Good Decisions Require Firm Geological Foundations

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This paper argues that a thorough understanding of the geology that underpins a project is a critical pre-requisite for good decision-making. Gaining that understanding, and communicating it, requires an ability, and the techniques, to visualise and to express numerically the range of possible geological outcomes, in terms of risk and volumetric/value uncertainty.

Risk (or chance) can have several somewhat different meanings, in this context, including the chance of finding measurable quantities of hydrocarbon (GCoS or Pg) and the chance of finding economic quantities of hydrocarbon (ECoS or Pe). In SPE/WPC/AAPG Resource Classification framework terms, GCoS/Pg is the chance of converting a Prospective Resource into a Contingent Resource (and one minus this is the risk of drilling a dry hole); ECoS/Pe is GCoS/Pg multiplied by the conditional probability (chance) that the quantity found will be economic, that is greater than the economic threshold volume.

To compute Expected Monetary Values, we should use ECoS/Pe, although it is common practice to approximate that by using GCoS/Pg and letting the low volume end of the range have negative value, if that's what the cash flow analysis indicates. For portfolio optimisation, the risk measure used depends on the parameter that is being optimised; for discovered volumes (that is, contingent resources plus reserves), GCoS/Pg should be used; for reserves or value, it should be ECoS/Pe.

Uncertainty in the range of volumes and/or value can be handled satisfactorily by a variety of methods, including Monte Carlo simulation, multiple scenario analysis and Swanson's Rule.

The SPE/WPC/AAPG Resource Classification framework is proposed as the basis for capturing and quantifying concepts of risk and uncertainty, as these relate to projects.

Successful Decision-Making in Future Exploration: High Technology, Geological Model, Organization

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According to Industry benchmarking for the last decade, the Majors have discovered decreasing reserves per exploration dollar, from year to year over the period. The situation of increasing competition and the need to hunt for more difficult plays entails pushing away the limits of technology, while returning to the fundamentals of petroleum geology for better interpretation and possibly new concept generation. An improved recognition of play drivers and more accurate predictivity are expected, and in fact observed, in the practice of risk analysis and related decision-making. Those trends are illustrated with examples from the Gulf of Mexico, North Africa,the Gulf of Guinea and South America, focusing on improvements in seismic imaging combined with proper geological models, and a compulsory "return to the rocks", still more notable when seismic is poorly conclusive. The application of consistent risk management to a recent portfolio shows significant progress in forecasting, with respect to prospect reserves particularly, and illustrates the importance of observing a minimum level of chance factor and selecting acceptable target sizes, while avoiding the "high risk-high reward" illusion. Setting up an exploration organisation and culture is a must to ensure the most efficient use of technology, the basics of geology and related management tools. Some preferred avenues are presented in the fields of accountable technical lines and career development. In an increasingly mature reserve base, the modern explorationist is faced with a durable search for new frontiers in technology, accessibiliy and even politics, and a "wishing list" of challenging needs and future exploration grounds is proposed in conclusion.

Intuition and Bias in Risk Assessment: Impact and Remediation

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Psychological research has demonstrated that people are prone to cognitive biases – discrepancies between calculated, optimal decisions and those made using intuition – and that these are particularly prevalent when decisions are made under risk and uncertainty. We present analyses of responses to a questionnaire designed to highlight well-known cognitive biases and other flaws in intuition. The biases are discussed and their potential impact on risk assessment within the industry is discussed with a focus on remediation.

To avoid criticisms of domain specificity sometimes levelled against biases research, all questions used were specifically related to the petroleum industry. Questions designed to show anchoring, overconfidence and availability biases and logical and probability-based problems were included and administered to 187 petroleum industry personnel.

Despite domain familiarity, industry personnel exhibited strong biases in their intuitive judgements, indicating that familiarity/expertise does not eliminate bias. We conclude that such biases are likely to already be impacting on industry assessments of probabilistic outcomes. The effect of previous risk training is also discussed, with the conclusion that, if risk training does provide benefits, these are eroded over time and more regular training is needed to maintain the skills taught in such courses.

We conclude that a better understanding of biases that can affect industry decisions, not just in terms of their existence but also their mechanism of action, will allow more meaningful attempts at remediation. Current techniques designed to reduce bias need to be examined critically and the strengths and weaknesses exposed.

Best Practices in the Management of Uncertainty in the Upstream – Concepts and Examples

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Uncertainty is becoming an increasingly important topic within the upstream energy industry. This is driven by complex opportunities, incentives to monetize assets rapidly, large up-front investments, and a fierce competitive climate. This has catalyzed improvements in the characterization and communication of uncertainty, along with its integration with decisions.

A learning-based system describes a generalized uncertainty work process. Initially, it is important to do a Situation Analysis, to evaluate the objectives, constraints, previous learnings, and critical factors. This sets the context and ensures a shared understanding of the problem. The next step is to Define Alternatives. This requires us to develop alternative hypotheses, identify risks, and evaluate dependencies. Alternatives are developed in a climate of collective inquiry, with external views sought and honored. Third, is the development of an Integrated Uncertainty Model. In addition to the familiar probability distributions generally employed, it is critical that discrete scenarios are developed to help describe, test, and communicate uncertainty. Additionally, an uncertainty management plan is developed. The last aspect is to Execute and Steward – monitor results, share learnings, and administer the plan. The cycle is repeated as important learnings trigger a new uncertainty evaluation, starting with Situation Analysis.

From the case studies presented, human factors remain a challenge, with several pitfalls illustrated: • Key uncertainties overlooked (unknown unknowns) • Inability to see alternatives (myopia) • Systemic errors based on paradigms (bias) • Misalignment of expectations and results (surprises) • Reluctance to accept uncertainty(demand for definitive answers) • Business factors override technical characterization (momentum)

Realizing the Potential of Decision-Making Under Uncertainty

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Over the past few decades there has been strong uptake, at the exploration end of the oil and gas industry stream, of probabilistic decision-making. This has not, however, been reflected at the more downstream development and production end of the oil and gas decision-making spectrum.

Improving decision-making relies on understanding the types of decisions being made in the oil and gas industry and ensuring that optimal decision processes are implemented in these real world decisions so as to maximise the chances of good outcomes.

There has been much work carried out, within cognitive psychology, in observing how people actually make decisions. Little work, however, directly relates these findings to the specific decision-making circumstances of the upstream oil and gas industry. Nor has there been work on how the insights stemming from psychological research might be used to improve decision-making in the industry.

This paper documents the theoretical differences between exploration, development and production decision-making and marries this with observations as to how decisions in these fields are currently being made and suggests how decisions of the observed types should be made.

A primary observation is that different types of decisions require different decision-making approaches in order to achieve optimal outcomes. The implications of this conclusion are examined in relation to the question of the application of deterministic versus probabilistic tools, data and processes to a variety of oil and gas decisions including reserves calculations.

Simple Models for Decision-Making under Uncertainty

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Decisions about field development are typically made on the basis of maximising some economic criterion (such as net present value or internal rate of return). These are determined by explicit modelling of field performance usually based on a fine grid geological description followed by numerical flow simulation. In the presence of uncertainty this must be done many times to sample different realisations of possible reservoir structure. For any given production strategy this will give a range of possible NPVs or IRRs. Then the decision is based on which production strategy maximises the expectation value of NPV or IRR, or possibly some other moment which better accounts for the risk. The problem with this strategy is that it is extremely time consuming and very field and model dependent. It is generally not possible to determine how the uncertainty affects the nature of the decision or what the impact of the decision criterion is.

To study these we have developed some very simple generic models of reservoir decision making. These start from the observation that the net present value is the Laplace transform of the cash flow for the project and the internal rate of return corresponds to the zeros of this Laplace transform. We then propose some simple generic models of cash flow which enable the Laplace transform to be carried out analytically. From this we demonstrate several generic results. i) The optimal decision can depend crucially on the decision criterion (NPV or IRR) ii) depending on the nature of the uncertainty, decisions based on deterministic models can be over or under optimistic. These results give insights into the way that real decision making models work.