RISC Advisory: Common misconceptions in risk analysis
Common Misconceptions in Subsurface and Surface Risk Analysis

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Agenda

- Describing the problem
- Impact of problem
- Small Samples
  - Wrong Tool (EMV) & Theory of Inevitable Disappointment
- Large samples & portfolio effect
  - Would you invest in this company?
- Conclusions
- Suggestions to improve decision making
### Decision Makers

- Requires management to steer towards required outcome
- Poor estimating
- Wrong decision tools

**Grey Area**

- $2 + 2 = 4$
- $2 + 2 + a = x$?
- $2 - 2 = 4$
The Problem: Poor Surface Estimating

COST

E&P Project Cost Overruns:
25 major projects since year 2000

TIME

FID to RFSU Avg. Overrun: 10 months (23%)
1 project (Darwin LNG) came in on schedule

Comparison of targeted FID date to actual FID date for ten Australian LNG projects

<table>
<thead>
<tr>
<th>Project</th>
<th>Operator</th>
<th>Target FID</th>
<th>Actual FID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pluto 1</td>
<td>Woodside</td>
<td>2007</td>
<td>August 2007</td>
</tr>
<tr>
<td>Gorgon 1-3</td>
<td>Chevron/Exxon/Shell</td>
<td>2004/2008</td>
<td>September 2009</td>
</tr>
<tr>
<td>QC LNG</td>
<td>BG Group</td>
<td>Early 2010</td>
<td>November 2010</td>
</tr>
<tr>
<td>GLNG</td>
<td>Santos/Petronas</td>
<td>Mid 2010</td>
<td>January 2011</td>
</tr>
<tr>
<td>APLNG (Train 1)</td>
<td>Origin/CoP</td>
<td>End 2010</td>
<td>July 2011</td>
</tr>
<tr>
<td>Wheatstone</td>
<td>Chevron</td>
<td>End 2011</td>
<td>September 2011</td>
</tr>
<tr>
<td>Ichthys</td>
<td>Inpex/Total</td>
<td>End 2010</td>
<td>January 2012</td>
</tr>
<tr>
<td>APLNG (Train 2)</td>
<td>Origin/CoP</td>
<td>End 2011 to Early 2012</td>
<td>July 2012</td>
</tr>
<tr>
<td>Browse</td>
<td>Mid 2012</td>
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<td>TBA</td>
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The Problem: Poor Subsurface Estimating

Exploration Optimism

Expert Complacency

Anchoring

Complexity & Complacency

If information ‘unpacked’ uncertainty is recognized better

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Impact of Poor Estimating

NPV gained (or lost) after two years of production relative to plan at sanction

1) Poor estimate of inputs
2) Inappropriate project ‘shaping’ i.e. wrong development for the resource
3) Confusing accuracy with confidence as information increases
4) Believing sophistication reduces risk
5) Under-estimation of time to complete tasks
6) Scope changes: poor definition, lack of rigor in approval process
7) Ignoring dependencies and inter-dependencies
8) Poor risk management: Lack of contingency, ineffectual contractual protection

70% of projects had lower NPV than forecast at FID
Average NPV = 41% lower than planned

10 year sample

Reasons for NPV loss of 60 well programme

- 32% Forecast
- 73% Initial Production Rates
- 4% Drilling Costs
- 4% Project Delays
- 27% Project Type
- 32% Base Case Realisation

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Average NPV = 41% lower than planned

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Portfolio Theory v Reality (eg: small samples)

1. Prospect Identified

2. Probabilistic Risk and Resources Calculated with Standard Software

3. Peer Review Meeting

4. Compare to Portfolio

5. Prospect Technically Mature

- EMV > 0: Drill
- EMV < 0: Drop

*Markowitz (1959)
Hydrocarbon Resource Distributions are typically Log Normal

So what goes into EMV calculation?

Central Limit Theorem
Expected Monetary Value (EMV)

- EMV = (Chance of Success x NPV) – (Chance of Failure x Cost of Failure)
- EMV is a good tool but not understood
- Used as hurdle to accept/reject **BUT** used incorrectly most of time : WHY?
- ‘Expected’ = Most Likely = Mode
- Mode ranges from P90 to P50 in Log Normal distributions
- Decisions need to understand whole distribution, not just one point
- Theory of Inevitable Disappointment (Horner, 1982) highlights inadequacy of using EMV and not considering whole distribution
Actual performance of portfolio of assets will inevitably be worse than predicted

- Assume perfectly unbiased prediction with dispersion
- Projects chosen for investment in portfolio based on predicted or expected value

Horner (1982)
Actual performance of portfolio of assets will inevitably be worse than predicted

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Outcomes below threshold, but projects were chosen for portfolio based on predicted value

Horner (1982)
• Equally there will be portfolio outcomes above the ‘company hurdle rate’/threshold
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Modelling of 255 ‘Normal’ projects

Portfolio predicted Rate of Return = 27%
Actual outcome Rate of Return = 18%

Horner (1982)

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E&P projects versus stock market returns

Portfolio Effect of predictability of multiple prospects/projects

- Normal
- Main Risk is Volatility

- Lognormal
- Risk of Total Loss

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Would you Invest in this Exploration Co?

Cumulative Value

Prospect 1
Prospect 2
Prospect 3
Prospect 4
Prospect 5
Prospect 6
Prospect 7
Prospect 8
Prospect 9
Prospect 10
Prospect 11
Prospect 12
Prospect 13
Prospect 14

1 Year

>90% of Total Predicted MMBoe

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Major components of flawed thinking relevant to project related cost/time estimates can be grouped into the following:

- **Pragmatic**: Focus on these which have biggest impact
- **Overconfidence**: People tend to think they are better than most
- **Anchoring**: Reliance on a few (not necessarily representative) data points
- **Packing**: Answer depends on how question is presented
- **Availability**: Skewed by recent or more vivid events
- **Social biases**: Human tendency to conform to views of group to which we belong
- **Planning Fallacy**: Tendency to hold a confident belief that one’s own project will proceed as planned, even while knowing that the vast majority of similar projects have run late
RISC has evaluated hundreds subsurface (reserves and resources) & surface (costs and schedule) projects over twenty years.

- No one individual or company has all the answers
- Same mistakes keep being made and repeated – We learn but also forget
- Recognise “black swan” events & make allowance with contingency
- Be wary of over confidence & experts: use genuinely independent peer reviewers
- Be aware of culture of many organisations that suppresses uncertainty & reward behaviour that ignores it (e.g. an executive who shows greater confidence in a plan is more likely to get it approved than one who lays out all the risks and uncertainties)
- Awareness of the effect of heuristics and biases on our decision making abilities
- Learn from previous experience (feedback/post-mortems), **calibration is KING**
Thank you to my current & former colleagues Simon Whitaker & Henry Pettingill for their contributions.