Integrated approach to upstream decision making

London 20 – 21 January 2010
Production decline and smaller discoveries are seen in many mature areas.

Oil and gas companies are looking for new areas, risk and uncertainty may be high

- offshore ultra deep water
- challenging logistics onshore
- new technology required
Upstream – ”a complicated industry”

Risks and uncertainty everywhere

- exploration
- recovery
- new technology
- infrastructure
- market
- rules and regulations
- prices
- etc...
Risk and uncertainty influence on upstream decisions

Typical upstream decision situations

- drill exploration well
- start field development
- select drainage strategy
- concept selection
- drill production wells
- portfolio transactions (buy and sell)
- etc…
Exploration

• Discovery?

\[ P_{\text{probability of success}} = P_{\text{trap}} \times P_{\text{res}} \times P_{\text{source}} \]

• Discovery volume?

\[ \text{STOOIP (stock tank oil originally in place)} = \frac{\text{GrV} \times \text{NG} \times \Phi \times (1 - S_w)}{B_o} \]

Seismic interpretation

Geoanalyses
Recoverable volume

How much of the STOOIP can be produced?

Reserves = STOOIP \times R_{\text{rec.factor}}

Reservoir quality          Analyses             Decisions
Development and operation

Drilling time and cost?
- Rig rate
- Cost of materials
- Rig availability
- Drilling time

Production start, cost and regularity?
- Technology
- Capex
- Infrastructure
- UP time
- Opex
- Shut down
Economic modelling basis for decision making
Essential in an upstream decision making process

- Integrated work approach
- Software tool to handle all data
Integrated work approach

Economics

Rules Regulations
Tax
Market

Geology
Geophysics

Reservoir engineering

Drilling engineering

Field Development

Production

Cost elements

Commercial premises

Economic analysis

CAPEX
OPEX
DRILLEX
TARIFF
ABANDM.
Integrated work approach - benefits

• Includes all disciplines from subsurface to portfolio management – common understanding

• Inspires and promotes cooperation within the project teams - better communication

• May trigger new and different perspectives

• Includes all relevant data

• Takes risks and uncertainties for all relevant disciplines into account

• Ensures that all sides of a decision situation are considered

• Easier to update project if needed
### Example - Decision making process

<table>
<thead>
<tr>
<th>Signature Bonus</th>
<th>Prospect def.</th>
<th>Exploration/ Appraisal</th>
<th>Dev. plan</th>
<th>CAPEX</th>
<th>OPEX</th>
<th>Economics</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Signature Bonus" /></td>
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<td><img src="image" alt="OPEX" /></td>
<td><img src="image" alt="Economics" /></td>
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### Risks
- Uncertainties
- Scenarios

### Discovery and prospect located close to infrastructure offered for sale

### Work to be done

- map discovery STOIOIP
- map and risk the prospect
- decide drainage and production strategy
- make a development plan
- price prognosis
- evaluate the tax system and possible fees
- decide to include the prospect or not
- evaluate the discovery in relation to total portfolio

### Calculate and decide bid for the discovery with or without prospect!

**Discovery A**

**Prospect B**
Some of the uncertainties

- STOIP?
- Oil price?
- Pipeline capacity?
- Tie in to Field A?
- Tariff?
- Available processing capacity?
- New Platform?
- Regularity?
- Subsea?
- Pre-drilled wells?
- # wells?
- # templates?
- Discovery A
- Production rate per well?
- Cost per well?
- Injection wells?
- Pipeline cost?
- CAPEX?
- Drilling rigs?
- Market?
- Logistics?
- Exploration risk?
- OPEX?
- Prospect def.
- Exploration/Appraisal
- Dev. plan
- CAPEX
- OPEX
- Economics
- Signature Bonus

Risks
Uncertainties
Scenarios

INTEGRATED DECISION SUPPORT SYSTEM
Define concept scenarios

Concept scenario decision tree

Base Scenario

New platform

Existing Infrastructure

Discovery A

Prospect B

P = 0.20

P = 0.20

P = 0.80

P = 0.80

P = 0.20

P = 0.80

Base scenario

Drill prospect

Platform

Drill prospect

Subsea
Deterministic vs. probabilistic approach

How can input risk and uncertainty be quantified?

**DETERMINISTIC**

- Three discrete outcomes
- Base Case ≠ Expected for the project
- High case and low case are extremely unlikely to occur

**PROBABILISTIC**

- Full range of possible outcomes
- True expected NPV
- True P90
- True P10
- Correct comparison and ranking of options
### Statistical Measures

<table>
<thead>
<tr>
<th>Oil</th>
<th>Mean</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>2.16</td>
<td>1.59</td>
</tr>
<tr>
<td>Mode</td>
<td></td>
<td></td>
</tr>
<tr>
<td>St.dev</td>
<td>1.10</td>
<td></td>
</tr>
<tr>
<td>P0</td>
<td>0.33</td>
<td></td>
</tr>
<tr>
<td>P5</td>
<td>0.78</td>
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<tr>
<td>P10</td>
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<td></td>
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<tr>
<td>P25</td>
<td>1.39</td>
<td></td>
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<tr>
<td>P50</td>
<td>1.93</td>
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<tr>
<td>P75</td>
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<tr>
<td>P90</td>
<td>3.62</td>
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<td>P95</td>
<td>4.20</td>
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<tr>
<td>P100</td>
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</table>

**Mean**  
The same as expected value. Arithmetic average of all the values in the distribution. The preferred decision parameter.

**Mode**  
Most likely value. The peak of the frequency distribution. Base case?

**P50**  
Equal probability to have a higher or lower value than the P50 value. Often referred to as the Median.
Probabilistic approach

**SIMULATION**

Presents full range of possible outcomes

Key factors contributing to overall uncertainty

**RESERVES**

- **GRV**
- **N/G**
- **Ø**
- **Sw**
- **Rc**
- **Bo**

**NEXT TARGET**

**PRODUCTION**

- **DEV.COST**

**Table and Chart**

<table>
<thead>
<tr>
<th>NFV</th>
<th>Mean</th>
<th>Mode</th>
<th>Std.dev</th>
<th>P10</th>
<th>P50</th>
<th>P90</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>256</td>
<td>293</td>
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<td>-58</td>
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<td>271</td>
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<tr>
<td></td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>0.5</td>
</tr>
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**IPRES**

INTEGRATED DECISION SUPPORT SYSTEM
Decision support tool outline – consistent approach

- Rock Volume Parameters
- Rock & Fluid Characteristics
- Recovery Factor

Oil and Gas Reserves / Resources

Capacity Constraints
Facilities & Wells, Schedule

- CAPEX
- OPEX

Production Profiles

- Revenue
- Tariff

Cash flow

- Cut off
- P&A Abandonment
- Fiscal Regime

Results
- Probability Plots
- Time Plots
- Decision Trees
- Tornado Plots
- Summary Tables

INTEGRATED DECISION SUPPORT SYSTEM
Compare and rank

Concept scenario analyses

Analyses

Compare and rank

Optimize and update

Value of "best branch" basis for bid
Proposed decision-making process

1. Frame the decision using a decision tree
2. Select a base (reference) analysis
3. Model key uncertainties and risks for all disciplines (starting with the base analysis)
4. Run probabilistic simulation sampling all input distributions
5. Inspect results and refine model if necessary
6. Model the range of options that exists (use the base model as starting point)
7. Solve decision tree with price simulation and as part of portfolio
8. Review and decide
Portfolio effects on risk

Systematic risk

Cannot be reduced by diversification.
Risk associated with market, (price, currency, inflation, material cost).

Unsystematic risk

Can be reduced or eliminated in a portfolio of assets through diversification.
(Specific risk).
Risk associated with exploration, recovery and production, development and operation.
Decision support tool - benefits

- Consistent approach assures consistent and comparable results
- Provides for full data capture and results in full range of possible outcomes (probabilistic simulation)
- Helps to make complex situations clear and readily understood
- Fast updating of projects
  - Can be used under negotiations
- Results in improved decision making over time, which maximizes the value of the portfolio
Conclusion

<table>
<thead>
<tr>
<th>EXPERTS</th>
<th>PROJECTS</th>
<th>DATA</th>
<th>ANALYSES</th>
<th>DECISIONS</th>
</tr>
</thead>
</table>

- Method x
- Analysis 1
- Method y
- Analysis 2
- Method z
- Analysis 3
- Analysis 4
- Analysis 6

DECISION-MAKING PROCESS

PORTFOLIO

CONSISTENT APPROACH → IMPROVED DECISIONS

INTEGRATED DECISION SUPPORT SYSTEM
Decisions generate money!

Decision theory
- Decision parameters
- Project optimization
- Decision trees
- Portfolio management

Technical Disciplines
- Basic economics
  - Systematic, unsystematic risk
  - NPV, discount rate
  - Tax systems, price simulation

Basic probabilistics
- Monte Carlo simulation
- Mean, Mode, P10, P50, P90
- Correlations

Quantifying uncertainty
- Geology, geophysics
- Production, drainage
- Drilling, facilities, timing

DECISION SITUATIONS
- Drill exploration wells
- Choose field development concept
- Choose drainage strategy
- Rank and drill production wells
- Buy/sell assets

DECISIONS
- Top Management
- Portfolio Managers
- Economic Analysts
- Project Managers
- Technical Disciplines

Come see us at our booth for further discussions.
Backup
‘Mean’ for decision-making

• A serious problem (10 days delay) has a ~25% chance of occurring.

• However, additional information indicates a possible delay of ~20 days.

• Both cases were run through a Monte Carlo simulation.

• Mode and P50 are identical in the two Monte Carlo evaluations.

• Mean increases from 70.3 to 73.4 days.

• Only the Mean takes into account that the problem is more serious than what was first assumed.
Example Contact Uncertainties

On a piece of paper:
• Sketch the most optimistic case with respect to reserves
• Sketch the most pessimistic case with respect to reserves
• Sketch a base case with respect to reserves
Example Contact Uncertainties - Cases

Non-communication

Communication

PESSIMISTIC

OPTIMISTIC

EXPECTED CASE???
Economic potential

Influence on commerciality

- reservoir depth
- production /well
- water depth
- technology
- logistics
- costs
- tax and other fees
- oil and gas price
- etc.