams on a wide range of projects. Major decisions that he has worked on include oil and gas field development options, refurbishment of large scale processing facilities and asset integrity management. In particular, his expertise and skills include: risk management; workshop facilitation; petroleum recovery techniques, including gas injection, depressurisation, gravity drainage, gas condensates and waterflooding; production technology, including subsea well hook-up, commissioning and start-up, hydraulic fracturing, chemical well treatments, corrosion management, sand management and produced water management; cost optimisation.

Mitch Bilderbeck
Mitch has a BSc in Petroleum Engineering from the New Mexico Institute of Mining and Technology and an MBA from the University of Texas at Austin. He is a Licensed Professional Engineer in Oklahoma, USA, and an SPE Certified Petroleum Professional.

Mitch began his career in 1977 as a petroleum engineer with Phillips Petroleum Company and worked in a variety of senior positions, including assignments as lead petroleum engineer for development and operation of the core Phillips-operated oil and gas fields in the UK Sector of the North Sea. Since 1990 he has worked as an independent consultant on a wide range of oil and gas development projects and has broad experience in the evaluation of risk and uncertainty at all stages of the Field Development Process including Appraisal, Concept Selection, Definition Engineering and Detail Design. He has prepared evaluations of technical, commercial, schedule and interface risks for a number of development projects around the world, including projects in the North Sea, West Africa, Middle East and Asia.

Otto Aristeguieta
Otto has a BSc in Geophysical Engineering, an MBA and an MSc by research, specialising in portfolio optimisation. He has developed an understanding of economic modelling and risk analysis for exploration and production. He has analytical skills in optimisation techniques, project appraisal, strategic planning and international petroleum fiscal systems. He has performed portfolio analysis and optimisation studies in the North Sea and in Angola. Otto has dual Spanish and Venezuelan nationality, and speaks fluent Spanish, English and basic Portuguese.
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