

Broadleaf 

Assessing Risks in Large Capital-Intensive Resource Projects

Dr Dale F Cooper
BROADLEAF CAPITAL INTERNATIONAL
www.Broadleaf.com.au

GARP Presentation, Sydney, 25 July 2003

© Broadleaf Capital International Pty Ltd, 2003 - www.Broadleaf.com.au

This presentation forms the first part of a two-part session conducted with the Global Association of Risk Professionals (GARP) in Sydney on Friday, 25 July 2003. It is designed to lead in to a second paper presented by Jay Horton, 'Learning to Love Uncertainty: Understanding and Valuing Projects Using Real Options'.

Broadleaf **Assessing risks in capital-intensive projects**

© COPYRIGHT

This document contains substantial pre-existing intellectual property of value to Broadleaf Capital International Pty Ltd.

It is provided for information only but not to sell, licence or otherwise transfer it to any third party, whether in its original form or as part of any further development that the recipient might undertake, without Broadleaf's prior written agreement.

Dr Dale F Cooper
Director
Broadleaf Capital International Pty Ltd
ABN 24 054 021 117
Cooper@Broadleaf.com.au
Tel: +61 2 9488 8477

© Broadleaf Capital International Pty Ltd, 2003 - www.Broadleaf.com.au 2

Broadleaf **Assessing risks in capital-intensive projects**

Summary

Introduction to project risk assessment
Quantitative risk analysis process
Simple economic evaluation models
Project risk evaluation in practice

© Broadleaf Capital International Pty Ltd, 2003 - www.Broadleaf.com.au 3

This presentation provides a basic understanding and a lead-in to Jay Horton's paper on real options.

Broadleaf Assessing risks in
capital-intensive projects

Project risk assessment: why bother?

Economic evaluation
Is the project worth doing?

Financial feasibility
Can we pay for it?

Project optimisation
What is the best contracting strategy?
Can we plan and deliver the project better?

Planning and management
What risks & opportunities to plan for & manage?

© Broadleaf Capital International Pty Ltd, 2003 - www.Broadleaf.com.au 4

Different purposes for project evaluation lead to slightly different models, but they use similar basic approaches.

Quantification is not always necessary, but when it is needed it is usually important to get it right!

Broadleaf Assessing risks in
capital-intensive projects

Basic economic evaluation

Owner's discounted cash flows
Net present value
Return on capital employed

Cash outflows
Capital cost
Operating cost
Capital maintenance and upgrades
Financing costs

Cash inflows
Revenue from sales

© Broadleaf Capital International Pty Ltd, 2003 - www.Broadleaf.com.au 5

The models can be made more complicated, depending on the purpose of the evaluation:

- Basic economic evaluation
- Depreciation and tax
- Financial structures (equity, short-term project finance, mezzanine debt, long-term bonds, ...)
- Project or enterprise perspective (balance sheet effects, not just profits and cash flows)

Broadleaf Assessing risks in
capital-intensive projects

How do we account for risk?

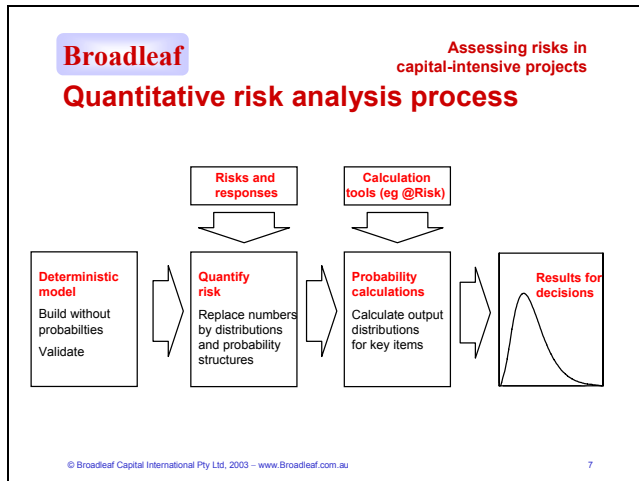
*** Add a margin to the cost of capital**
How do we determine the appropriate margin?
Does it have an economic meaning?

✓ Incorporate risk and uncertainty explicitly
Identify potential changes in cash flows
Variations
Events
Positive and negative changes: opportunities as well as risks
Include distributions and event probabilities in NPV models
Use simulation to generate ranges of outcomes

© Broadleaf Capital International Pty Ltd, 2003 - www.Broadleaf.com.au 6

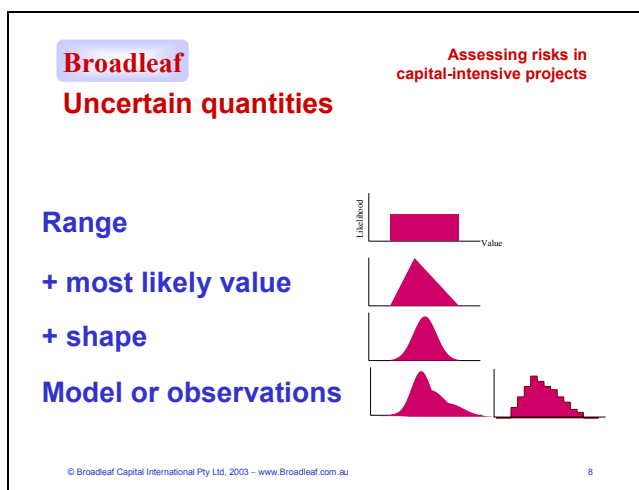
The CAPM approach requires project betas that are often difficult to estimate. By increasing the discount rate, more focus is placed on downside risks and the early periods when cash flows tend to be negative. Long-term opportunities are discounted more heavily.

More explicit consideration of risks and opportunities provides a more balanced perspective.



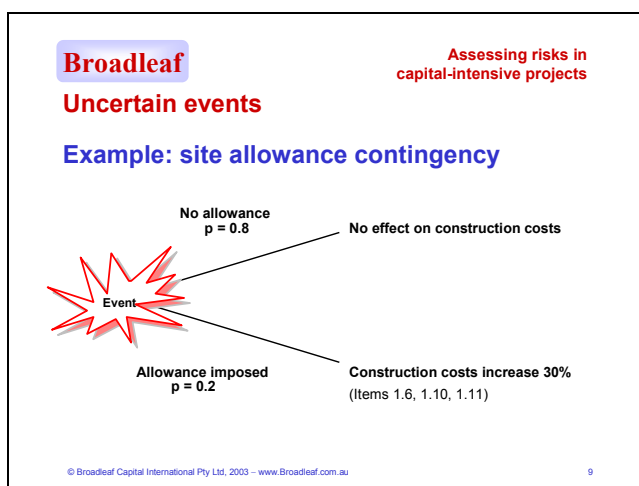
When quantifying risks and their effects, it is important to take into account the most likely practical management responses were a risk to arise. Risks usually generate actions – this is not theory!

Tools like @Risk, embedded in Excel, provide a commonly-used approach for preparing models of this kind. @Risk uses simulation to generate model outputs as distributions, not just numbers.



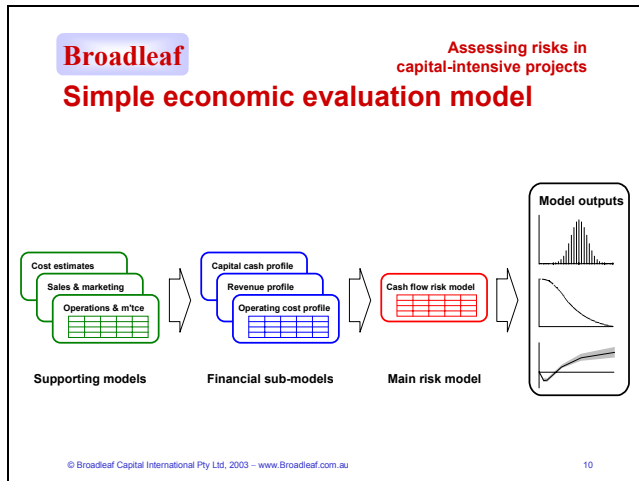
Uncertain quantities may be represented in different ways, according to the level of knowledge and information available.

For resource projects, there may be good distributional information available from field observations, assays and geological models.

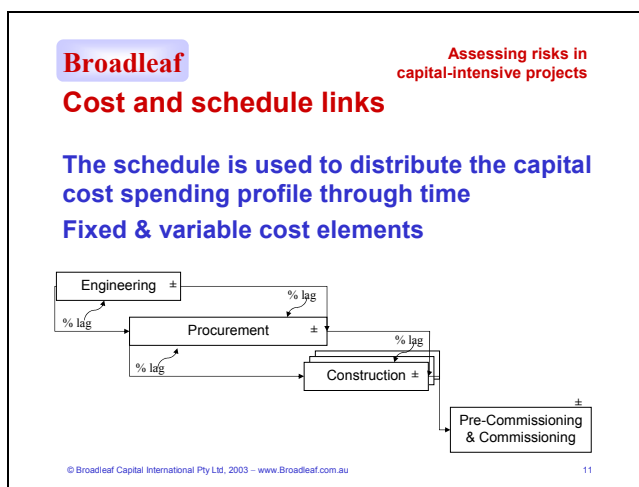


Note that this diagram represents a probability tree structure that could have many branches, not just two.

Project evaluation models can also incorporate decision nodes and conditional branches.

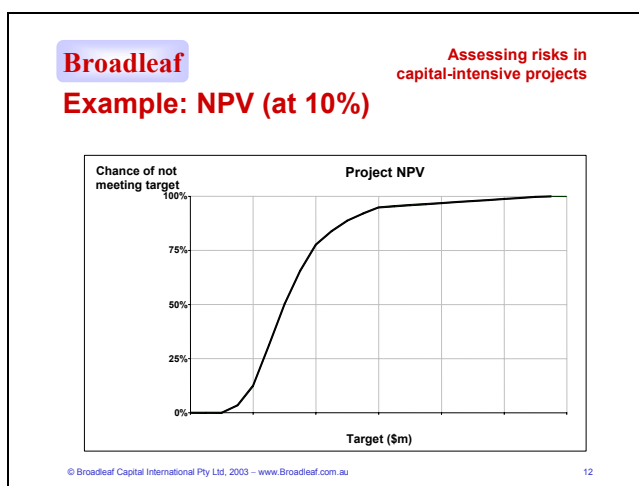


For resource projects, the supporting models on the left are often quite complex – more on this later.



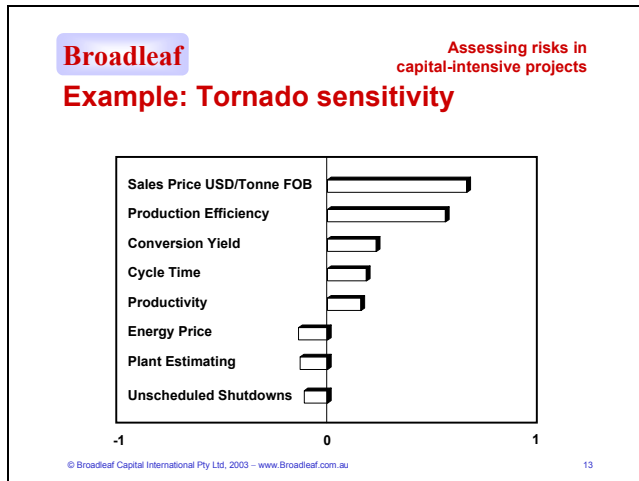
Schedule variation often has a profound effect on project economics, as a common outcome is a delay in generating a revenue stream.

Modelling ramp-up profiles as new processing plant is commissioned can be difficult.



This is an example from a recent minerals processing project. It is typical of the kind of distribution produced by a project evaluation model using @Risk simulation.

More stringent targets lead to a greater risk of failure.



This tornado diagram from a large mineral-processing project illustrates the most important contributors to NPV variability. As often occurs with resource projects, the resource itself and the associated revenue stream generates the bulk of the uncertainty. Technology was also an important driver in this case, but capital cost variation (the Plant Estimating item) was relatively unimportant.

Broadleaf Assessing risks in capital-intensive projects

Traps for the unwary

Poor modelling practice (but this is not specific to risk models!!)

- Poor analysis
- Inadequate validation

Inappropriate levels of detail

- Too much or too little ...
- ... in the model
- ... in the analysis of risks and uncertainty

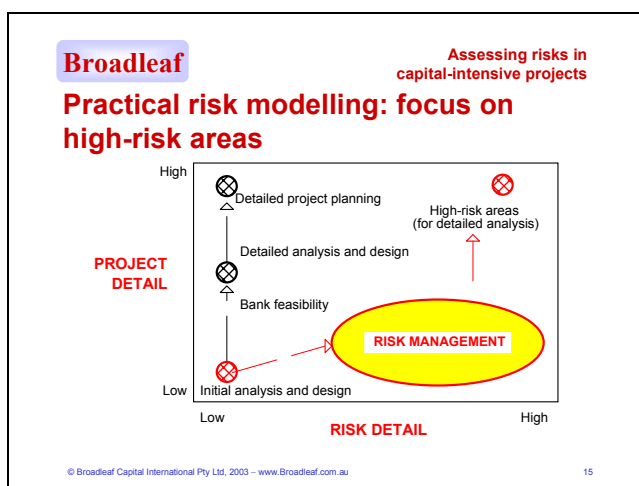
Wrong focus

Correlations omitted

© Broadleaf Capital International Pty Ltd, 2003 - www.Broadleaf.com.au 14

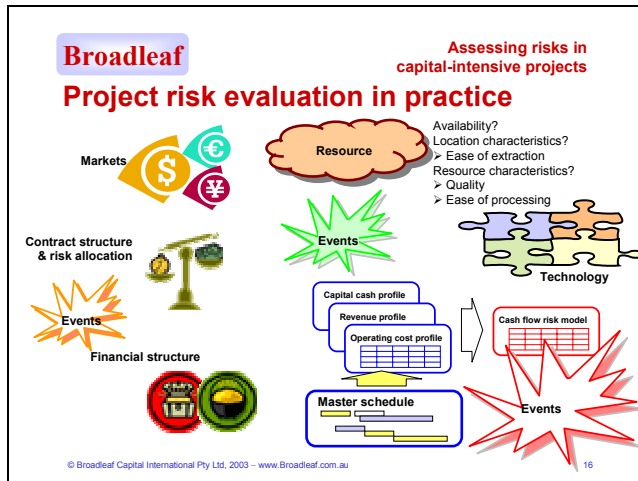
Levels of detail are discussed in the next slide.

Sound modelling of correlation is essential to getting meaningful results – inappropriately assuming independence between uncertain variables can lead to huge errors. (We had one client whose model generated a capital cost variability of less than 2% for a new-technology development. After correlation was included, the variation was closer to 15%!)



In some cases, project evaluation models are very detailed (too detailed in our view), with only simple (simplistic?) sensitivity testing to deal with risk. Often, such models are too big to be understood by anyone.

We prefer to start with a far simpler model of the project, to allow risk and uncertainty to be addressed more fully. Extra detail can be added where it produces a positive contribution to understanding.



Schedule risk is often a major driver of outcome variability in large projects.

Resource modelling may be complex. It varies in form depending on the kind of resource (minerals, oil or gas; surface, underground or offshore; simple or complex geology; level and nature of impurities; simple or complex processing ...).

Resource and technology are often closely related.

This presentation provides a flavour of the main aspects of incorporating risk and uncertainty in large resource projects. It also leads in to the second part of the presentation on real options.

Contact us for more information, and have a look at our web site:

www.Broadleaf.com.au

For an overview of our activities in the resources sector, see

www.Broadleaf.com.au/Sectors/Sec_Re sources.pdf

Broadleaf Assessing risks in
capital-intensive projects

Broadleaf's risk management services

- Quantitative risk & financial modelling
- Risk assessment for private financing options
- Strategic & policy risk management
- Project & procurement risk management
- Risk assessment workshop facilitation
- Risk management plans & implementation
- Risk management procedures review
- Risk management training

© Broadleaf Capital International Pty Ltd, 2003 - www.Broadleaf.com.au 20

Broadleaf Assessing risks in
capital-intensive projects

Further information

Dale F Cooper: Applying Risk Management Techniques to Complex Procurement
Purchasing Australia, Australian Government Publishing Service, Canberra, 1997, ISBN 0 642 26803 7

Stephen Grey: Practical Risk Assessment for Project Management
John Wiley & Sons, Chichester, 1995, ISBN 0 471 93979 X

Dale F Cooper and Chris Chapman: Risk Analysis for Large Projects
John Wiley & Sons, Chichester, 1987, ISBN 0 471 91247 6

Australian/New Zealand Standard on Risk Management, AS/NZS 4360
Standards Australia, Standards New Zealand, 1995

Please contact Dr Cooper for further information

© Broadleaf Capital International Pty Ltd, 2003 - www.Broadleaf.com.au 21