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Specialists in Strategic and Project Risk Management

Implementing Risk Management in Large Projects Dr Dale F Cooper, Director, Broadleaf Capital International Pty Ltd

Invited paper presented to the 2003 Conference of the Project Management Institute of New Zealand (PMINZ), held in Christchurch, New Zealand, over the period 5-7 November 2003.

Acknowledgement: The author wishes to thank the Centre for Advanced Engineering for inviting him to attend the Conference, supporting his travel and providing wonderful hospitality in Christchurch. The CAE is a not-for-profit organisation established in 1987 to commemorate the centenary of the School of Engineering at the University of Canterbury and based at the University. For more information about the CAE, see www.caenz.com.



Implementing Risk Management in Large Projects

Dr Dale F Cooper
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Project Management Institute, New Zealand, Conference
Christchurch, 6 November 2003

This paper touches on a number of practical matters associated with implementing risk management successfully in large projects. Topics range from 'simple' qualitative analysis for setting priorities to more complex quantitative modelling, and cover both technical and non-technical aspects of achieving useful outcomes. Experiences from recent projects are used to illustrate the main points.



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Implementing risk management in large projects

Summary

Large projects have characteristics that set them apart from 'routine' activities

Risk management for these projects usually requires

- > Careful selection of the approach to be used
- > Modifications of 'standard' approaches to suit the project and the context

Many of the lessons apply to smaller projects too

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What's special about a large project?

Many powerful stakeholders, inside and outside the organisation
Complex requirements, contracts, insurances
Large cash flows:

- Potential for large gains or losses
- Unbalanced, front-loaded
- Close to financial limits

Scale effects: organisation and technology
Regulatory scrutiny: safety, environment, political

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Characteristic: many diverse and powerful stakeholders

Most projects have several stakeholders
With large projects:

- There are often many more of them
- More of them must be actively engaged with the project to achieve success
- Many of them have more power, including veto rights in some cases

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With many stakeholders, risk management processes must be structured carefully

Examples:

- Owners: sponsor(s), procurement team(s)
- Users: operators, maintainers, logistics support
- Advisers: technical, financial, legal, probity
- Counterparties: contractors, suppliers, purchasers
- External: community, environment, media
- Regulators: planning, environment, safety

Need to design

- Governance structures
- Risk management processes

... that take account of the context, the stakeholders, the organisation and the culture

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Other stakeholders, some of which may be antagonistic to project outcomes:

- Other projects, agencies or business units that are competing for funds;
- Competitors with a vested interest in project postponement or failure;
- Other entities with a vested interest in frustrating the sponsoring agency;
- Contractors, employees, unions, equipment providers, materials suppliers;
- Financial and insurance markets, and providers of equity, debt and credit support;
- Suppliers of inputs to the completed project asset, and purchasers of its products or services.

For a detailed discussion on the design of risk management processes in different organisations and cultures, see DF Cooper, Organisational and Cultural Aspects of Risk Management Implementation, a presentation to the pre-conference CAE Workshop, 5 November 2003, available at www.Broadleaf.com.au/publications/articles.htm.

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Communication with stakeholders is critical at all stages of large projects

Risk and project communication should be integrated
Develop a communication strategy for risk to:

- Address both internal and external stakeholders
- Understand and take account of different perceptions of risk
- Foster ownership and engagement of stakeholders with the risk management process and its outcomes
- Develop a consultative team approach

Communication is a two-way process

- Consultation, not selling

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Large projects require good communications strategies, and often a formal Communication Plan. The communication strategy should incorporate media, community, Government and regulatory liaison, as well as processes for involving internal stakeholders. Risk communication will be a core part of the overall strategy.

The Environmental Impact Statement preparation and approval process is an important part of the public communication process for large projects in Australia.

See, for example, Janet Gough (Editor), Sharing the Future: Risk Communication in Practice, Centre for Advanced Engineering, Christchurch, 2003, ISBN 0 908993 32 3.

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Stakeholder aspects must be included at all stages of the process

Context development

- Objectives, criteria, scales
- Elements, areas of concern

Structured workshops for risk identification, assessment and evaluation

- Make best use of diverse expertise
- A risk assessment workshop may be the first time some stakeholders have seen the whole project in its entirety (and with a very large project, even that may not be possible)

Risk treatment and change management

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These are a few examples.

Processes for structuring problems to take account of diverse stakeholders, in a wider context than risk management, are reviewed in:

Mingers, J and J Rosenhead (2004) Problem structuring methods in action. *European Journal of Operational Research*, 152, 530-554.

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Characteristic: complex requirements and contracts

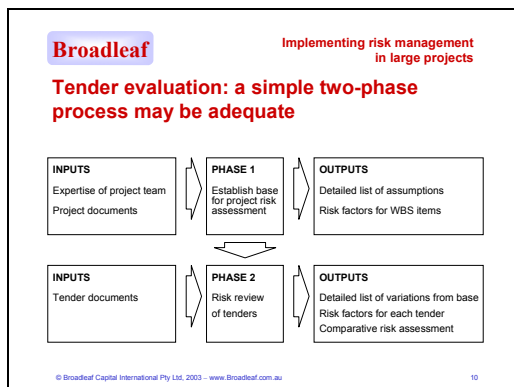
Size and complexity often go hand in hand

There are often more than just scale effects

Particular care is needed in:

- Tender evaluation
- Contract negotiation and risk allocation

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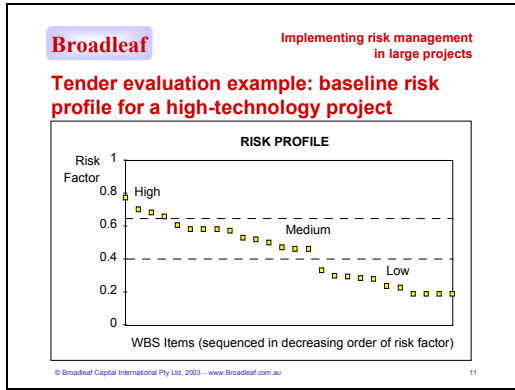


The objectives of the risk assessment in tender evaluation are:

- To provide an initial indication of where the major risks might arise in the project, prior to receipt or detailed examination of tender responses, based on a set of credible assumptions about how the project might be conducted;
- To develop a risk baseline against which individual tender responses can be compared;
- To assist the project team to focus on potential risk areas in their evaluations of offers and in their evaluation visits to tenderers' sites;
- To provide a risk profile for each tender offer submitted, developed on a consistent and justifiable basis;
- To provide a documented audit trail of the project team's assumptions about potential risk areas and their reasons for adjusting their assessments in the light of individual tender responses or site evaluation visits.

The first phase provides inputs to the Request for Tender, the draft contract terms and conditions and the Tender Evaluation Plan.

The second phase provides inputs to the risk component of the tender evaluation process.



In several projects, we have used semi-quantitative approaches for assessing risks, applied to Work Breakdown Structure (WBS) items (at an appropriate level) or work packages. In other cases, we have conducted more detailed analyses, based on specific identified risks.

The project in this example had only 26 WBS items, so a relatively high-level view was being taken.

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Contract negotiation requires more detail in the assessment

WBS items may be adequate for tender evaluation and source selection ...

But risks must be considered explicitly for contract negotiation

The assessment usually requires two sets of criteria:

- > Performance criteria
- > Contract criteria

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Defence contract negotiation example

Criteria:

- > **Performance:** functional capability, delivery schedule, life-cycle cost, supportability, safety
- > **Contract:** acquisition cost, industry involvement, good management, good contract

Risks:

Criteria	Extreme	High	Medium	Low	Total
Performance	1	22	78	56	157
Contract	2	8	77	70	157
Agreed priority	2	38	80	37	157

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This example shows a qualitative rating process. Five performance criteria were combined in the performance rating; four contract criteria were combined into the contract rating; and these two ratings were combined into the overall agreed priority.

Note the general increase in the agreed priority, compared with the individual components.

The outcomes from this risk assessment were used as one of the inputs for developing the contract negotiation strategy for the project.

'Good management' includes probity, processes, systems; 'Good contract' includes being seen as beneficial and good value for money for the client and the nation (i.e. a political impact measure as much as anything).

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Characteristic: large and unbalanced cash flows, close to financial limits

Most projects involve initial spending, before any revenue benefits are realised

For large projects, this may be a critical factor

- The initial spending requirements may be very high
- There are large uncertainties in size and timing
- Long construction and commissioning periods extend the payback period and reduce the NPV
- Construction incentives may be necessary
- Trading-off reduced construction costs and a faster schedule for increased through-life costs may be a false economy

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Cash flow models provide the quantitative basis for evaluating project risk consistently

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Typically, the models represented here are in the form of Excel spreadsheets, with probability and distribution information included by means of the simulation add-in @Risk.

@Risk also performs the simulation and generates the output statistics and graphs.

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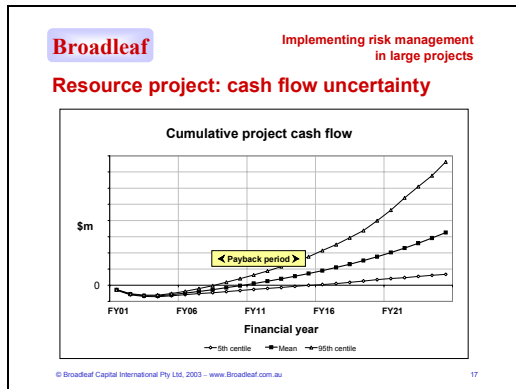
Use the project NPV distribution to set the cost target according to the appetite for risk

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In this example, the percentile has been set initially at 90%. This is relatively conservative – it implies only a 10% chance of failing to achieve the cost target. Note that this distribution, taken from a resource project, has a long tail to the right. Setting targets and budgets becomes an interesting exercise in balancing risk and reward in these circumstances, and additional attention must be paid to risk management and project management.

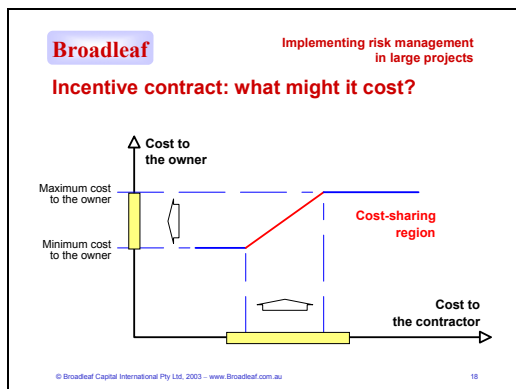
We have participated in one project where the 95-percentile was used, and in another where the 50-percentile was preferred. (Using the 50-percentile seems overly optimistic, while the 95-percentile might be a bit too conservative. It depends on the sponsor's appetite for risk.)

The graph shows the way in which the chance of achieving the target (on the vertical axis) increases as the cost target (on the horizontal axis) increases.

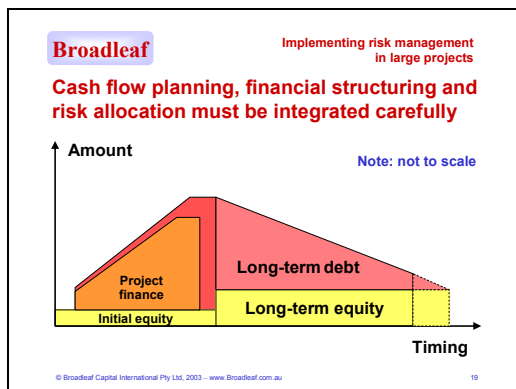


Large projects may have large cash-flow uncertainty, and hence the payback period may have a wide range.

This project involved a capital spend of about AUD 1.5 million. The large cash flow spread in later years was primarily the result of future uncertainty in the sales price and the exchange rate. (The product was sold in USD, but the client's accounts were in AUD.)



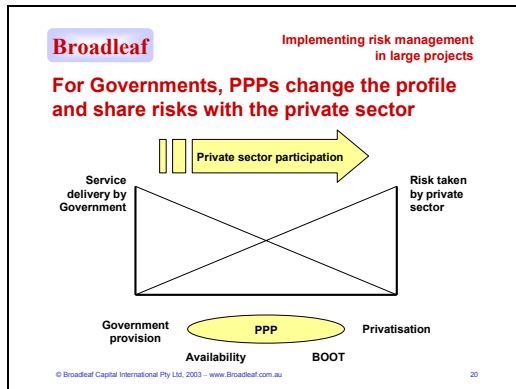
The models can be extended to examine other aspects of the project. For example, incentive contracts can be used to focus the attention of the contractor on performance delivery outcomes, as well as limit the risk to the owner. However, if the contractor's performance starts to fall outside the acceptable limits (e.g. at the right-hand end of the range in the diagram), the incentive structure may break down and overall performance may deteriorate rapidly.



Financial risk management is important for large projects. In a highly simplified view, financial structures include short-term and long-term equity and debt.

- Initial project planning and preparation is likely to be funded from equity.
- The requirement for project (construction) finance may be faster, larger and longer than planned. Project finance tends to be expensive, as the risks are large in this phase of the project life.
- Once the project has been commissioned and accepted, much of the risk has been dissipated. It is now possible to sell the project to equity investors and the long-term bond market, to pay back the construction debt and recompense the initial equity providers for the risk they have taken.

Simple quantitative project risk modelling is unlikely to be sufficient for large projects. It is often necessary to model financial structures and view the project on a business or enterprise basis. Further extensions to include tax and accounting matters are common.



Governments sometimes use Public Private Partnership (PPP) arrangements for smoothing budgetary cash flow requirements, as well as for transferring risk and increasing efficiencies.

There are a number of ways in which public sector services can be provided with the assistance of the private sector. They merge into one another as we move from left to right, and the private sector takes more risk as we move from left to right:

- In an ‘availability’ model, the private sector provides an asset that is available for public sector use to an agreed standard and level of availability. A number of school and hospital projects are like this, where the private sector builds and maintains an asset and Government provides the expertise and equipment to deliver the service to the public.
- In a Build-Own-Operate-Transfer model (or one of its variants), the private sector provides all the assets and the services, with the assets reverting to the Government after the expiry of a concession period. Examples include toll roads, ports and airports. In the UK, some schools and training facilities have been provided on this basis, with the private sector delivering the basic education services as well as building and maintaining the assets.
- Privatisation transfers the assets and the service delivery to the private sector, and Government sources all services from industry. Examples include vehicle fleets and power generators.

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Characteristic: technology and scale

Large projects often involve:

- Complex technical and operating linkages
- New technology
- Technology at new scales

Not all of the implications of scale and technology choice are obvious

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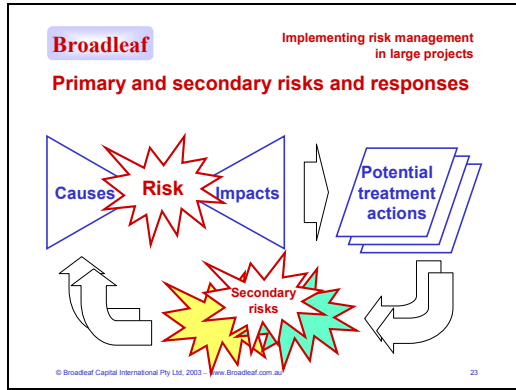
Risks and their implications must be specified in great detail

It is usually not sufficient to consider only primary risks and treatments

The causes and consequences of risks must be modelled more precisely

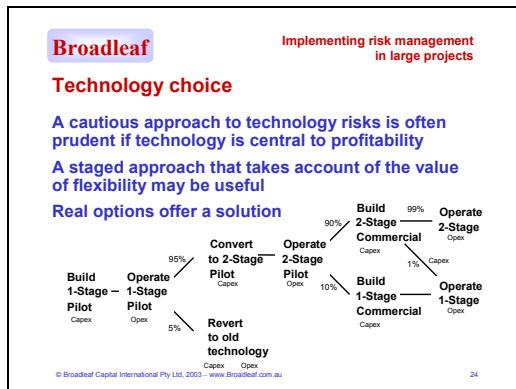
Secondary risks associated with treatment actions must be incorporated in the analysis

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The initial analysis structure is sometimes called a 'bow-tie' diagram. The causes of risks may be modelled using fault tree analysis or some similar method that identifies and structures the precursors of the risk event. The impacts may be modelled using event tree analysis or some similar method that links the risk event to outcomes and consequence measures. Both the cause and impact models may use probabilistic approaches.

Because risks in large projects can have many links to other areas, there are often several potential treatment actions. These may be significant activities in their own right, and there may be a range of secondary risks that emerge as the outcome of choosing any particular course of action. These must be analysed and treated in turn.




This diagram is a probability tree for a minerals processing project, showing a sequence of staged activities and decisions associated with pilot-testing potential new refining technology. This toe-in-the-water approach provides flexibility to adjust the project according to the outcomes that are obtained at intermediate points, thus lowering the overall risk compared to building a commercial plant in one phase.

Quantitative risk models can be used to determine a value or price for this flexibility.



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Example: mine waste planning at Ok Tedi Mining Limited



- 10-12 m rain pa
- Unstable geology
- 50 m tonnes waste rock pa
- High sediment loads
 - > River bed aggradation
 - > Environmental degradation
 - > Dieback of trees
 - > Loss of gardens and amenities
 - > Declining fish populations
- 4 mine waste options

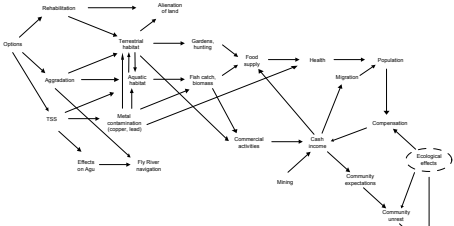
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This project required several major risk assessments over a period from 1995 to 2001. The author's role was to audit the overall risk assessment processes, a large and complicated undertaking involving many people from a wide range of disciplines.

Much of the quantitative risk assessment discussed here was undertaken by Malcolm Lane and Dr Adrian Bowden of URS Corporation. The risk diagrams shown below were developed by the author.

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Many risks and linkages ...

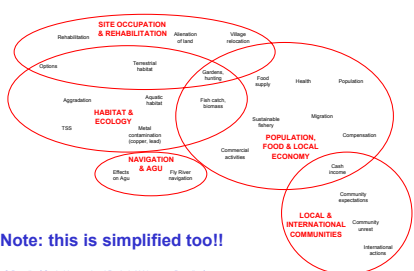


Note: this is the simplified version!!

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... based on five very detailed models

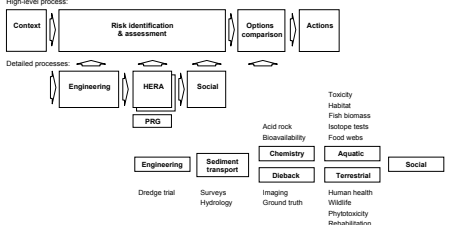


Note: this is simplified too!!

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Multi-level risk assessment processes and numerous technical models



High-level process: Context → Risk identification & assessment → Options comparison → Actions

Detailed processes: Engineering, HERA, Social

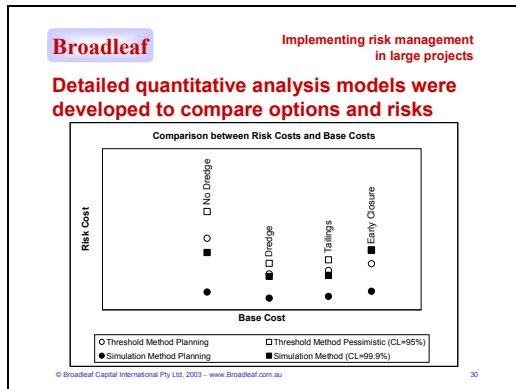
PRG (Peer Review Group) includes: Engineering, Sediment transport, Chemistry, Aquatic, Dieback, Terrestrial, Social

Technical models include: Toxicity, Habitat, Fish biomass, Isotopic tests, Food webs, Acid rock, Bioavailability, Chemistry, Aquatic, Dieback, Terrestrial, Social, Dredge trial, Surveys, Hydrology, Imaging, Ground truth, Human health, Wildlife, Phytotoxicity, Rehabilitation

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The risk identification and assessment process involved several levels. A screening level risk assessment with very conservative parameters was used to eliminate factors that could not be important; a detailed level risk assessment was undertaken on those factors that remained to focus on the potentially important areas.

The PRG was an international Peer Review Group of eminent scientists who reviewed the scientific aspects of the many studies and models that underpinned the risk assessment.



Details of the computation processes are provided in Bowden, AR, MR Lane and JH Martin (2001) Triple Bottom Line Risk Management. John Wiley & Sons, Chichester. ISBN 0 471 41557 X.

A variety of approaches were used to model risks quantitatively. Results were presented in a way that demonstrated the variability in the outcomes, to provide as much information to the Board as possible. The aim was to provide results in a way that could be understood readily, without either over-simplifying or over-complicating them.

In the diagram, the Base Cost (on the horizontal axis) includes the opportunity cost of lost revenue, hence the high apparent cost associated with mine closure. Several measures of Risk Cost (on the vertical axis) were used, to demonstrate clearly to the Board the effect of the significant uncertainty in the environment and in the risk modelling process itself.

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The aim of the process was to develop an outcome that was sound and defensible

Risk identification and assessment

- > Many technical studies
- > Engineering, HERA and social workshops
- > Combined risk workshop
- > Detailed quantitative modelling

Extensive review, validation and audit

Most reports published on the internet

- > Maximise transparency

The company was subject to international scrutiny, and the Board wanted to demonstrate clearly that it was doing its best for all the stakeholders, particularly the local communities.

For further information about the mine and the risk assessment, see www.oktedi.com.

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Conclusions: there are many ways of looking at risks

<p>Risks</p> <ul style="list-style-type: none"> > Riskiness of work items > Risk lists > Staged risks > Primary & secondary risks > Complex linkages & interactions 	<p>Models</p> <ul style="list-style-type: none"> > Qualitative > Semi-quantitative > Quantitative <ul style="list-style-type: none"> - Costs only - Cash flows (costs, revenues & schedule) - Advanced (tax & accounting)
--	--

There are many ways of looking at risks, from the riskiness of work items seen in the tender evaluation example through to the detailed identification and inter-linkages seen in the Ok Tedi case.

Similarly, models may range from the very simple priority setting approach used in the contract negotiation example through to complex quantitative cash flow uncertainty models and financial models that include tax and accounting effects to form an enterprise view of the project.

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Plan your approach carefully and early: it will be well worth the effort

There are risks associated with most aspects of large projects, at all stages of their lives

Many approaches to risk management are feasible, depending on the project, its scale, its level of development and the issues of concern

There is no single 'best' method that suits all phases of all projects

Plan the risk management process very carefully, start early, and select judiciously from your portfolio of approaches

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The main message here is that you have many potential ways of looking at risk in a large project, so you need to plan carefully to make sure you select the approach that is the most appropriate for the circumstances. (And this applies to smaller projects, too!)

Please contact us for more information

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Broadleaf's risk management services

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

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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, 1999

Please contact Dr Cooper for further information

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