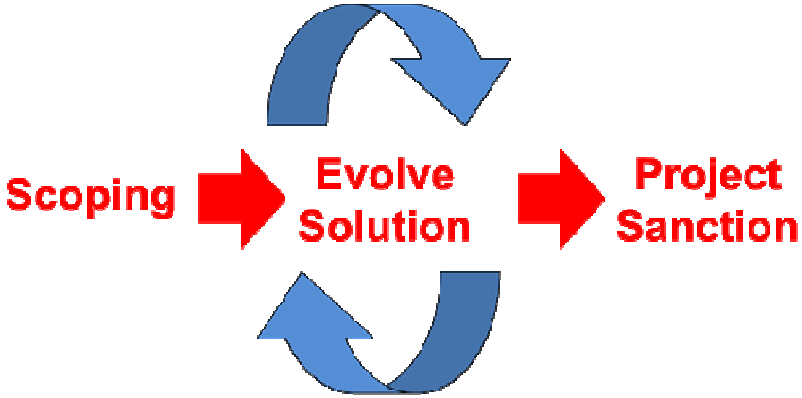

Resilient Field Developments that can Accommodate Uncertainty are the Best Solution for a Sustained Low Oil Price Environment

Dr Chris Hopper

Current State of the E&P Industry

Strategy - Technology - Business

Wednesday, January 20, 2016 1:41 PM

Shell Fires Another 10,000; Energy Layoffs Top 250,000; Oil Breaks $28 Again

- The drop in oil price in 2015 has led to a major retrenchment in the industry with many projects cancelled and staff laid off
- High costs due to a hot market were seen as part of the problem. This has led to arbitrary across the board cuts, which on their own will not make projects economic
- While the oil price may recover from the current low levels, it is unlikely to return to the $70 – 110/bbl range seen between 2005 and 2015
- Relying on cost reductions, an increase in oil price or by hoping that doing things the same way will produce a different outcome is unlikely to be a successful strategy

In a period of sustained low oil prices, a different approach is required

Project Performance – Industry Benchmarks

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Our research shows that the majority of projects are facing delays and/or cost escalations and these overruns are prevalent in all of the segments and geographies.

64% of the projects are facing cost overruns.

73% of the projects are reporting schedule delays.

Europe

53% Proportion of projects facing cost overruns

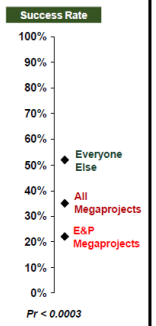
74% Proportion of projects facing schedule delays

57% Average project budget overruns

Paradoxically, we delivered our worse performance on a large scale…

We deem a project to be a failure if one or more of the following occurred:

Costs Grew	25% +
Overspent (Absolute Measure)	25% +
Schedule Slipped	25% +
Schedule v. Industry Average	50% +
Severe and Continuing Production Problems *(First Two Years)*	Yes



CONFIDENTIAL R INDEPENDENT PROJECT ANALYSIS

- How good is the industry at delivering major projects?
- Earnst & Young in a 2014 report showed that 74% of European projects had schedule delays, with 53% having cost overruns at an average cost overrun of 57%
- IPA came to similar conclusion in 2011 and reported that only 22% of E&P projects succeeded, compared to a 52% success rate in other industries
- IPA also showed that project performance in the E&P industry has got worse in recent years, with only 50% of E&P projects failing in 2003 compared to 74% today

These high levels of project failure are due to a systemic failure of project delivery

Production History of the UKCS

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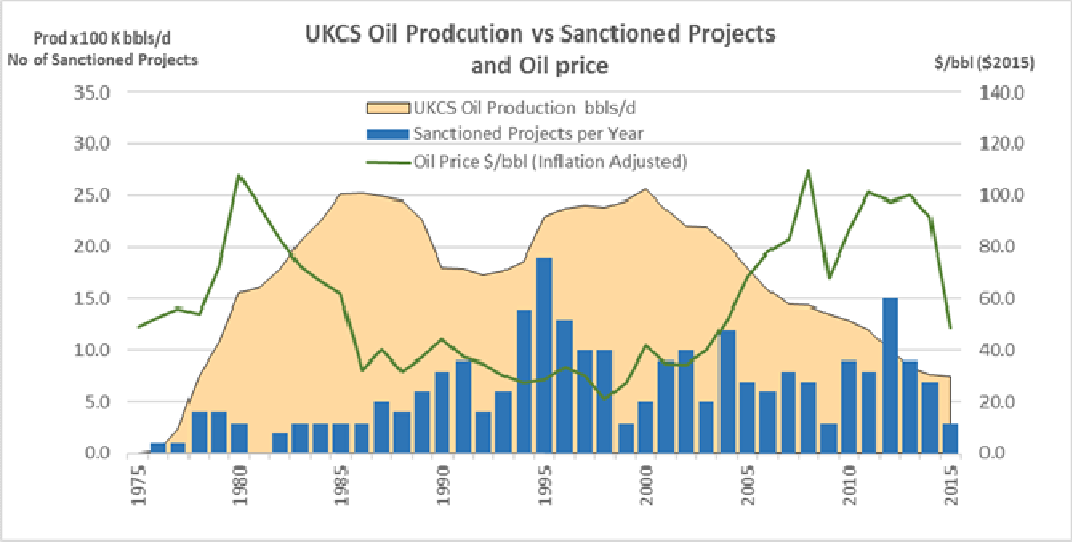

- Project delivery was much more successful 10 – 20 years ago, so what was the reason?
- In the UKCS, this period saw the execution of a large number of projects that produced an increase in production from 1.9 mm bbls/d in 1990 to 2.6 mm bbls/d in 2000
- The maximum number of projects sanctioned in a single year was 19 in 1995, which is still a record
- The increase in the number of projects was not the result of a high oil price, which remained between $30 & $40/bbl from 1985 to 2005 (in escalated 2015 $)
- The increase was not due to a string of new discoveries as many of the discoveries had been stranded for many years

The increase in sanctioned projects in the 1990's was due to the use of different business models, such as regional hubs, alliance contracts and 3rd party processing

Some of these 1990's Projects

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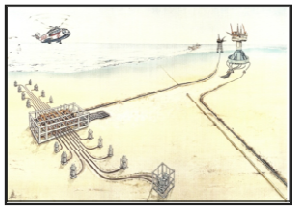
Strathspey



- Discovered in 1975
- Stranded for 15 years
- Largest subsea development in the UKCS with 18 subsea wells
- Project sanction after 18 months
- First oil in 1993
- Longest subsea tieback
- First 5x2" 10M subsea trees
- First 3rd party tieback to a host platform in the UK
- Commercially driven
- Conflicted Joint Venture
- Conflicted gas transporter

Captain

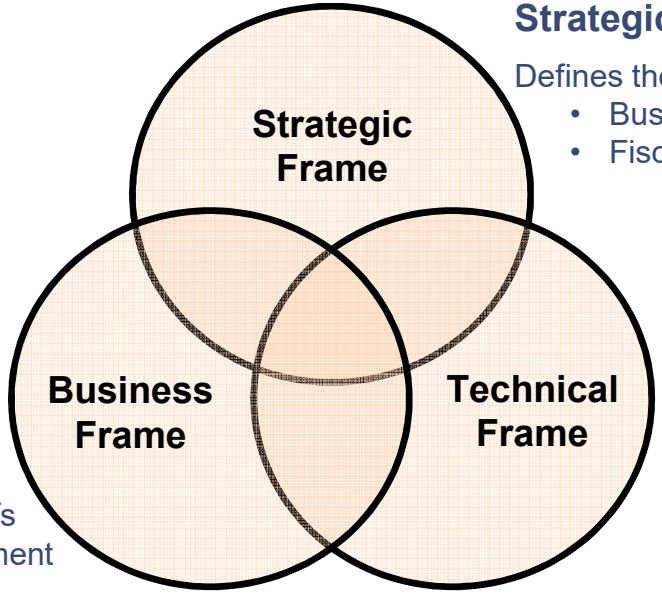
- Discovered in 1977
- Stranded for 15 years
- First high viscosity heavy oil development in the UKCS
- Project sanction after 2 years
- First oil in 1997
- Fiscally driven project plan
- Design contest to select development option
- No takers when 50% equity put up for sale for $15mm
- 15% equity sold at sanction valuing the field at $1,500mm

Galley

- Discovered in 1974
- Stranded for 20 years
- Smallest stand alone project in the UKCS
- Project sanction after 2 years
- First oil in 1998
- 11 appraisal wells over 15 years proved up 20 mm bbls
- Large reserve uncertainty
- Gainshare contract for the FPS

- **All these projects had been stranded for 15+ years**
- **All were brought to sanction in less than two years**
- **All used innovative business models and commercial strategies**
- **All focused exclusively on monetizing the asset**

How Was This Achieved – A Holistic Approach



Strategic Frame

Defines the Playing Field
- Business model
- Fiscal Terms

Business Frame

Defines the Value
- Commercial/Tariffs
- Partners/Government

Technical Frame

Defines the Solution
- Facilities
- Subsurface

- **Most projects focus on the Technical Frame**
- **Most problems and solutions lie in the Business Frame**
- **Most money is made in the Strategic Frame**

Combined with a Discovery Driven Process

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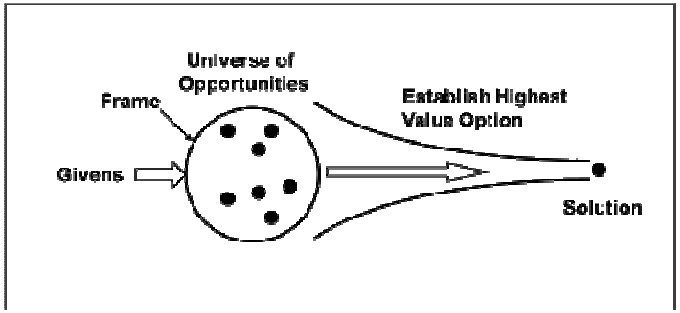
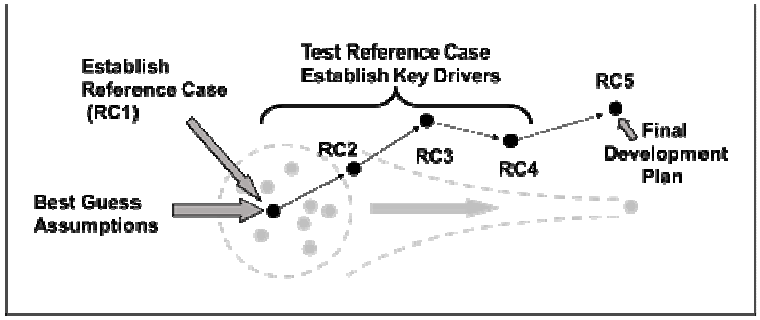


Traditional / Waterfall Approach

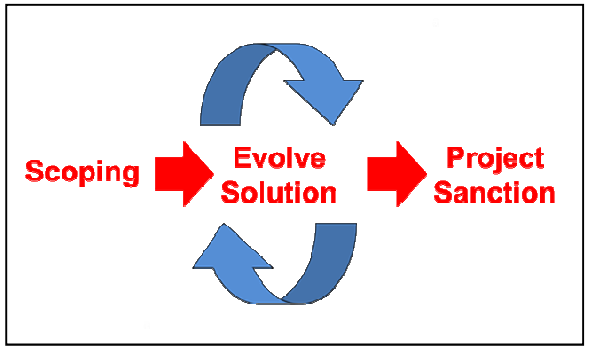


Discovery Driven / Agile Approach

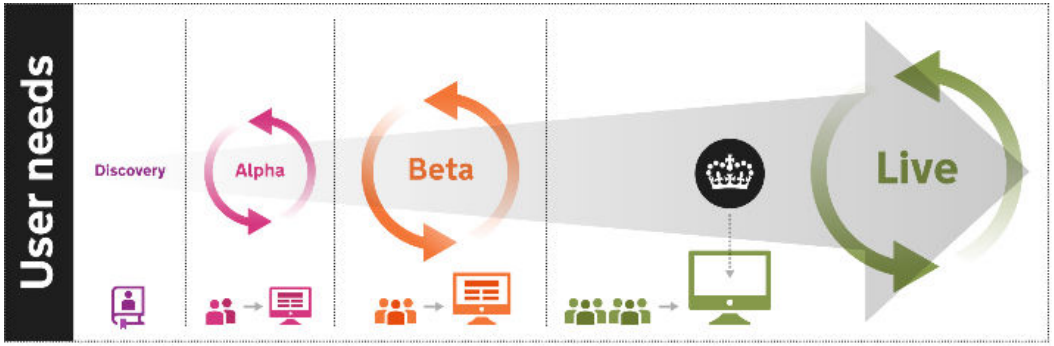
- A traditional gated approach specifies Givens, generates a Frame and then selects a solution using a rigorous linear process
- A Discovery Driven approach defines a Reference Case and evolves a solution by testing the assumptions and looking for a better outcome through an iterative process
- The traditional approach is well suited to projects where the Givens are well defined and a Universe of Opportunities can be generated that includes all possible outcomes
- A Discovery Driven approach is better suited to projects that have uncertainty, poor definition or the solution cannot be defined without additional information

With a Discovery Driven approach, the final solution is often not predicted at the outset and so unexpected and higher value solutions are a common outcome

Similar Processes are Used in Other Industries



Discovery Driven



UK Government Digital Services

- This Discovery Driven approach, where a solution is evolved through a prototyping and iterative process has many similarities to business processes used in many other industries
- Discovery Driven Planning was described by McGrath & MacMillan in 1995
- In a 2006 survey, the IT industry had a failure rate of 65% with an average schedule overrun of 46%. Agile Project Management has been widely adopted by as a way to improve project delivery
- Adaptive processes are now commonly used in many industries
- Management by Discovery (MBD) is an approach where Klein states that "***The MDB mindset is to look for opportunities to figure out better goals than the ones specified at the beginning***"
- VUCA (Volatility, Uncertainty, Complexity & Ambiguity) has recently become a fashionable approach
- The UK Government Digital Services has gone totally Agile

Agile and Adaptive processes are being adopted across many industries

What is a Resilient Project?

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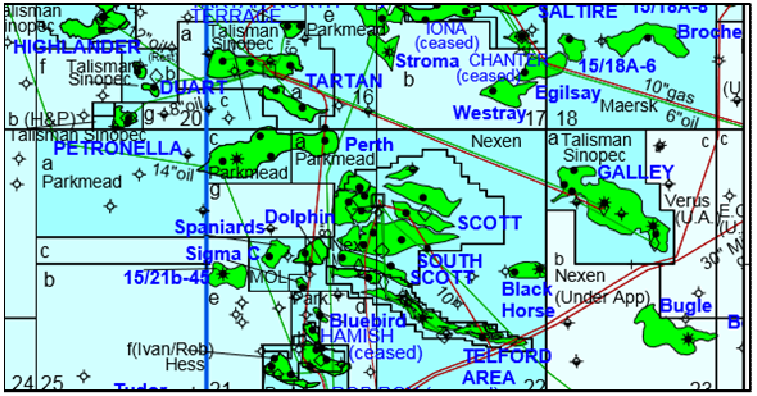
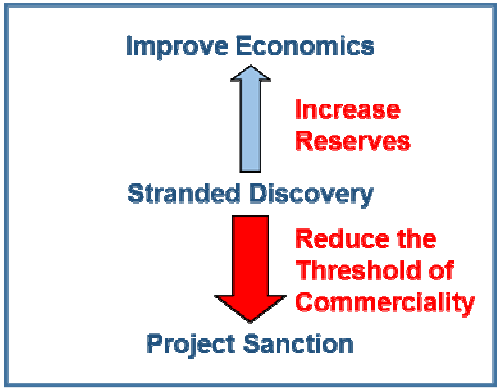
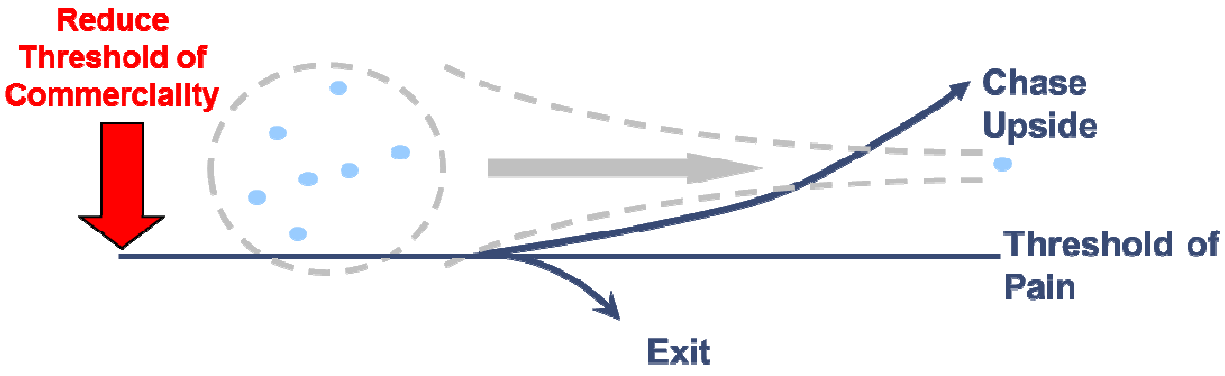




- Galley was discovered in 1974. Over the next 21 years, 11 appraisal wells proved up 20 mm bbls
- Appraisal was suspended in 1995 and instead of trying to increase the reserves by drilling, the Threshold of Commerciality was reduced by adopting a different commercialisation strategy
- Project sanction was achieved in 18 months, with first oil 12 months later in 1998
- The facilities were designed for 45,000 bbls/d while the base production profile was 25,000 bbls/d
- A gain share mechanism was agreed with an FPS contractor, which used a fixed dayrate for the base reserves of 20 mm bbls combined with a tariff for upside production
- A project Capex of $130mm produced annual earnings of > $100mm (10% of Texaco's total worldwide earnings)

Galley – Commercialization Strategy

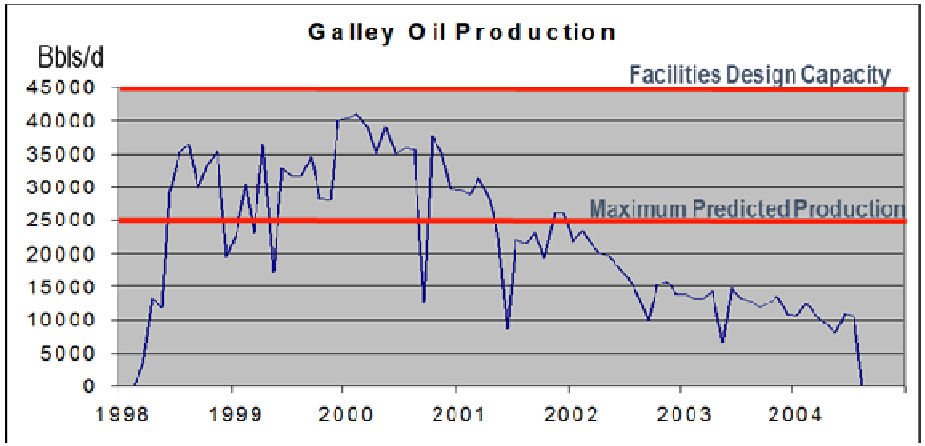
Strategy - Technology - Business



- 11 appraisal wells had proven up 20 mm bbls. Additional wells were unlikely to add sufficient reserves to make the project economic and so the appraisal program was shut down
- Instead of trying to increase reserves, the threshold of commerciality was reduced to make the known reserves economic
- Option value was built in by sizing the facilities for twice the known production and a cluster development proposed to aggregate adjacent discoveries and facilitate exploration
- Exit plans were put in place in the event the asset could not be commercialized
- A 30-50% capex reduction was required to make the project economic, which was impossible. Instead, a gainshare mechanism was agreed with an FPS contractor to provide a facility with a 4 year contract based on a 12 year amortization, effectively giving a 60% capex reduction
- To give the contractor confidence in the upside, a data room was opened when the FPS was bid

Galley – Build It and They Will Come

Strategy - Technology - Business



- The Galley partners did not accept the concept and so Texaco sole risked the development planning
- The Bugle and Black Horse JV's refused to discuss a cluster development. To date, neither field has been developed
- A contract was awarded for the provision of an FPS, but the contractor reneged on the contract. The eventual FPS contract was awarded to the Ali Baba/Emerald Producer and the facilities capacity reduced from 50k to 45k bbls/d due to constraints in the existing equipment
- The current Woodmac report on Galley states that:

  "Historically, Galley production levels have been constrained by the processing facilities. It is estimated that the three producing wells were capable of producing over 55,000 b/d through the peak period. However, the floating production facility (FPF) was only capable of processing a maximum of 43,000 b/d"

  In reality, the FPS was designed for twice the known production of 25,000 bbls/d

At sanction, the Galley reserves were "*Somewhere between 20 and 100 mm bbls*"
The project was sanctioned with 20 mm bbls and eventually produced 65+ mm bbls

What is Uncertainty?

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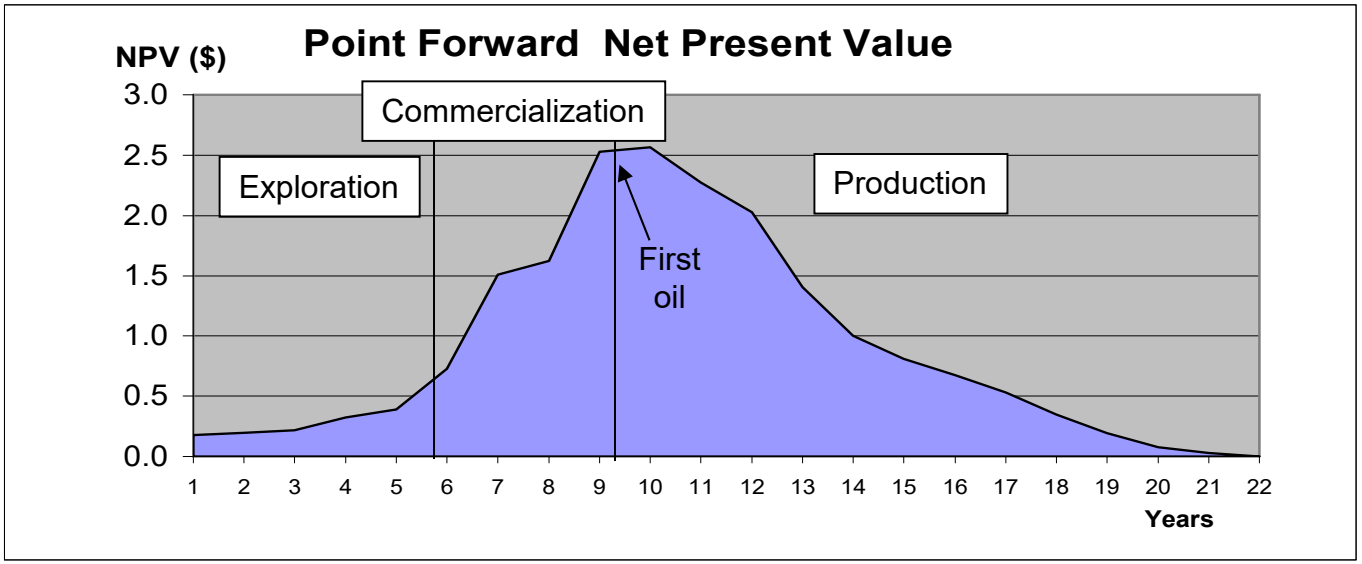

$$EMV = NPV * P_E * P_C$$

Where: **NPV is the unrisked NPV**

P_E is the probability of exploration/subsurface success

P_C the probability of commercialization success

- P_E is normally calculated using a rigorous risking process to provide a probability of exploration success or a P90 – P50 – P10 range of reserves
- P_C is commonly not included in the calculation or assumed to be 1.0

Value Chain – Bang for your Buck

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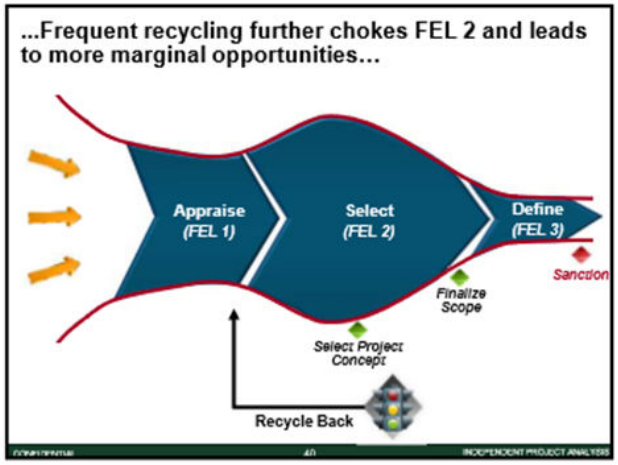
	Exploration	Commercialization		Production
		Pre-Sanction	Post-Sanction	
Capex	Medium	Low	High	Low
Delta NPV/I	High	High	Low	Liquidation
Outcome	P_E ⇨ 100%	P_C ⇨ 100%	Max NPV	Max Cash
Metrics	Success Ratio	ΔNPV/I	On Budget On Schedule	ROCE

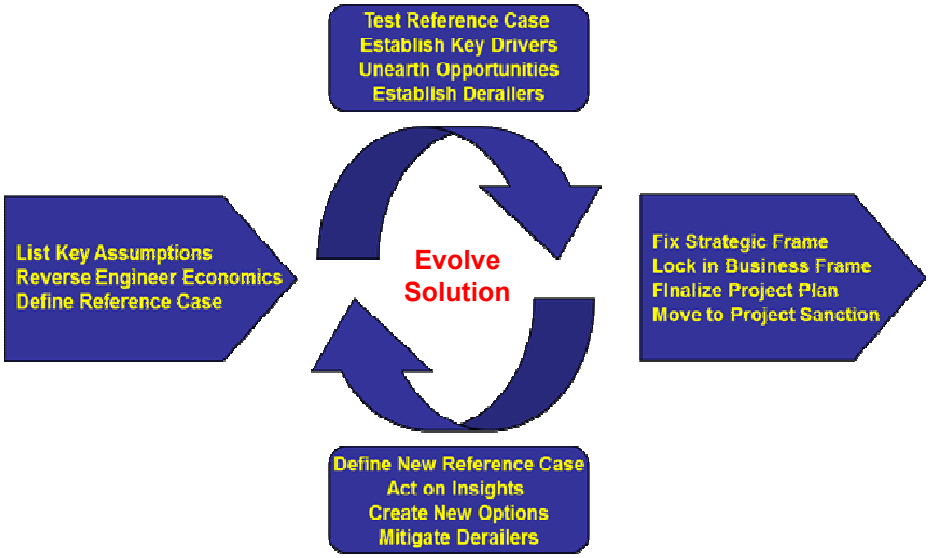


- Many companies assume P_C to be 100% and treat pre-sanction as a linear process from Appraisal thru Select and Define that inevitably leads to sanction
- This is valid if the projects are straight forward and the development concept self evident, but with more complex projects this can lead to recycles and stranded projects
- For those projects where P_C is low (say 20%), the pre-sanction commercialization phase can add greater than a x5 multiple to NPV, which gives you the biggest Bang for your Buck

Exploration turns Prospective Resources ⇨ Contingent Resources

Commercialization turns 2C Resources ⇨ 2P Reserves

Risk vs Uncertainty



- Risk can be defined and even quantified, whereas Uncertainties are the "***Unknown unknowns, the ones we don't know we don't know***" (Rumsfeld, 2002)
- Taleb calls uncertain events Black Swans and shows how their impact on "***Fragile***" systems can be catastrophic
- He suggests that systems should be designed to be both resilient and "***Anti-fragile***", where they actually benefit from adversity, uncertainty and stress to get better

Stress testing a project turns uncertainties into risks that can be mitigated

Front End Loading and the Influence Diagram

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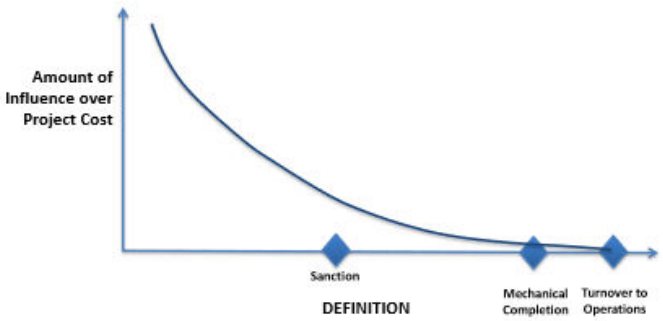
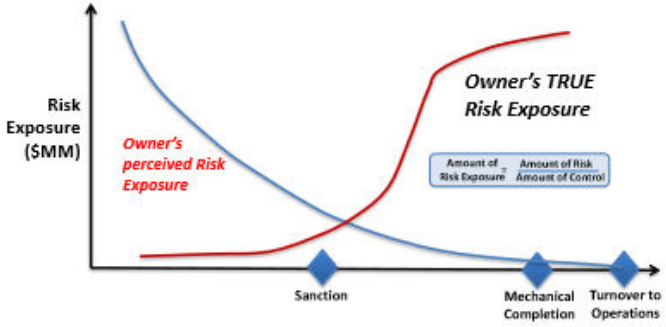
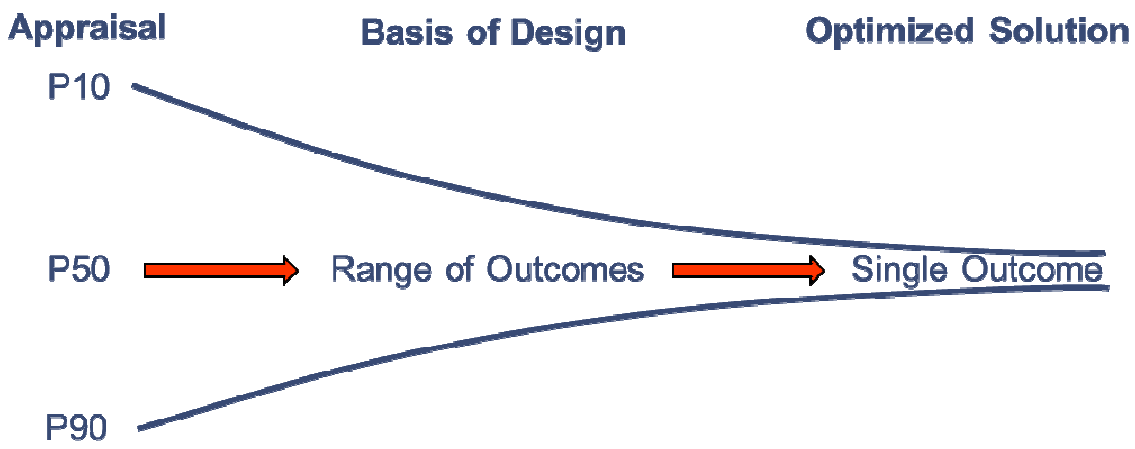




- Conventional practice follows the influence diagram, where the amount of influence over project cost is assumed to reduce with time. This has led to the use of linear processes, where Front End Loading (FEL) is the key measure used to define and control risk
- At each step, extensive engineering studies are undertaken, the number of options reduced and the facilities optimized to increase the FEL
- In reality, the true risk exposure can increase with time due to the impact of things that are not in the owners/project's control such as markets or changes in scope
- These risks can often be anticipated and mitigated in the development plan

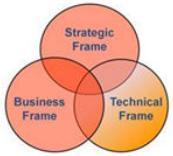
Every major project undertakes a probabilistic cost estimate. An average historic cost overrun of 57% shows that the major risks are not normally accounted for

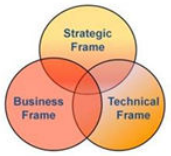
Design Points and Ranges of Outcome

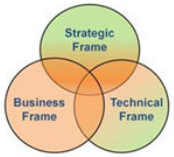


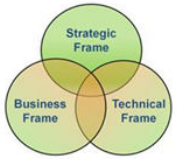
- Most cost overruns occur because an unforeseen event impacts a development plan that is unable to accommodate the change, rather than because not enough engineering was done
- In the subsurface world, ranges of outcome are an accepted way of doing business and all projects define a P10, P50 and P90 outcome for reserves and profiles
- However once this range is handed over to a facilities group, the uncertainty is commonly lost and a single design point used instead
- Many projects focus on looking at multiple development options and optimize a solution for this single design point, while losing sight of the fact that it is just one of a range of outcomes

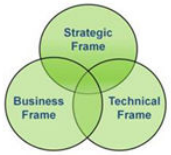
The time and effort involved in optimising multiple options often delays a design freeze and so ironically can both increase execution risk and reduce the true FEL











How to Incorporate Uncertainty?

Commercialization Roadmap

Pre-Project Workstage 1	Appraise Workstage 2	Select Workstage 3	Define Workstage 4	Execute Workstage 5
• Define Reference Case • Obtain partner agreement to plan • Define acceleration potential • WP&B approved	• Initial commercial discussions with 3rd party hosts • Facility feasibility studies • Finalize appraisal program/well plan • Short list development options	• Submit tariff request to 3rd parties • Detailed commercial negotiations • Drill appraisal well • Pre FEED/FEED engineering studies • Select final option	• Finalize fully termed agreements • Complete FEED on selected facilities option • Bid/evaluate EPC and Long Lead contracts	• Sign commercial agreements • Award EPC contracts • Execute project • First oil/gas

- Opening the Frame, unconstraining the solution and stress testing prototypes can lead to instabilities that could increase the risk of a project going off the rails
- So called “Fast Track” projects often remove constraints and cut corners to save time, which commonly leads to recycles, schedule delays and cost overruns
- When a solution is deliberately unconstrained to increase the range of outcomes, the process need to be more rather than less rigorous to avoid instabilities

By applying a systematic process that accounts for Strategic, Business and Technical drivers, complex projects can routinely be brought to project sanction

How to Create a Resilient Project

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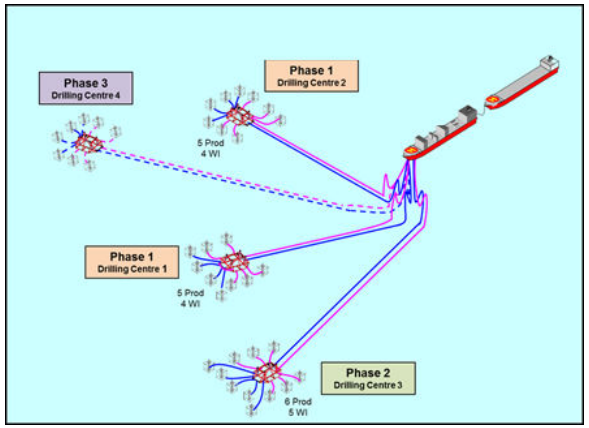

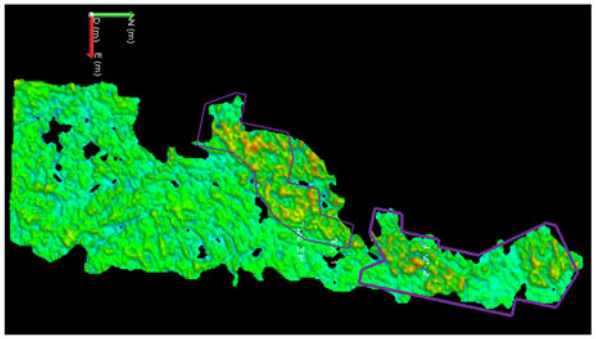

• The Phase 1 development focuses on the high seismic amplitudes

- This approach has recently been applied to a UKCS heavy oil field that was brought to sanction by integrating uncertainty into the development plan
- The development plan was focused on a sweet spot defined by seismic hydrocarbon indicators
- Phase 1 developed the sweet spot, Phase 2 developed the remainder of the field, while Phase 3 was an exploration prospect to the West
- The field was discovered in 1985 and three appraisal wells drilled in 2007, 2008 & 2010
- A commercialization initiative was started in early 2010 and FPSO bids issued in May 2011
- An appraisal well was drilled in Oct 2011 and a horizontal well test completed
- FPSO bids were received in December 2011

A CPR defining 170 mm bbls of 2P reserves was issued in Feb 2012, four months after a horizontal well test produced the first meaningful hydrocarbons to surface

Reference Case Development

Case	Date	Wells		Reserves	Oil Rate	Comments
		Prod	Inj	mm bbls	kbbls/d	
RC1	Mar 2010	4	1	51	30	Demonstrate viability
RC2	Sept 2010	4	1	77	30	Update development plan
RC3	Mar 2011	8	7	103	60	Incorporate results of appraisal well
RC4	May 2011	16	15	136	60	Build in upside capacity
RC5	July 2011	16	15	129	60	Final option selection
RC6	Dec 2011	16	14	174	60	Incorporate results of appraisal well

- A series of Reference Cases were used to evolve a solution, the first Reference Case (RC1) was used to demonstrate economic viability based on 51 mm bbls of reserves
- The results of the appraisal well drilled in Sept 2010 increased the reserves from 50 – 70 mm bbls to over 100 mm bbls. This was used to generate an RC3, where the process capacity of the FPSO was doubled from 30,000 bbls/d to 60,000 bbls/d
- RC4 and RC5 optimized the facility and refined the reserves. The capacity was kept the same, but the number of wells and swivel fluid paths increased to accommodate the upside
- RC6 incorporated the results of the well test and the FPSO bids. The design of the facilities was kept the same and the production profiles made to fit the facilities rather than the facilities made to fit the production profiles

The appraisal program confirmed the facilities design rather than initiated it

FPSO Facilities Sizing

Field Production Design Rates		
Oil rate	60,000	bbls/d
Max total liquid rate from wells	240,000	bbls/d
Max water injection rate	240,000	bbls/d
Total Liquids (Including HSP Power)		
HSP power fluid	200,000	bbls/d
Max total liquids onto FPSO	440,000	bbls/d

- RC1 was sized for 30,000 bbls/d to test the economic viability of the core reserves. This was increased to 60,000 bbls/d once it became clear that the reserves were greater than 100 mm bbls
- This step function change in capacity allowed the facilities design to be frozen and bids issued for the FPSO while the appraisal program was still underway
- A capacity of 60,000 bbls/d of oil and 500,000 bbls/d of total liquids makes this the largest FPSO in the North Sea. Increasing the capacity to over 60,000 bbls/d would have required a bespoke design
- Commercial terms such as the capex to dayrate conversion factor and the cost of the hull were agreed early on. This locked in a significant portion of the cost before FEED was started
- The FPSO contractors were kept informed about the status of the appraisal program to give them confidence and create a collaborative working environment

A rolling optimization of the design to produce small capex savings would have prejudiced the ability to get firm prices up front and so increased the execution risk

A Resilient Project Development Plan

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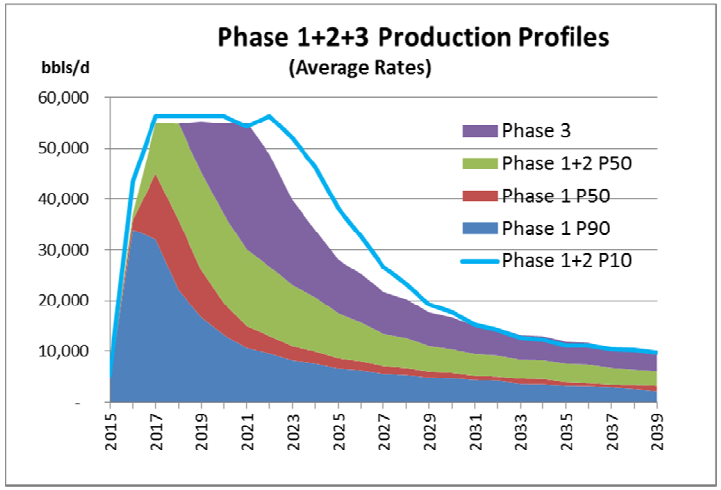

- The project was designed to be resilient and able to accommodate uncertainty
- The project was economic with the Phase 1 P90 production of 30,000 bbls/d, yet could accommodate the Phase 1 P50 production of 45,000 bbls/d and the Phase 2 production of 55,000 bbls/d
- The upside P10 production from Phases 1 & 2 and any Phase 3 exploration success could be accommodated using the same facilities by extending the plateau
- 60% of the field was put up for sale in Jan 2011, but got no takers. 6 months later, 30% was sold for ~$0.50/bbl. In Jan 2012, 45% of the equity was sold for $6/bbl, valuing the field at $960mm

The change in value from being worthless to $960mm in 12 months was not the result of a change in reserves or development concept. What changed was the perception of whether the project would work

Conclusions

Strategy - Technology - Business

- The E&P industry has failed to deliver projects on budget or on schedule over the last ten years
- In a low price environment, the current level of project failures cannot be sustained and so a different approach is required
- Current projects are more complex and have a higher degree of uncertainty than before
- The extensive use of Linear/Waterfall processes for project development planning has contributed to these failures by not being able to accommodate change
- Building uncertainty into a plan produces robust projects that can accommodate change while reducing both cycle time and execution risk
- A Discovery Driven process that iterates to a solution combined with a holistic approach that accounts for Strategic, Business and Technical issues is a way to create resilient projects

1. **The industry needs to improve its success ratio on major projects and the key to achieving this is to embrace uncertainty rather than fight it**
2. **This will require a change in mind set as much as a change in process, which will not be easy, but is inevitable**

Questions

Dr Chris Hopper: chrishopper@movingfuture.com