RISK PLANNING FOR LARGE AND BOT PROJECTS: A HOLISTIC FRAMEWORK

by

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

in

THE FACULTY OF GRADUATE STUDIES
Department of Civil Engineering

We accept this thesis as conforming
to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

January 1994

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Date: 11 January 1994

ABSTRACT

Large engineering projects embody a number of special aspects and unique characteristics in comparison to smaller undertakings. Additionally, a growing number of large projects are undertaken employing the **B**uild–**O**perate–**T**ransfer ('BOT') approach, significantly increasing the project's complexity. With the BOT model of project delivery, the private sector finances, builds and operates a revenue-generating project, usually one which would have traditionally been executed in the public sector.

Despite the range of available risk assessment methods and techniques, significant aspects of the challenges which large and BOT projects face may be attributed to shortcomings in current risk planning processes. On larger projects, risk planning is important as risks are more numerous; additionally on BOT projects risks are not only more numerous, many are novel and longer-lasting.

The unique aspects of large engineering projects were defined, with a view to provide guidance to participants. The 'BOT' project delivery process was examined, and through an examination of the approach, the six phases of 'PEN-BOT' were proposed (Propose, Evaluate, Negotiate, Build, Operate, Transfer) as a better description of the phases and the process.

A survey illustrating the increasing popularity of the PEN-BOT approach was presented, including a detailed case study of the Channel Crossing project, outlining both the

prevalence and the unique challenges of the such projects and lessons drawn from the problems encountered.

The attitudes and perceptions of project participants respecting risk planning issues were surveyed in a working environment through a "Project Planning Issues Questionnaire". The significant differences, amongst project participants, in risk and project planning attitudes and perceptions was revealed with a number of recommendations addressing these problems developed.

A Holistic Risk Planning Framework was presented as a map of a process to address many issues which in themselves, are difficult to structure, particularly within the environment of large and PEN-BOT projects. The Framework defines an approach to formalize and organize risk planning processes with the benefits of identifying linkages, gaps and weaknesses in the planning process, and thus enhancing the project's chance of success.

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INTRODUCTION

1.1 BACKGROUND

Large engineering projects, for example, the English Channel Crossing and the Mackenzie Valley Oil Pipeline, embody a number of special aspects and unique characteristics in comparison to smaller undertakings. Additionally, a growing number of large projects are undertaken employing the **B**uild–**O**perate–**T**ransfer ('BOT') approach, significantly increasing the project's complexity. With the BOT model of project delivery, the private sector finances, builds and operates a revenue-generating project, usually one which would have traditionally been executed in the public sector.

Judging the success of large projects is difficult, for, with numerous participants, they must by necessity achieve numerous objectives. Many are not explicitly identified or may be conflicting. Not unexpectedly, a significant portion of large projects cannot be considered *successful*, i.e. in terms of meeting time, budget or quality implementation targets; achieving commercial or technical functionality measures; or when judged against other more qualitative criteria, e.g. sociopolitical aspects such as public acceptability.

Risks on large projects must be identified, assessed, quantified, responded to, managed and allocated. Some are more readily identified, analyzed and quantified (e.g. financial risks) than others, such as organization and conflict risks, which are difficult to visualize and quantify.

Despite the range of available risk assessment methods and techniques, significant aspects of the lack of project success may be attributed to shortcomings in current risk identification, assessment and management processes. Particularly on large projects, all risk sources, and their interplay between project variables, are difficult to identify a priori. There may be a dichotomy between risks focused upon, because they are readily quantifiable, and those which actually contribute to a project's lack of success but are difficult to quantify. On larger projects, risk planning is important as risks are more numerous; additionally on BOT projects risks are not only more numerous, many are novel and longer-lasting.

This thesis will address some of these shortcomings, with an emphasis on non-traditional risks and BOT projects, and present elements of a risk planning framework, with a view to providing guidance for potential project participants on large projects.

1.2 MOTIVATION: THE CHALLENGE OF LARGE PROJECTS AND THE IMPORTANCE OF RISK PLANNING

Evidence can be found that a substantial number of large projects can be considered less than successful. Morris (1986) noted projects often exceed their cost or schedule targets or fail to perform satisfactorily. Morris & Hough (1987) reported on a survey of over 3,500 major projects worldwide. They noted cost overruns, as one measure of successful implementation, were the norm, typically ranging between 40% and 200% with even greater overruns on some types of projects, such as the U.S. nuclear program.

Murphy (1983) reported completion delays and cost escalations are common on 'macroprojects' executed in less developed countries. Further, it was found that the likelihood and magnitude of delays, escalations, postponements and suspensions increased with the size of the project.

The World Bank experience is similar; they annually conduct systematic performance evaluations of their projects. Their most recent evaluation of the execution of over 1500 projects (World Bank, 1988), considered quantitative measures such as project implementation time and cost, and qualitative success measures such as sustainability and overall success. It was reported that almost 90% of World Bank projects required more time to complete than originally estimated, with 49% of the projects requiring over 50% more time and 21% requiring over 100% more time. Respecting cost performance, 52% of all projects overran the original budget by more than 10%, with 17% of all projects overrunning by more than 50%. Lastly, 17% of all projects were considered 'unsuccessful' in that they achieved few, if any objectives and no foreseeable worthwhile results.

A recent World Bank confidential report indicated the situation is not improving, with unsuccessful projects becoming even more prevelant—upwards of 35% of recent projects are considered 'unsuccessful' and the number of projects cancelled because of problems rising by 50% since 1988. The report cited a tendancy to underestimate the potential for problems, including delays and opposition from local stakeholders, coupled with a tendancy to overestimate potential project benefits (Hossie, 1992).

In response to the lack of project success, the World Bank (1988) called for broader risk analysis and more deliberate efforts at risk management. Jaafari & Schub (1990) indicated many project failures are related to inadequacies in risk planning and control processes, and risk identification and project planning tasks are paramount. Murphy (1983) noted in light of the common occurrence of problems, the project's planning stage is crucial. Hayfield (1986) felt the majority of project failures are related to non-technical causes; this points to the importance of planning in the project's initial phase, and highlights risk identification, analysis and management tasks. It was noted that risks are sometimes inadequately identified, or only partially identified but highly analysed. Morris & Hough (1987) suggested that the causes for a lack of project success may be found in areas which traditionally have not been the concern of project management—escalation, changes, uncertainty respecting regulatory requirements and other externalities—which has tended to focus more on the technical aspects of the project. Horwitch (1984) noted the more ambiguous factors of politics, organizational strength, quality of champions and managers, and corporate strategic support usually makes or breaks a large project; where organization, political, historical and stakeholder awareness is at least as important as technical and economic expertise.

Large engineering projects present a particular challenge from a planning and organizational perspective, and are characterized by structural complexities and a high degree of environmental uncertainty (Yeo, 1982; Tatum & Fawcett, 1986). Horwitch (1984) noted the predominant characteristic of large projects which embody multiple and

diverse participants, is their diverse and extreme complexity. The projects are volatile, vulnerable and unprotected.

Additionally, the environment for executing large projects is evolving and becoming increasingly complex and turbulent. 'BOT' undertakings are becoming more prevalent, and project participants find themselves encountering numerous non-traditional risks and uncertainties of which they have little experience to draw upon.

Horwitch (1984) described the recent evolution of large projects through three stages: first, large projects in the post-war to mid-1960's period were commonly defense and aerospace projects, aided and facilitated by national prestige and strong political commitments. Second, a transitional period followed, where large projects were proposed in new sectors and became increasingly dependent upon private sector customers, but momentum based on national defense, national prestige or international rivalry was sometimes insufficient to overcome problems. The third and present implementation environment for large projects, sees the development of commercialization goals for large projects, with the emergence of multiple stakeholders in an open and diverse environment, and the vanishing protection of national security or prestige support. This emphasizes how the role and importance of stakeholders has changed significantly and broadened considerably over the past several decades. Stakeholders view large projects, project participants and even government with increased criticalness and skepticism. These considerations, coupled with an increasingly-complex regulatory environment, can lead to costly delays in planning and execution (Anderson, 1979).

As projects become more complex, it is increasingly-important for participants to be able to adapt a holistic viewpoint. For example, Morris (1985) suggested the absence of a premier proponent, i.e. one person or organization in charge and one participant with a holistic viewpoint, has allowed some large projects to proceed when perhaps they should not have. These failures were attributed because there was no one party able to come to grips with all the potential problems: there was no holistic viewpoint adopted. While the converse may not always be true, adapting a holistic project viewpoint will certainly aid the chances of a project's success.

Ward & Chapman (1991) noted the use of formal risk planning activities are often overlooked for a number of reasons, including a lack of awareness, expertise or time, but also because some owners may view the risks as either well-understood or not large enough, or, conversely, see the risks as difficult or impossible to quantify and thus analyse.

Risk planning involves proactive, anticipatory consideration of risk issues. Implementation problems, and the lack of success of some large projects, can often be attributed to risks not normally considered, and thus implicitly traced to weaknesses in the risk planning process. An industry-labour-government 'Major Projects Task Force' has noted further research is warranted respecting risk issues as they relate to the undertaking of major projects (Construction Industry Development Council, 1984).

The lack of a suitable risk planning framework for project participants is hampering the approval and implementation of these types of projects. Proponents seek guidance with

respect to appropriate processes and procedures, a structure for organizing risk planning knowledge and experience, and guidance on effectively utilizing relevant portions of the diverse body of knowledge with respect to risk analysis. Accordingly, the notion of a *'framework'* herein implies an approach in which to formalize and organize risk planning processes with the benefits of identifying linkages, gaps, and weaknesses and thus enhancing the project's chances of success.

1.3 OBJECTIVES OF THESIS

The objectives of this thesis are:

1.3.1 Large Projects

a. To characterize unique aspects of large engineering projects and attributes of the projects' environment.

1.3.2 BOT Projects

a. To define the important phases of the 'BOT' project delivery process.

b. To characterize, as a special case of large projects, unique aspects of 'BOT' projects and attributes of the projects' environment.

1.3.3 Risk Planning and Large and BOT Projects

a. To identify risk planning process considerations, from the literature and observation.

b. To identify problems which may result from inadequacies in risk planning, from the literature and observation.

c. To formulate a holistic risk planning Framework addressing identified problems and shortcomings.

d. To suggest the applicability of some of the diverse body of knowledge and experience with respect to risk planning.

e. To examine some risk planning postulates, including identifying the risk characteristics important to stakeholders such as relevant quantitative and qualitative dimensions.

The thesis will approach the process definition and framework formulation with a view towards practical implementation and to operationalize some of these approaches, with the contribution being one of development of an implementable process: one which can assist participants in their risk planning and in the evaluation of BOT projects, including consideration of when it may be appropriate to withdraw from or terminate the process.

1.4 METHODOLOGY

The methodology employed was a combination of investigation, observation, experience and literature review. A comprehensive review and compilation of relevant literature from a wide range of fields was undertaken. A bibliography of over 1000 works was collected, making extensive use of non-UBC sources through the facilities of the Inter-Library Loan service. This encompassed both engineering and non-engineering fields, including decision and risk analysis; engineering management; construction and project management; business and management science; and risk and decision-related areas of sociology and psychology. In this manner, many non-engineering perspectives were brought to bear on issues of engineering project management. The study of the literature was distilled to about 250 relevant works as cited in the thesis. To assist with the usefulness of such citations, an author index has been compiled and is included with the bibliography. The thesis can thus serve as a useful compendium for future work as well as a source embodying useful guidance for project participants such as consultants, contractors and financiers.

The thesis has also been based upon formal and informal discussions; interviews with project participants; a project planning questionnaire, and first hand observations gained from over sixteen years of professional experience related to project planning and delivery. This also includes recent engineering senior management experience, where an emphasis was placed on addressing project planning issues and non-traditional areas of risk, including needs and objectives definition; stakeholder consultation and management;

project participant team-building and consensus building, necessitating reconciliation of particularly divergent perspectives.

1.5 ORGANIZATION OF THE THESIS

In summary, the thesis is organized as follows:

Chapter 1 presents the motivation for the thesis, thesis objectives and discusses some important definitions which will be useful throughout the thesis. It also describes existing risk planning approaches.

Chapter 2 outlines the unique characteristics of large engineering projects (and their environment) which are important from the aspect of risk planning.

Chapter 3 focuses upon the development of BOT projects as an increasingly-prevalent subset of large projects; and identifies their important characteristics, the delivery process and environment.

Chapter 4 presents a case study of the Channel Tunnel BOT project to serve as the backdrop for risk planning discussions.

Chapter 5 describes the results of a questionnaire survey of practitioners and discusses postulates and a number of issues related to project planning and how participants view risk.

Chapters 6, 7, 8 and 9 detail the three stages of the proposed holistic Framework for risk planning, including examples from the Channel Tunnel BOT and other projects as an illustration of the proposed Framework.

Chapter 10 describes the use of a Risk Planning Brief as an effective tool to operationalize the Framework.

Chapter 11 outlines conclusions and recommendations.

1.6 SOME DEFINITIONS

1.6.1 Stakeholders, Participants and Feasibility

Project *stakeholders* are considered to be those persons, groups, companies or agencies which have, or perceive to have, an interest or involvement in the project or its outcome. Cleland (1990) also suggests the term 'organizational claimants' as describing stakeholders, and notes 'strategic issues' impacting the project may arise from stakeholder groups—a condition of internal or external pressure which may have a significant effect on some aspect of the project.

Within the context of this thesis, stakeholders will also refer to groups of the 'public', and include parties such as public interest groups (e.g. project advocates, interveners or opponents and other ad hoc single–issue assemblages of varying formality); end users;

labour groups; regulators; legislators and other political constituencies. Stakeholders may also encompass groups which actively support a project.

Project *participants* are those directly involved in the project's management and execution—i.e. its formulation, planning, evaluation or implementation—such as the project owner, designer, or contractor. All project participants, by definition, would be considered stakeholders.

The concept of assessing a project's *feasibility* may be considered as the process of first identifying criteria with which to measure performance or expectations, and secondly, establishing thresholds from which to base decisions respecting the project. Often both the criteria and feasibility thresholds are dynamic and change as time and participants evolve.

1.6.2 What are *'risk'* and *'uncertainty'*?

Risk will be considered to embrace issues of technological, sociopolitical, environmental, organizational, economic and financial *uncertainties,* in that some or all aspects of knowledge related to those issues is uncertain. Technological issues can include those associated with the design, construction and performance of the project. Sociopolitical issues can embody nonmarket uncertainties in the environment of the project, which is sometimes referred to as 'political' and 'country' risk (e.g. Kennedy, 1991). Environmental issues are those associated with the potential or perceived influences on the surroundings or ecosystems. Organizational issues may be those related to the internal

structure and interelationships within the project or venture. Organizational issues may also be associated with the stakeholder's uncertainty related to identifying risk thresholds and measures, as well as their potential temporal fluidity. Economic issues include a broad range of market and other external uncertainities and more global influences, such as inflation and exchange rate variations. Financial issues can be considered as those related to the financing, revenues, and costs.

A variety of definitions of *risk* and *uncertainty* are commonly encountered in the literature. All recognize *risk* and *uncertainty* are ubiquitous on large engineering projects, but few would agree as to exactly what are 'risk' and 'uncertainty'. A brief survey of the literature reveals the variety of concepts and definitions which are offered, reflecting classical decision theory, technological risk assessment, as well as psychological, managerial and construction perspectives. This survey is briefly presented to highlight the necessity and advantages of considering risk as previously defined: issues of technological, sociopolitical, environmental, organizational, economic and financial uncertainties.

Vlek and Stallen (1980) suggested a qualitative definition of 'risk' as the complete description of possible undesired consequences of a course of action, together with an indication of their likelihood and seriousness. They offered six alternate definitions for a quantitative risk variable: the probability of loss; the size of loss; the expected loss; the variance of the probability distribution over the utilities of all possible consequences; a semi-variance of the utility distribution; or a linear function of the expected value and the variance of the distribution of consequences.

Vesely (1984) felt 'risk' is always associated with an undesirable event which can produce harmful consequences, and involves both the frequency of the undesirable event and the severity of the consequences. Similarly, Holdgate (1981) defined 'risk' as the probability of a particular outcome following from an event or action; and 'uncertainty' as the situation where this cannot be quantified. Gratt (1987) considered 'risk' as the potential for realization of unwanted, adverse consequences to human life, health, property or the environment.

Hansson (1989) noted 'risk', in its everyday usage has two closely related main senses. It can refer to the estimated probability that an undesirable event will occur. Secondly, in a more general sense, 'risk' can be used to refer more in general to a situation where it is possible, but not certain, that an undesirable event will occur, which includes the concept of both the probability and the character of the undesirable event. Sherif (1991) considered 'risk' as the potential for the realization of unwanted negative consequences of an event, and an uncertainty in the occurrence of that consequence which can be expressed in the form of a probability of occurrence.

A number of authors approach risk from the perspective of engineering projects. Erikson & O'Connor (1979) considered 'risk' as exposure to possible economic loss or gain arising from involvement in the construction process. Wideman (1986) considered 'project risk' as the chance of certain occurrences adversely affecting project objectives. Noting risk and uncertainty are inherently present in construction projects, Perry and Hayes (1985b) felt distinctions between risk and uncertainty, and also between pure risk

and speculative risk, are usually unnecessary and may even be unhelpful. Cooper & Chapman (1987) defined 'risk' as exposure to the possibility of economic or financial loss or gain, physical damage or injury, or delay, as a consequence of the uncertainty associated with pursuing a course of action. Jaafari & Schub (1990) defined 'risk' as the presence of potential or actual constraints that could stand in the way of project performance, causing partial or complete failure during construction, commissioning or operation. Bunni (1990) considered the 'best' definition of risk as that given by British Standard No. 4778, as the combined effect of the probability of occurrence of an undesirable event, and the magnitude of the event. Al-Bahar & Crandall (1990), however, noted there was no uniform or consistent usage of the word 'risk' in the literature, and commented that most definitions of risk have focused only on the downside associated with risks such as losses or damages, and neglected the upside such as profits or gains. They proposed 'uncertainty' to represent the probability that an event occurs (thus a 'certain' event has no uncertainty) and 'risk' as the exposure to the chance of occurrences of events adversely or favorably affecting project objectives as a consequence of uncertainty.

Others view 'uncertainty' differently. Kaplan & Garrick (1981) considered that 'risk' must involve uncertainty and damage; i.e. probability and consequence. Baird & Thomas (1985) described a typical definition of 'risk' as a condition in which the consequences of a decision and the probabilities associated with the consequences are known entities. 'Uncertainty' exists if the problem structure, consequences, and probabilities are not fully known. They noted, however, there is considerable overlap in the literature respecting the

usage of the terms 'risk' and 'uncertainty', and pointed out some conceive of 'risk' as expected value, encompassing both the outcomes of a decision and some representation of the probability of the outcomes, whereas others (Sjoberg, 1980; Vlek & Stallen, 1980) suggested outcomes and probabilities as separate proxies for 'risk'. Alternately, the variance or dispersion of outcomes has also been a common surrogate for 'risk' in both the finance and psychological literature (Libby & Fishburn, 1977).

Lopes (1983, 1987) described 'risk' as referring to situations in which a decision is made whose consequences depend on the outcomes of possible future events having known probabilities. If the knowledge of probabilities is very inexact or unknown, then such decisions are regarded as involving uncertainty.

Moskowitz and Bunn (1987) saw 'risk' and 'uncertainty' as closely related and involved in virtually all important decisions They felt conventionally, 'uncertainty' refers to probabilities and to probability distributions associated with decision alternatives having uncertain outcomes which may be favourable or unfavourable. 'Risk', they noted, has many interpretations, and its precise meaning and usage varies across individuals, disciplines, and contexts. Loosely defined, 'risk' is associated with the likelihood of an unfavourable outcome, noting 'risk' increases as unfavourable outcomes become more probable, or probable unfavourable outcomes increase in adversity.

Kahneman & Tversky (1982a) considered that assessments of 'uncertainty' can be made in different modes, by focusing on frequencies, propensities, the strength of arguments, or

direct experiences of confidence, and these variants of 'uncertainty' are associated with different expressions in natural language. Paterson (1986) considered 'uncertainty' as a measure of our inability to predict accurately the future as it affects decisions. As the future is intrinsically uncertain to a greater or lesser extent, decisions which can only be implemented at some future date are likely to be more uncertain than decisions which can be acted on immediately. Rodgers (1987) noted 'uncertainty' may go beyond probabilities, including 'transcientific' uncertainties, involving an attempt to predict the unpredictable, compare the incommensurable, identify elusive political or cultural preferences, respond to ever-changing constituencies, choose among values, and elevate one discipline over another, where views and information are constantly changing.

Some feel considering 'risk' only in terms of probabilities and outcomes is inadequate and may lead to misunderstandings. Fraser (1979) pointed out because we consider 'risk' so commonplace in everyday life, most of us are quite certain we know what it means, but referring to a 'big risk' may mean very distinct things to different parties. For example, it may mean some unforeseen event may occur to upset existing plans; or there is great uncertainty as to whether some damaging event may occur or not; or that some damaging event is very likely to occur; or that if some damaging event occurs, a large amount of money may be involved.

Sjoberg (1980) also noted the word 'risk' is ambiguous, and considers three broad classes of meanings: those concerned with the probability of negative events, those concerned with the negative events themselves, measured in some suitable way, and those concerned

with a joint function of probability and consequences, most often their product. But it is also suggested that 'perceived risk' is seldom well pictured by the product of probability and consequences and the use of this product and its use, although it is often suggested as the definition of 'risk', can be quite misleading within the context of public decision making.

Fischhoff, Watson & Hope (1984) observed the meaning of 'risk' has always been fraught with confusion and controversy, and while some of this conflict has been overt, more often the controversy is unrecognized. The definition of 'risk' is felt to be inherently controversial, and the choice of definition is a political one, expressing someone's views regarding the importance of different adverse effects in a particular situation.

Hohenemser, Kates & Slovic (1985) distinguished between a 'hazard' and 'risk'; where 'hazards' are defined as threats to humans and what they value, and 'risks' defined as quantitative measures of hazard consequences expressed as conditional probabilities of experiencing harm. Slovic, Fischhoff & Lichtenstein (1985) however, considered that 'risk' should include a wide range of cognitive dimensions that extend well beyond the idea of quantitative measures of hazard consequences expressed as conditional probabilities of experiencing harm. Arabie & Maschmeyer (1988) also pointed out if we are to gain further understandings of reactions to 'risks' and 'hazards' over diverse contexts, then more versatile models than a unidimensional continuum are needed to represent the perception of 'risk'.

Rayner (1987) felt the concept of 'risk' has been refined to the extent that we have lost sight of many aspects of 'risk' as a multifaceted phenomenon. There may be a consensus the essence of 'risk' consists of the probability of an adverse event and the magnitude of its consequences, which may be adequate to define 'risk' at the level of engineering-type calculations, but is quite misleading at the broader, more intractable, level of risk management. Hence Rayner (1987) pointed out the need for a polymorphous definition that encompasses purely societal concerns about equity from the risk-management perspective (i.e. allocation amongst stakeholders), and purely engineering-type concerns about probability and magnitude from technical perspectives. He proposed a concept of 'risk' as a way of classifying a whole series of complex interactions and relationships between people, as well as between man and nature.

From a managerial perspective, MacCrimmon & Wehrung (1986) noted 'risk' embodies three components: the magnitude of a loss, the chance of a loss, and the exposure to the loss, with the degree of 'risk' viewed as directly proportional to the chances and size of the loss, and to the degree of exposure. Shogren (1990) defined risk in terms of two elements: probability and severity. Boodman (1987) claimed most senior corporate managers lack an understanding of the basic facts of 'risk', and few can define the term appropriately.

March & Shapira (1987) commented that in classical decision theory, 'risk' is most commonly conceived as reflecting variation in the distribution of possible outcomes, their likelihoods, and their subjective values. However, they noted, finding a satisfactory

empirical definition of 'risk' within this framework has proven difficult. They suggested the ways in which human decision makers define 'risk' may differ significantly from the definitions of 'risk' in the theoretical literature, and that different individuals will see the 'risk' in the same situation in quite different ways (e.g. Kahneman & Tversky 1982a). March & Shapira (1987) further noted that managers often see 'risk' in ways that are both less precise and different from 'risk' as it appears in decision theory. They felt most managers do not treat uncertainty about positive outcomes as an important aspect of 'risk'; it is not primarily a probability concept; and while managers seek precision in estimating 'risk', most show little desire to reduce 'risk' to a single quantifiable construct.

The Construction Industry Institute (1989) noted 'risk' is usually defined in terms of its parent, 'uncertainty', which can be considered as the set of favourable and unfavourable possible outcomes. 'Risk' would be considered as the probability of an unfavourable outcome, and 'opportunity' as the probability of a favourable outcome.

Perry & Hayes (1986) noted that while the boundaries are blurred between 'risk' and 'uncertainty', and 'risk' and 'hazard', the practical aspects of considering 'risk' outweigh the semantics, and a better understanding of the project flows from identifying the sources of events which may change predictions.

Narrowing considerations of 'risk' in terms of 'consequences' and 'probabilities' or thinking of uncertainty only in terms of probabilities, has been common in the construction field (for example, Al-Bahar & Crandall, 1990). However, this narrow perspective may

contribute to the difficulty some project participants may have in envisioning the broader, qualitative context of many important project risks. On large undertakings, for example, proponents may be viewing 'risk' as financial, which can be readily understood in a quantitative manner. Some stakeholders, however, may be viewing 'risk' in terms of social or environmental adverse effects, which may be both very difficult to represent quantitatively and difficult to agree upon a common perception of a representation. The definition employed in this thesis embodies this implicit recognition of the various facets of 'risk' and the importance of the various participant and stakeholder perspectives.

1.7 RISK PLANNING APPROACHES

1.7.1 What Is 'Risk Planning'?

Risk planning will be considered in this thesis within the context of large engineering projects. It may be defined as a systematic, iterative process in which issues of uncertainty are identified, acknowledged, considered and responded to in a manner which best uses the project's resources and best addresses the project's and stakeholders' objectives. *Risk planning approaches* can be considered as a number of related comprehensive, implementable protocols and activities which are carried out with the goal of improving the project's success through management of risk.

Similar to project planning (Cleland, 1990; Laufer, 1990a), risk planning can embody a number of components such as anticipatory decision-making; the systematic integration of

independent decisions into a hierarchical framework; and forecasting, information-gathering, analysis, decision-making and implementation activities.

1.7.2 Existing Risk Planning Approaches

A number of project risk assessment and management techniques have been described in the literature. The evolution of such risk planning approaches, as outlined in this section, highlights how risk identification and allocation checklists have evolved to an examination of risk event cause-and-effect linkages and expert system frameworks. Nevertheless, it would appear few techniques have gained wide-spread acceptance and implementation. Ward & Chapman, (1991) noted to their knowledge, only BP International utilizes a comprehensive methodology for risk identification, understanding and management.

Erikson & O'Connor (1979) examined risk assignment in construction, but limit their examination of risks to those related to the construction process. They outline a procedure for risk identification followed by a risk-sharing approach by means of contractual assignment. A checklist of risks (project related, outside influence and contractual risk) are provided as a guide to allocation to the appropriate party (owner, designer or contractor).

Ashley (1981) categorized risks into three categories (performance, completion and liability), and recommends a coordinated approach to construction risk management. The advantages in considering a broader perspective (owner, contractor, designer, financier, regulatory bodies and users) are recognized. The potential for conflicting participant

objectives is also noted. A number of risk management options are presented and the importance of evaluating the impact of risk reallocation on all participants is acknowledged.

Perry & Hayes (1985a) highlighted the importance in risk identification and quantification during the early stages of project appraisal. A detailed list of risks in seven categories (physical, design, political, financial, operational, construction and environmental) is presented to aid in the identification, assessment and allocation processes.

Perry & Hayes (1985b) considered the risk management process of identification, analysis and response (avoidance, reduction, transfer or retention). A variety of financial risk analysis techniques are summarized and nine categories of sources of risks are suggested (physical, environmental, design, logistics, financial, legal, political, construction, and operational), building upon the seven previously suggested. Examples of risk identification, quantification and allocation strategies are given. Table 1.1 summarizes in a checklist, the cited primary sources of risk in projects.

Hayes, Perry, Thompson & Willmer (1986) presented an overview of the risk management process, encompassing risk identification, analysis and response. The importance of early quantification of risk and the choosing of appropriate risk allocation strategies (through contract strategy) is highlighted.

Wideman (1986) proposed a systematic approach to risk management, through risk identification, impact analysis, response planning, response system and data applications.

Five categories of risks are suggested (external, unpredictable; external, predictable; internal; technical, and legal). Building on the risk categorization and management model proposed by Wideman (1986), Al-Bahar & Crandall (1990) developed a risk model entitled 'Construction Risk Management System', which is intended to allow contractors to identify and classify project risks (acts of God, physical, financial and economic, political and environmental, design, and construction-related), primarily in a traditional construction setting, and respond with one of five strategies (risk avoidance, loss reduction and risk prevention, risk retention, risk transfer, and insurance). The model is cited as having potential use by the construction industry as part of an 'analytical hierarchy process' to evaluate the riskiness of a project when bidding (Mustafa & Al-Bahar, 1991).

Physical:
- Loss or damage by fire, earthquake, flood, accident, landslip.

Environmental:
- Ecological damage, pollution, waste treatment.
- Public enquiry.

Design:
- New technology, innovative applications, reliability, safety.
- Detail, precision and appropriateness of specifications.
- Design risks arising from surveys, investigations.
- Likelihood of change.
- Interaction of design with method of construction.

Logistics:
- Loss or damage in transportation.
- Availability of specialized resources.
- Access and communications.
- Organizational interfaces.

Financial:
- Availability of funds, adequacy of insurance.
- Adequate provision for cash flow.
- Losses due to defaults of contractors, suppliers.
- Exchange rate fluctuations, inflation.
- Taxation.

Legal:
- Liability for acts of others, direct liabilities.
- Local law, legal differences between home country and home countries of suppliers, contractors, designers.

Political:
- Political risks in countries of owner and suppliers, contractors.—war, revolution and changes in law.

Construction:
- Feasibility of construction methods, safety.
- Industrial relations.
- Extent of change.
- Climate.
- Quality and availability of management and supervision.

Operational:
- Fluctuations in market demand for product or service.
- Maintenance needs.
- Fitness for purpose.
- Safety of operation.

Table 1.1 Checklist Example of Primary Sources of Risk in Projects (Perry, & Hayes, 1985b)

Similarly, Jaafari (1987) proposed a 'Management Confidence Technique' to assess the project's riskiness and overall propensity to succeed or fail as a result of project 'constraints' (obstacles to achieving project goals). These constraints are broadly classified as project-related, management-related and environment-related (sociopolitical); a list of suggested initial constraints is provided. It is recognized further work will be necessary to identify and formulate a relationship between project constraints and the riskiness, or overall propensity to succeed or fail. The World Bank (1988) recommended the use of such approaches to evaluate a projects' overall propensity to succeed or fail. Jaafari (1988b) further outlined some of the key aspects of the strategic assessment of project options, at the early stages of the project's development and prior to the use of the 'Management Confidence Technique'.

Cooper and Chapman (1987) described a number of risk analysis approaches suitable for large projects, suggesting techniques to assess primarily time and financial risk. Ashley & Levitt (1987) and Mohan (1990) surveyed the development of a number of expert systems in the area of construction management. Two in particular are related to project risk management and are described further below.

Ashley & Perng (1987) reported on the development of an 'Intelligent Risk Identification System', which is designed to be an expert system for the identification of construction problems, their potential impact and possible actions, based upon past experience. The system is intended to assist users, in the early stages of a project, in analysing risk and potential problems. Influence diagrams illustrating problem causes-and-effects can be

generated, indicating the potential impact of the risk on project cost, schedule and construction. The further development of the system is described by Ashley, Stokes & Perng (1988). In a similar manner, Bufaied (1987) identified major construction risk variables, at the project level, and modelled causal linkages.

Kangari & Boyer (1987) described a knowledge-based construction risk-management system, 'Expert-Risk', intended to provide guidance to owners, designers and contractors. The system functions as an intelligent questionnaire on risk, assisting with risk identification, management and fuzzy set evaluation of risk, and is integrated with financial and cost data bases. Kangari (1988) further described 'Expert-Risk'. The system considered six categories of risks (construction related, contractual and legal, physical aspects, performance and management, general economic factors, and political and public) and could offer suggestions for risk sharing or allocation. Kangari and Riggs (1989) detailed the fuzzy set aspects of the risk analysis and described the use of natural language terms, which allowed the system to evaluate the overall risk of a project.

Both the 'Intelligent Risk Identification System' and 'Expert-Risk' approaches build on experiential knowledge through capturing the experience of construction participants to establish cause-effect linkages and potential risk impacts. The systems can, based upon this knowledge, suggest risk allocation or contractual strategies.

These approaches are an attempt to develop an operational model for risk planning, but are, at this time, limited in breadth and cannot yet be regarded as providing a broad

framework for risk planning. Large and BOT projects by their nature are unique. Many risks and even categories of risks are novel; the contractual and organization structure of the project is unique; and participants need process guidance. Checklist approaches are useful if participants use them as tools to assist in the "brainstorming" of possible risks and scenarios. However, while approaches described in the literature are useful in assisting some of the participants evaluate some aspects of the project, none could offer 'holistic'—broadly based, multiperspective—risk planning assistance.

As previously noted, another important facet of risk planning would be the project 'stakeholder management' process. However, from a project risk planning perspective, it has received relatively little attention in the literature. Weiner & Brown (1986) noted that issue management leads to stakeholder management. It may be observed that their suggested strategic planning approach may be useful for risk planning if placed within a project context.

Cleland (1986) noted the importance of explicit stakeholder management on projects, and suggested a multi-stage 'Project Stakeholder Management Process' (identification; gathering information, stakeholder mission, characteristics, and strategy identification; behaviour prediction; and implementation of stakeholder management strategy). Cleland (1990) recognized that a well-designed and properly implemented 'Project Stakeholder Management Process' can forestal potentially adverse stakeholder activities and enhance stakeholder support for the project. He extended stakeholder management from an organizational perspective into a project perspective. The importance of formal

stakeholder management on large projects is emphasized. The linkage is also made to the identification, assessment and management of project 'strategic issues' (Cleland, 1990).

Ward & Chapman (1991) described numerous important roles for risk analysis and their possible uses by different project participants, such as the client and the contractor, with the goals of minimizing uncertainty respecting time, cost and quality. They question why risk analysis is not as extensively used as it might be.

In partial answer, further attention towards the development of practical, comprehensive approaches, formalized through a framework, with the goal of facilitating risk planning from all persectives for all project participants with due attention to ease of use and demonstrated usefulness, will likely encourage their application, as noted in Section 1.2. No such comprehensive risk planning framework exists. This thesis describes such a Framework.

CHAPTER 2.
THE UNIQUE ASPECTS OF LARGE ENGINEERING PROJECTS

Large engineering projects, for example, the English Channel Crossing or the Mackenzie Valley Oil Pipeline projects, quite apart from dollar value, embody many special aspects and unique characteristics in comparison to smaller scale undertakings. Many labels have been attached to describe the scope of such undertakings, such as 'mega-projects', 'giant projects' (Sykes, 1982); 'VLP's' or 'Very Large Projects' (Kelley & Morris, 1981); 'major projects' (Morris & Hough, 1987); and 'super projects'. Warnock (1979) noted projects (or at least their terminology) have evolved from 'large' to 'jumbo', 'giant' and even 'super'. Within the context of this thesis, however, all these undertakings will be referred to as 'large' projects. BOT projects, discussed in detail in the following chapter, represent an important sub-set of large projects.

A variety of authors, such as Claxton (1978), Warnock (1979), Hoffman (1979), Kelley & Morris (1981), Yeo (1982), Sykes (1982), Murphy (1983), Morris (1985), Morris & Hough (1987) and Lang (1989) presented a number of unique attributes of large engineering projects. Based upon these and other observations, it is proposed that the important characteristics of large engineering projects—as compared with smaller scale projects—from the aspect of risk planning can be categorized in accordance with ten distinctive characteristics. The characteristics are summarized in Table 2.1 and discussed in the following sections 2.1 through 2.10.

- Uniqueness and Complexity
- Numerous and Large Risks
- Project Indivisibility
- Longer Execution Times
- Large Financial Requirements
- High Vulnerability
- Multiple Stakeholders
- Appreciable Organizational Challenges
- Difficult Logistics
- Broad Impact.

Table 2.1 Unique Characteristics of Large Engineering Projects

2.1 UNIQUENESS AND COMPLEXITY

Large projects are generally complex and particularly demanding, in terms of size, urgency, or technology. They often involve technological advances, new materials and innovative construction techniques. They are unique in terms of type or size; often the projects are the largest undertakings of that type to date. Because of the uniqueness, there is little opportunity for learning curves. Significant infrastructure to support the project itself may be required. The projects are highly intricate in scope and are difficult to control in terms of complexity, including engineering, legal, management and organizational requirements, financing, and staffing demands.

Many of these complexities foster risks which cannot be addressed by specific experience, since the project is unique.

2.2 NUMEROUS AND LARGE RISKS

Project risks are numerous and inescapably large, and cannot be averaged out through repetition because of their magnitude and the singularity of the project.

Participants can take no solace in averaging potential losses, for the project is non-repeatable. As well, the magnitude of risks may be so great such that participants may not be able to recover from an adverse effect—i.e. the risks may be so great as to threaten the survival of the enterprise or the firm or the project may be lost.

2.3 PROJECT INDIVISIBILITY

Large projects are often essentially indivisible, i.e. have no value unless completed. Additionally, there are commonly significant ancillary requirements—training, institutional adjustments, support infrastructure, etc.—which must be provided or the project cannot function. The participants are faced with the situation where they *must* complete the project or it has no value—an incomplete tunnel, bridge, or plant, has no value. This 'all or nothing' attitude contributes to escalation, irrational judgements respecting 'sunk costs' and the evaluation of additional commitments judged on criteria other than normal considerations.

While large projects are indivisible, they are often comprised of inter-related but very different components which must be highly-coordinated and well-integrated; this leads to increased complexity and risks related to these interfaces.

2.4 LONGER EXECUTION TIMES

Large projects commonly require a significantly longer-than-normal length of time to plan and execute, including a longer construction period.

The longer time frames required for the planning and construction phases expose the project to much greater uncertainties. Commitments are made in the planning stage respecting actions very much in the future. Longer construction periods result in greater negative cash flows, and increase the projects sensitivity to interest and escalation charges.

Longer execution times are also linked with longer term payoffs. This may include both a longer time until positive cash flows and positive returns; and the return and payoff stretched over a much longer period of time.

2.5 LARGE FINANCIAL REQUIREMENTS

Large projects require large financial commitments and sophisticated financing arrangements, which may go beyond traditional sources of financing and commonly requiring financing from a wide range of sources, including public and private. More financial participants increases the level of complexity and elevates the potential for conflicts. Each financial participant may have their own criteria to address with respect to risk allocations; government and international arrangements may also contribute additional complexities and introduce sources of risk (e.g. exchange rates).

2.6 HIGH VULNERABILITY

Large projects typically have a higher level of vulnerability and sensitivity to external and environmental factors, as such projects often cross national boundaries or are otherwise

highly dependent upon global economics and political environments and other externalities and unforecastable events.

2.7 MULTIPLE STAKEHOLDERS

Typically, large projects attract a greater-than-usual number and diversity of project stakeholders. They offer 'large targets' and thus become more exposed to the attentions and agendas of participant or stakeholder groups, some of which may coalesce solely because of the project. Large projects have a high profile and are subject to intense government and public scrutiny, a complex (and sometimes shifting) regulatory environment, and societal debate. Large projects may entail the involvement of many thousands of individuals, often in cross-cultural settings, adding complexities and conflicts, and are particularly vulnerable to labour unrest and disruptions.

Often the projects' multiple objectives are ill-defined and conflicting, increasing potential risks. A large number of stakeholders leads to incongruities in perspectives, including objectives, social and cultural values. Stakeholder management, as part of risk planning, becomes an essential but potentially difficult task.

Multiple project participants are common, resulting in multiple, often conflicting, goals, as the risk of conflict escalates with the number of participants (and thus number of inter-relationships between participants). Large numbers of participants add complexity and significantly encumbers the decision-making process.

2.8 APPRECIABLE ORGANIZATIONAL CHALLENGES

Because of the project's size and complexity, large projects are typically beyond the capabilities of a single organization. Joint ventures, and joint ventures of joint ventures, are commonly required. Joint ventures bring extra risks, as the partners accept exposure risks of all other partners. Trans-national contributions and the participation of one or more governments may be necessary, as the projects usually will require an official sanction, sponsorship, guarantee or other implicit or explicit government participation.

These relationships add organizational and cultural complexities. The organization of large projects is a major challenge in itself. The bargaining powers of the prospective participants varies widely and adds uncertainty and conflict. The project organizations themselves are commonly ad hoc by virtue of the uniqueness of the project, and are extremely dynamic, undergoing significant change throughout the project life-cycle. There is a need to not only manage the project by means of the organization, but manage all necessary change within the organization itself. This contributes to stress, conflict and uncertainty.

Senior project participants are often seconded from other organizations, which may be unpopular, and they may lack sufficient large project experience or be subject to conflicting loyalties or demands, particularly in early phases. Large projects, as they are executed by aggregations of organizations, may lack a readily-identifiable identity, 'corporate culture', and important information paths of communication, adding

uncertainties and conflicts from blending corporate cultures. Often large projects lack an identifiable project 'champion' or premier proponent.

2.9 DIFFICULT LOGISTICS

Projects are often executed in unfamiliar, difficult or hostile location, climate or terrain, often spanning large geographical areas and extending over national boundaries, contributing to logistical, management and construction difficulties. This adds complexities and risks, some more readily identifiable (procurement lead times and international shipping complexities, etc.) than others, which may be 'soft' risks such as productivity, motivational, social, and cross-cultural problems, or recruiting difficulties at remote sites. Challenging logistics and climatic extremes increases demands upon supervision and other management and planning tasks.

2.10 BROAD IMPACT

Large projects sometimes have the ability to significantly influence their own environment as well as project participants. Because of their size, some large projects can have a wide–reaching influence upon economies at the national level. In the extreme cases, the projects provide an element of improvement of quality of life and possibly a change in the social order; they represent step-like advances, have a potentially significant impact upon society and thus may have impacts far beyond what was envisioned. They often have a potentially significant environmental impact and may be socially and culturally incongruous,

particularly if executed in remote or less developed regions. The potential for such broad impacts add significant levels of uncertainty and complexity.

CHAPTER 3.
THE 'BUILD-OPERATE-TRANSFER' APPROACH

3.1 THE EVOLUTION OF THE BOT APPROACH

Within the realm of large projects, the **B**uild–**O**perate–**T**ransfer ('BOT') approach is becoming increasingly prevalent and important. With the BOT model of project delivery, the private sector finances, builds and operates a revenue-generating project, usually one which would have traditionally been executed in the public sector.

Some projects may be alternately labelled as **B**uild–**O**wn–**O**perate–**T**ransfer ('BOOT', terminology common in the United Kingdom (Barnett, 1989)); **F**inance–**B**uild–**O**perate–**T**ransfer ('F-BOT'), or 'F-BOOT'. Other less frequently applied acronyms include **D**esign–**B**uild–**O**perate–**T**ransfer ('DBOT'); **D**esign–**B**uild–**O**perate–**M**aintain ('DBOM') and **B**uild–**O**wn–**O**perate ('BOO') (McCarthy & Tiong, 1991).

The development of the present form of the BOT model is attributed to the Turkish Prime Minister Turgut Ozal in 1984 (Tiong, 1990a). While the current structure of the approach was proposed in Turkey, the first major BOT project to proceed was a US$1.8 billion highway in Malaysia (Carnevale, 1988).

The government granting of concessions for private sector-provided infrastructure is not in itself a new concept. Many seminal large projects, such as railways and canals in Canada and elsewhere, were financed and undertaken by the private sector (Thompson, 1988). As early as 1972, large project participants began to find 'financial engineering'

aproaches were increasing in prevalence. This required contractors and other participants to assemble financial packaging, raise equity or organize countertrade arrangements (ENR, 1984b). These approaches added significant complexities and risks to the project planning process, particularly if countertrade or barter provisions were involved.

In response to the 1981-82 debt crisis, it was noted (Barrett, 1986; Mills, 1987) that engineering and contracting companies were being asked to accept even greater risks than before by taking equity stakes in, and operating projects once completed, including involvement with BOT projects. Interest in BOT projects continued to grow as financiers and government credit agencies became more comfortable with the approach (ENR, 1988b), but the risks of the approach still had forestalled most potential BOT projects. Typically, large projects (particularly those in developing countries) had employed 'project finance' approaches, whereby the financing risk was evaluated on the basis of the project's cash flows as opposed to the borrower's credit worthiness (Carnevale, 1988). With the debt crisis of 1981–82, compounded by the fact revenues of many projects failed to meet expectations, financiers looked to models which shifted risks to the contractors, such as the BOT approach.

The current motivations of governments adopting this approach are many. They range from shortages of hard currency in developing countries; an increased desire to transfer infrastructure costs more directly to users; a reluctance (or inability) to fund large capital projects in the face of escalating costs of social programs, to simply the predominance of political philosophies favouring privatization. Governments share the attendant desire to

obtain project benefits yet minimize risks (i.e. transfer them to the private sector); the risks of some large projects may be viewed as more palatable politically if tackled by the private sector. Enhancing the attractiveness to government of the BOT approach are the increasing need for infrastructure development and renewal, compounded with increasing debt loads and growing taxpayer fatigue.

The private sector, seen by governments as possessing the ability to finance, build and operate infrastructure projects, is aggressively responding. The net result is contractors, consultants, banks and others are increasingly called upon to become involved in BOT projects, with the attendant new gamut of risks. As BOT projects become increasingly prevalent, some contractor and consulting firms are examining their corporate structure and ownership with a view towards enhancing their financial strength, to permit a more ready involvement in projects requiring an equity position (ENR, 1991g). Banks are not only increasingly financing BOT projects, but are taking equity positions as well (Construction Weekly, 1991f).

3.2 THE INCREASING PREVALENCE OF BOT PROJECTS: A SURVEY

There are many examples regionally, nationally and internationally, of projects, in the proposal or execution stage, which traditionally would have been executed in the public sector, but are now being transformed by governments into a BOT approach. Utility or transportation infrastructure projects are most common by virtue of their revenue–generating capabilities coupled with likely growth in demand.

The development, design, financing, construction and operation of the English Channel Tunnel, with an estimated capital cost of over $17 billion is a conspicuous example of a BOT project under construction. Tiong (1990b) cited fourteen BOT projects which are currently under construction worldwide outside North America, ranging in size from US$8.0 million to US$9.2 billion (which has subsequently escalated to over US$17 billion), including eight of the projects at over US$500 million. A recent survey identified 175 worldwide projects, worth US$44 billion which were undertaken with non-traditional public-private approaches (ENR, 1990d). There are many others projects in the planning or proposal stage.

3.2.1 Canadian BOT Project Opportunities

In Canada, two notable BOT transportation infrastructure projects in various stages of study or implementation are the fixed link Northumberland Strait crossing to Prince Edward Island ("PEI"), and a high-speed rail line for the Windsor-Quebec City corridor.

Ideas for a PEI fixed link had been advanced since the 1880s and been the subject of federal election promises dating to 1891. More recently, the project was proposed by the government in the 1960s (Yaffe, 1985) with some approach roads constructed before the project cancelled because of cost considerations.

In 1985, the government received two unsolicited private sector proposals, and responding to a high level of interest by developers and contractors, openly requested proposals in 1987 (Duncan, 1988; Feltham, 1989). The seven proposals—six bridges and

one tunnel (Franklin & Matich, 1990; Dilger, Tadros & Calder, 1990)—were narrowed to three. With an originally estimated project cost of upwards of $700 million, it was estimated proponents spent between $3 million and $5 million preparing their proposals (Thompson, 1988).

Subsequently, the project appeared stalled following a recommendation against the project by a federal environmental review panel (Cox & Duerden, 1990; Federal Environmental Assessment Review Office, 1990; Globe & Mail, 1990b, 1990c, 1990d). With increased attention to environmental concerns, plans were revived amidst controversy (Cox, 1991a, Globe & Mail, 1991b), as proponents hoped a decision was possible before the end of 1991 (Cox, 1991b). In the ensuing two stage technical then financial review, the government approved the proposal of Strait Crossing Inc., an international consortium which at the time was 40% owned by a Calgary construction company, SCI Engineers & Constructors Inc.; 35% by Morrison Knudsen Corp. of Idaho, and 25% by GTM Entrepose of France. In early 1993 the consortia sought to raise financing for construction of their proposed $840 million, 13.3 km toll bridge through a $600 million offering of 40 year inflation-indexed bonds, with an after inflation return of 4.75%. In February, 1993, the consortium faced the hurdles of environmental hearings and approvals and court challenges from stakeholders opposed to the project.

As an example of the numerous and novel risks faced by project participants, the governments of Canada, New Brunswick and PEI found themselves at that time defending legal challenges with respect to their ability to even proceed with the project,

notwithstanding the challenge faced by the "successful" consortium. Given the uncertainty associated with the groundrules of BOT projects themselves, a challenge of such a basic premise of the project adds considerably to the risks and costs incurred by the consortium (and taxpayers).

By late March, 1993, the project's future was again cited as uncertain, as the Federal Court of Canada ruled the project could not proceed until an environmental review of the project was conducted—the earlier Environmental Review Panel undertook an assessment of a "generic" bridge crossing without reference to the specifics of the Strait Crossing's project (Fine, 1993). The project was also halted by the Court on constitutional grounds, as a violation of the Federal government's promise to P.E.I. dating from 1873 to provide "efficient steamship service" to the island from the mainland. The economic basis of the project was also questioned, as it was revealed a government-commisioned 1992 financial assessment found the project is not viable and indicated the federal government would provide guarantees to financiers for overruns or defaults in addition to an annual indexed subsidy of $42 million. The proponents, while asserting the project cannot afford any further delays, had not yet signed a contract with the government (Cameron, 1993) as the court challenges proceeded.

By late summer, 1993 the Federal Court challenge was still unresolved. The latest rulings in favour of the bridge were appealed by the "Friends of the Island". Although the bill to allow the project to proceed had been passed, proclamation was withheld pending the outcome of the environmental legal challenges. It was hoped the contract to allow the

consortium to proceed would be signed in early September, 1993. The Strait Crossing consortium noted the challenges had added to the cost of the project, in terms of delays, stand-by staff costs and legal bills which alone were cited as $1 million (Globe & Mail, 1993c).

Following the ultimate resolution of the environmental legal challenges in favour of the project, the final agreements and contracts were signed on October 8, 1993. Construction commenced within the following two weeks with an estimated May, 1997 completion date, at which time over 500 Marine Atlantic ferry service employees would loose their jobs.

The high-speed rail project was first proposed in 1989 with joint private-public financing. When the federal government announced no public funds will be available, two competing private-sector groups (including banking partners) advanced proposals (McKenna, 1991a). Amidst much lobbying, they have been vying for government approval of their plans for a high-speed rail line, originally estimated to cost from $3 billion to $5.3 billion (Gibbon, 1991) but most recently estimated at up to $7.1 billion including a required public subsidy of 30% to 50% (Howard, 1991). As of early 1993, a number of studies are proceeding pertaining to possible socioeconomic and environmental impacts, potential market share, and routing, but no final government approvals have been forthcoming.

A large Canadian engineering firm, Lavalin Group (now SNC-Lavalin), has been involved in a $2.3 billion BOT mass rapid transit project in Bangkok (McKenna, 1990a; 1990b).

The concession was awarded to the Canadian-Japanese-Thai consortium, winning over a Euro-Asian group, although a subsequent military coup placed some uncertainty on the project (McKenna, 1991b) with reports indicating the project will go ahead but not with Lavalin (ENR, 1991d). The project was to be financed through $500 million in equity, $800 million in low-interest loans from the federal government, and $900 million in loans from Japanese and Thai banks. The consortium was to operate the system for 30 years and collect fare revenues.

Canadian developers Huang and Danczkay Properties Inc. are actively pursuing BOT opportunities in Canada and worldwide. They have undertaken the development of the Trillium Terminal 3 in Toronto as the first privately-developed and operated air terminal in Canada; were one of the final three contenders on the Prince Edward Island 'Fixed Link' BOT project, and in November, 1991, had been shortlisted as one of four consortia bidding the new Athens International Airport BOT project, estimated to cost between $2 billion and $3 billion (Globe & Mail, 1991f). As an example of the degree of uncertainty and volatility associated with BOT projects, in October 1993 (only weeks before a federal election), their consortium was awarded the privatization contract for the other two Toronto airport terminals. The 57 year concession to redevelop and operate Terminals 1 and 2 at a cost of up to $700 million was cancelled by the newly-elected government about one month later, despite the reported lack of a cancellation provision in their contract.

A French company, Cofiroute, announced it was undertaking a $300,000, six–month study examining the feasibility of providing a bridge across the Detroit River (supplementing an existing tunnel and bridge), from Windsor, Ontario to Detroit, Michigan (Globe & Mail, 1991c). Recently, the Canadian half of the international Windsor to Detroit tunnel was transferred (somewhat reluctantly and prodded by court actions) from its private owner to the City of Windsor, under the terms of the original concession agreement.

In Vancouver, British Columbia, the Lions' Gate Bridge crossing Burrard Inlet, is an early example of a privately proposed, promoted, financed, constructed and operated project. Two rival consortia attempted to gain the crossing concession in 1926. A 1927 plebiscite defeated the proposal, however the two groups merged and the project received plebiscite approval in 1933 followed by government approval in 1936. The total cost of the bridge, which opened as a toll crossing in 1938, was $5.7 million (Harris, 1991). The project illustrates a slight variation of the true BOT model, in that the bridge was not transferred at no cost, but subsequently sold to the provincial government in 1955 for $5.5 million. Recently, in response to exponential growth in traffic crossing the bridge and the need for significant upgrading, proposals have been advanced in the private sector for a parallel crossing of Burrard Inlet, at an estimated cost of over $450 million.

3.2.2 North American and Worldwide Transportation BOT Project Opportunities

In the United States, three high-speed inter-city rail projects are being actively promoted, with one project in Texas, recently being awarded a 50 year operating concession. The

major promoter of the US $5.8 billion Texas project, Morrison Knudsen, is a traditional engineering and construction company seeking new opportunities and long-term sources of revenue (Saunders, 1991).

Current initiatives in California and Britain indicate governments are encouraging BOT developments through negotiated risk-sharing strategies. The State of California, responding to voter defeats of initiatives to raise gasoline taxes and issue highway construction bonds, has turned to the BOT approach for transportation projects. Four consortia (from thirteen contenders) were recently granted permission to proceed with the planning of their highway projects, ranging in value from US$88.3 million to US$1.2 billion. The consortia will be responsible to plan (including environmental approvals), finance and operate the projects, in return for a 35 year toll collection and land development concession (Campbell, 1990; ENR, 1990h). To reduce the liability and property taxation exposure of these private consortia, the ownership of the facilities will be transferred to the state immediately upon completion, in conjunction with a lease-back (International Road Federation, 1990). The concession for a US$83 million toll bridge was awarded to a Spanish-Puerto Rican consortium, encouraged by guaranteed debt-service agreements and generous financing arrangements (ENR, 1991h). Not limiting the use of the approach to highway projects, the Los Angeles County Transportation Commission recently initiated the proposal process for two BOT rail transit line projects (ENR, 1991i). The state of Massachusetts has begun the process of identifying portions of transportation infrastructure programs which potentially could be implemented as BOT projects (ENR, 1991h).

In Britain, private road projects are being attracted through government-promoter risk-sharing encouragements. The government announced legislation which would allow tolls to be determined in the free marketplace; to grant highway project promoters the related development rights; and to reimburse promoters who are awarded a concession but whose project is not approved at subsequent public inquires (International Road Federation, 1990).

Under construction in Britain is the US$215 million Dartford bridge across the Thames. The BOT project concession was awarded in 1986, after consideration of eight submissions. Construction commenced in 1988. The winning consortium also acquired the lease of two adjacent tunnels, thus obtaining an immediate toll revenue stream (Carlile, 1990; Construction Weekly, 1991d). The concession period will be a maximum of 20 years but may be less, for as soon as the consortium has recouped its costs, the crossings are returned to the government (Blaxall et al, 1991). The project participants see the project as a means of generating construction and financing returns rather than operational profits (ENR, 1991a). Similarly, the concession to finance, design, build and operate a US$450 million bridge across the Severn Estuary was awarded in 1990. The BOT project will also include the lease and operation of the existing Severn bridge, for a maximum of 30 years (ENR, 1990e). A similar BOT project is under construction in Australia. The $550 million Sydney Harbour tunnel concession also includes the operation of an existing bridge crossing, with a substantial increase in the toll (Tiong, 1990a).

The UK's first BOT roadway project (as opposed to river or estuary crossings) was recently awarded to an international joint venture. The consortium will be responsible for the design, financing, construction and operation of the £450 million toll road project near Birmingham. It is estimated the consortium will spend between £15 million to £20 million on the statutory procedures alone, including a possible public inquiry, prior to the final award of the 53–year concession. Tenders for a related project will be called early in 1992 (Construction Weekly, 1991i) with planning for another bridge project underway (ENR, 1991e). Nevertheless, while the Conservative government of the time continued to actively promote private sector projects, the pending election raised uncertainty, for the prospective Labour government voiced strong opposition to private road developments, indicating they not only would favour the elimination of all toll roads, but may rescind BOT concessions granted by the present government (Construction Weekly, 1991j).

Germany recently announced they were examining the BOT approach as a means to provide needed highway infrastructure, with a possible variation of the government leasing the routes from the private sector (Globe & Mail, 1991a). Up to 17 major rail and highway projects, valued at US$17 billion, could be implemented by the private sector utilizing the BOT approach (ENR, 1991g). In France, a number of transportation and transit projects are being promoted or are under construction. In 1991, the French government evaluated invited tenders for the study, financing, development and operation of a major underground toll road network in the Hauts-de-Seine region, a project estimated at 'many billions' of French francs (Globe & Mail, 1991a). Based upon the

tender evaluation, companies were invited to submit a detailed proposal, and will be compensated FF2 million (approximately $370,000) if not successful.

In Hong Kong, two major tunnels have recently been undertaken, including the 4km, HK$2.15 billion ($315 million) Tate's Cairne Tunnel, owned and operated by a consortium of contractors under a 30 year concession (Construction Weekly, 1991a; 1991h). One of the largest Asian BOT project which is underway is a US$1.2 billion toll highway from Hong Kong to China. The government of China has guaranteed to compensate the consortium should they close the border, which has prompted some financiers to point out if there is uncertainty associated with the Chinese government closing the border, there would appear to be similiar uncertainty of the same Chinese government defaulting on the compensation (Pallay, 1992).

3.2.3 Other BOT Project Opportunities

BOT projects are not restricted to the transportation or utility sector. The Province of British Columbia invited proposals from the private sector for the design, financing, construction and operation of a province-wide biomedical waste collection, treatment and disposal system (British Columbia Purchasing Commission, 1990). Proponents would be expected to assume all the risks associated with planning, operating and owning such a facility. An initial concession period of ten years is offered. Overseas, a major U.K. consultant is structuring, with contractor and banking partners, a US$130 million water pipeline BOT project in Indonesia (ENR, 1991i). A US$2 billion coal-fired generating

plant in China will be financed, developed and operated by the private-sector in partnership with a government agency. The BOT project will be undertaken by Hopewell Holdings Ltd., which is also finalizing plans for a similar US$800 million BOT plant in the Philippines, and is actively seeking partners and pursuing a number of other BOT ventures in various countries including the US$1.6 billion Bangkok mass transit system and the US$1.2 billion Hong Kong to China tollway (Pallay, 1992).

Across Latin America, with a particular emphasis in Mexico, governments are looking to the private sector to implement a wide range of infrastructure projects, including water treatment and distribution systems, wastewater treatment and disposal systems, and solid waste disposal systems. These BOT projects are attracting considerable interest from international consortia, as the governments view BOT as the only viable approach in light of their country's challenging economic environment.

This survey has attempted to illustrate the range of new opportunities which are presented to consultants, contractors and financiers, in many sectors including transportation infrastructure. Owners, which are usually various levels of government, in Canada, many parts of the United States, numerous European countries, and Asia are increasingly amenable to receiving private sector proposals for needed infrastructure or are adopting the BOT model themselves to implement many of their new projects.

3.3 THE PHASES OF BOT

As a project evolves through various phases during its life, project objectives, risks, and participants change. There is, however, no universal model of this process. Phases are distinguished by the type of characteristic tasks and linked by decision points (Adams & Barndt, 1978).

For example, the World Bank identifies five phases in the project cycle (Baum & Tolbert, 1985):

1. *Identification:* Identifying ideas which may meet objectives and priorities.

2. *Preparation:* Assess the technical, economic, financial, social, political, institutional and environmental feasibility of the project.

3. *Appraisal:* Formal assessment process and commitment to finance and proceed.

4. *Implementation:* Construct project.

5. *Evaluation:* Ex post evaluation and monitoring of project against objectives.

These five phases are descriptive of tasks and decisions from the World Bank perspective, and do not consider, for example, an operational phase per se. As 'evaluation' of projects

provides important input to 'identification', the project cycle is seen to be cyclical in nature.

Adopting a more generic perspective, Adams & Barndt (1978) identify four phases:

1. *Conceptual:* Identify need, establish feasibility, identify alternatives, budget, schedule, project team.

2. *Planning:* Implement schedule, conduct studies, design.

3. *Execution:* Procure, construct.

4. *Termination:* Train, transfer project, reassign project team.

Adams & Barndt (1978) indicate the level of effort peaks between the second and third phases, although capital expenditures will not peak until the execution phase is completed. Generally, these phases are oriented towards a traditional model of project delivery from the perspectives of an owner (phase 1), consultant (phase 2, 3, 4) and contractor (phase 3). The transition between phases are characterized by owner approvals to proceed to planning, proceed to execution, and turnover. Of note, there is no continuing operational phase which would extend over the life of the project.

Similarly, Tiong (1990b) briefly described a typical BOT project as having five linear phases:

1. *Pre-investment:* Feasibility study.

2. *Implementation:* Engineering and design, concession agreements, project financing.

3. *Construction:* Construction.

4. *Operation:* Operation and maintenance, sale of products or toll collection, loan repayment.

5. *Transfer:* Transfer of ownership to government.

It is observed the description of some phases is somewhat misleading. For example 'pre-investment' implies little or no investment with respect to the project is yet required, where in essence, proponents will have made considerable investment (including equity) in the project before it advances into an 'implementation' phase. No decision points signalling a transition between phases were noted. McCarthy and Tiong (1991) later defined the five phases of BOT projects slightly differently, as 'preinvestment', 'preconstruction', 'construction', 'operation' and 'transfer'.

To aid our understanding of the important differences of the BOT approach, a more complete characterization of BOT phases is desirable. It will serve to highlight some important differences and illustrate, from the perspective of participants, interactions and

phase transitions. The six phases which are proposed to better define the project cycle and characteristics of the BOT approach are further discussed in a following section.

3.4 SPECIAL CHARACTERISTICS OF BOT PROJECTS

BOT projects typically share the previously–noted characteristics (Table 2.1) of large projects. Further, it can be observed that BOT projects have a number of additional important characteristics when compared with projects undertaken by means of the traditional public sector proposed, financed and operated model. These include both risk related and project cycle related characteristics. These observed special characteristics are summarized in Table 3.1 and described in the following sections 3.4.1 through 3.4.4.

- Participants adopt new roles and objectives.
- Project and participants involve longer time frames.
- New risks are introduced and accentuated.
- Novel risk allocation considerations.

Table 3.1 Special Characteristics of BOT Projects

3.4.1 New Roles and Objectives

The private sector adopts, partially or completely, the roles of project proponent, financier, designer, builder, operator and maintainer. As a result, project participants play new and wider roles and respond to new objectives. Many of these roles evolve and

undergo significant changes throughout the project's life. Participants must be sensitive to the wider-than-expected range of perspectives of direct and indirect project participants, translated into project objectives and failure and success criteria, and recognize their potential to impact upon the project. These additional roles and objectives fuel many new management challenges. Participants are usually inexperienced in the new relationships, corporate structures and understandings required, and conflicts of interest are common.

Traditionally, the objectives of the project participants were focused towards the physical delivery of a facility (the "project"). In comparison, the objectives of a BOT project are commonly much more diverse and long–ranging, in that delivering the facility is only one, possibly relatively minor, objective; crafting, developing and managing a successful, long–term commercial enterprise are commonly the major objectives.

Each BOT project, by its nature, is particularly unique, requiring a custom-crafted assemblage of participants attempting to design the most appropriate response to the project's particular risks, environment, and needs. Contractors and other potential participants who wish to take advantage of the opportunities BOT projects provide, must be flexible and adaptive. They find themselves involved in many aspects of the project in which they have little experience to draw upon. Additionally, the number of participants is likely to be greater than would be the case on a non-BOT project.

For example, from the perspective of a contractor or engineering consultant involved on a BOT project, they will find themselves acting in new roles—perhaps including those of

aggressive project proponents, promoters, and champions, and over a much longer timeframe with a particular emphasis on unfamiliar decision problems and risks in the early, highest uncertainty, project phases.

3.4.2 Longer Time Frames

Participants must be active throughout more phases of the project, from proposal, through implementation and ultimately operation. Often commitments must be made regarding financing, design, construction and operational details of the project at the time of proposal submission, prior even to the award of the concession. The project phases typically overlap and are commonly protracted, necessitating considerable investment of 'sunk costs' with a difficult-to-judge chance of proceeding to concession award. For example, in the case of the PEI Fixed Link project, some members of the competing consortia have been involved, at considerable cost, for over seven years since first advancing proposals, and it remains uncertain as to if or when the concession will be awarded. Upon concession award, participants may expect a construction phase of four or five years, followed by an operational phase of 35 years. They will still have an indirect involvement for much longer, however, as they must assure the structure has been adequately designed and built and will perform satisfactorily for a further 65 years (Thompson, 1988).

Longer time frames introduce uncertainty, exacerbated by the inability to presume a continuity in forecasts. There is often a lack of continuity within the consortia themselves,

as partners come and go and alliances change, as has been the case on the PEI Fixed Link project. It would be difficult, if not impossible, to accurately model 'project demand' (and thus revenues) over a typical BOT operating horizon ranging from 20 to 55 years (as in the case of the English Channel tunnel project), as well as forecasting the continuity of the financiers and venture partners themselves. Participants may find it formidable adequately accounting for a possibility of some dramatic but unforeseeable event introducing a discontinuity in the forecasting model, such as innovations, sociopolitical changes, catastrophic or apocalyptic events.

3.4.3 New Risks

New risks are introduced and accentuated by longer time horizons, new roles, greater numbers of stakeholders, more complexities and influences on the project, and involvement in the non-traditional lobbying, financing, environmental approvals, planning, and operational phases. More stakeholders are involved as BOT projects typically have a higher profile, and as a result are often subject to a more intense political and public scrutiny and have a greater vulnerability than conventional projects. McCarthy and Tiong (1991) noted that even 'medium' sized BOT projects typically attract some of the problems which are normally associated only with 'large' projects.

New risks implies new skills are required of participants. For example, there is a much greater need for "soft side" skills as the proponents must forcefully enuciate their vision to give the project sufficient momentum through the lobbying, opposition from stakeholders,

environmental approvals, keeping financing partners and creditors from vacilating, and overcoming the inevitable inter-organizational conflicts.

Examining the risk allocation on BOT projects in comparison to traditional approaches highlights new risks. For example, Erikson & OConnor (1979) and Perry & Hayes (1985a) outlined the allocation of the numerous risks associated with a conventional project approach between the owner, designer, and contractor. Under a BOT approach, most, if not all, of the 'owner-retained' risks (such as changes in law; civil disorder; government approvals; and environmental damage) would be shifted, in various forms, onto the 'promoter-contractor consortium' undertaking the project. Figure 3.1 compares such risks for BOT participants with those of conventional and turnkey project approaches, illustrating the range of new risks associated with the BOT approach. The complexity of these required risk sharing and allocation arrangements often results in a reluctance amongst some participants, particularly if inexperienced with respect to BOT arrangement, to accept the degree of uncertainty and the novel risks (Pallay, 1992).

3.4.4 Risk Allocation Considerations

By their nature, BOT projects tend to achieve numerous objectives, many not explicitly identified and conflicting. Additionally, they tend to have a particular diversity of project participants and project stakeholders. Each brings to the project their unique risk perspectives and potential for conflict. Stakeholder opposition or support for a project should be considered as a significant risk, and one to which BOT projects can be

especially sensitive. For example, the Northumberland Strait crossing project has been particularly dependent upon the support of key stakeholder groups, including political advocates.

In its fundamental form, the BOT model allocates virtually all risks to the private sector, in comparison with the traditional approach, where many, if not the majority of these risks would normally have been assumed by the public sector. At times, government insistence on a total risk allocation to the private sector may halt the project.

For example, the Turkish government's continuing instance on such a de facto total risk allocation to the private sector—respecting proposed BOT CANDU nuclear power plant projects—has precluded the successful completion of concession negotiations for many years. The government has remained unwilling to give a subsidy or guarantee in the form of a take or pay agreement, nor grant protection against the potential 'skimming' of revenues, and foreign exchange or political risk. As a result, the Canadian government will not grant export credit guarantees, so the project languishes (Barrett, 1986).

	Conventional Project Approach			*Turnkey Project Approach*				*'BOT' Approach*			
	Owner	**Designer**	**Contractor**	**Owner**	**Designer**	**Contractor**	**Consortium**	**Government**	**Promoter**	**Contractor**	**Consortium**
Planning Risks	✖			✖						✖	
Design Risks		✖				✖				✖	
Construction Risks			✖			✖				✖	
Financing Risks	✖			✖		✖				✖	
Ownership Risks	✖			✖				✖		✖	
Operational Risks	✖			✖		✖				✖	
Revenue & Market Risks	✖			✖		✖				✖	

Note: The size of the "✖" illustrates the approximate relative share of the risk.

Figure 3.1 Risk Allocation Amongst Participants Comparing Conventional, Turnkey and BOT Project Approaches

On other projects, the wisdom and expediency of total private sector risk allocation could be questioned. Waste disposal projects (for example, the British Columbia government's invitation to the private sector respecting the management of biomedical waste) inevitably involve many risks, conflicts and tradeoffs which may be difficult to equitably resolve in the public interest, by the private sector. It may very well be that the private sector is being asked to deal with such risks in the face of an increasing public sector frustration or lack of ability to do so satisfactorily. It should be recognized that packaging an otherwise intractable project with the BOT approach will not guarantee private sector willingness to proceed; Barnett (1989) notes some lesser–developed countries are not yet fully cognizant of this.

Other governments recognize even an implicit sharing of risks with the private sector will be necessary to make BOT more attractive. This may include a variety of strategies, from political support, loan or export guarantees, offtake agreements, base revenue guarantees, or other direct or indirect subsidies. Proponents may be offered partial or complete remuneration for their submissions if the concession is not awarded or the project is otherwise halted before construction. In most cases, however, proponents must bear the often considerable costs of assembling and advocating a project proposal. A further difficulty is few governments have a mechanism whereby a proponent can be awarded a concession without a public competition or tender. Thus, proponents who first propose an unsolicited project enjoy little if any benefits, for they often find themselves bidding against a considerable number of competing consortia during the public competition.

For example, Trafalger House, a large U.K. engineering construction company, submitted an unsolicited offer for the Dartford bridge in July, 1985 (Carlile, 1990). However, the U.K. government lacked a mechanism for awarding a concession to an unsolicited proposal, and thus publicly invited proposals in 1986. Trafalger House then found itself competing against seven other consortia; they narrowly won out and were awarded the concession in September, 1986. The Northumberland Crossing project is also similar; unsolicited proposals from the private sector were first made in 1985, but the Canadian government responding by issuing a public proposal call in March, 1988, whereby seven competing submissions were received; three of which were shortlisted for further consideration. All financial proposals were deemed not to comply with the government's requirements, however, subsequently the concession was awarded to one of the three. It was not until October, 1993 that a signed contract was in place, only weeks before a national election.

The effect of these BOT project selection processes is that competing proponents are required to invest considerable resources in the face of highly uncertain chances of success, a highly unpredictable and protracted timeframe, and unclear and changing criteria for evaluation and award. For example, as previously noted, the cost of each of the seven competing groups' proposals for the Northumberland Strait crossing project was cited as between $3 million and $5 million (Thompson, 1988). Subsequently, some proponents have continued to incur significant additional costs. Coupled with government expenditures on the project, it is plausible that up to 10% of the value of the crossing has been spent simply attempting to choose who may proceed with the project. In contrast to

more traditional tendering procedures, participants must constantly evaluate the risks in investing more time and resources to continue to pursue the project, versus the decision to end involvement and absorb the sunk costs.

As an illustration of the uncertainty which BOT project participants face, particularly in the early stages of the project, Figure 3.2 compares typical BOT and conventional approach decision trees from the perspective of a project proponent (bidder).

In contrast to conventional approaches, the bidder interested in pursuing a typical BOT project is faced with more phases, more branches (possible outcomes) and many states of nature exhibiting dimensions over which the bidders can exercise little control.

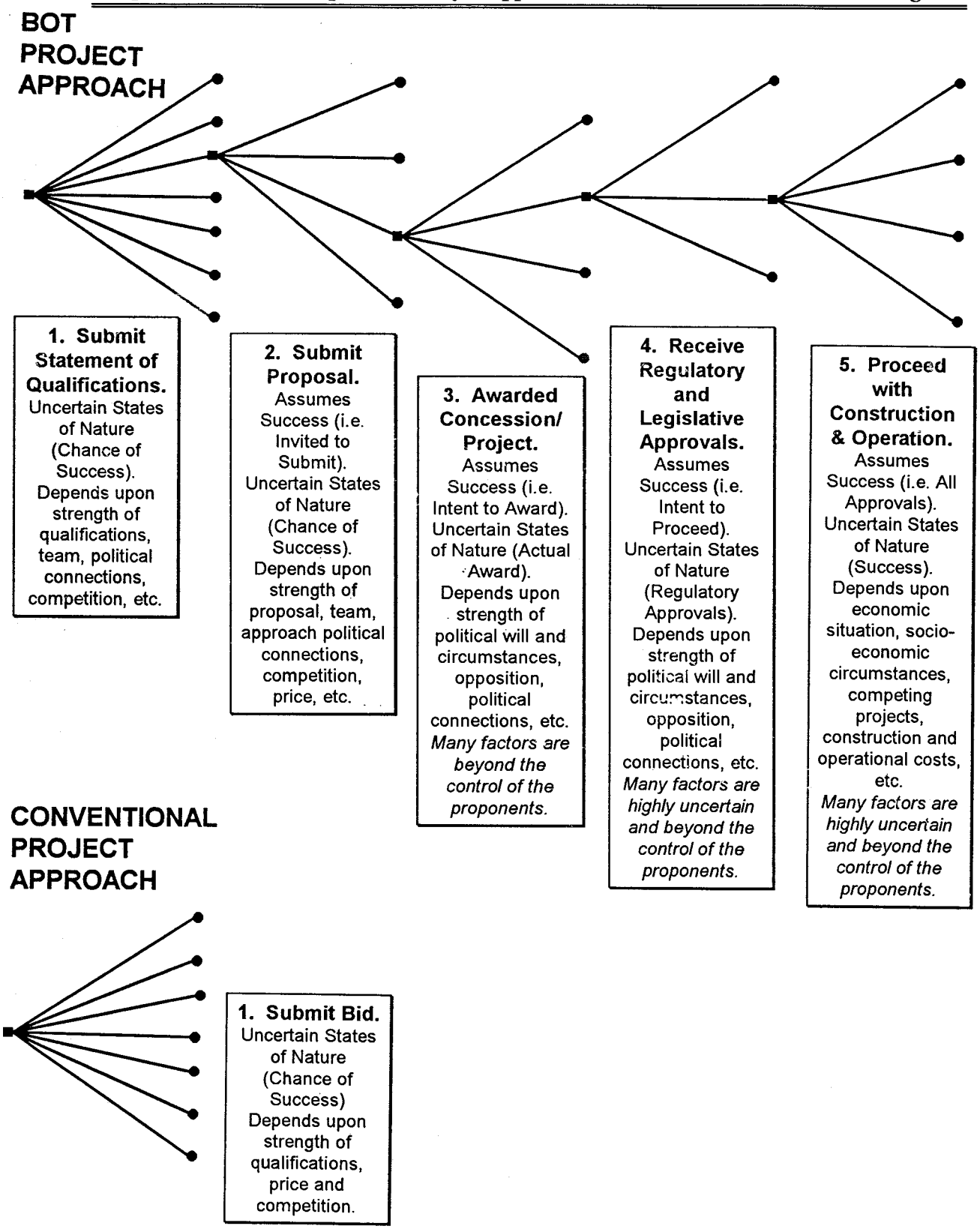

Figure 3.2: Decision Tree Comparison, Bidder's Perspective on BOT Project versus Conventional Project

3.5 THE PROPOSED SIX PHASES OF BOT

Figure 3.2 illustrates some of the many hurdles which must be overcome in the pre-construction phases of BOT projects. It is suggested these pre-construction phases are particularly important but often underestimated, and in recognition, six phases are proposed so as to better define the BOT project cycle. They are:

- **P**ropose;
- **E**valuate;
- **N**egotiate;
- **B**uild;
- **O**perate;
- **T**ransfer.

An illustration of these typical phases is provided in Figure 3.3.

3.5.1 The Importance of the PEN Phases of PEN-BOT

A more appropriate acronym **'PEN-BOT'** is proposed, which places a more realistic emphasis on the considerable front-end efforts and expenditures necessary before the project can ever be 'built'. It is in these PEN phases where participants may encounter many of the sources of much of the novel risks and uncertainties unique to these types of projects. Thus, it is suggested, it is the PEN phases which emphasize the uniqueness of the BOT approach.

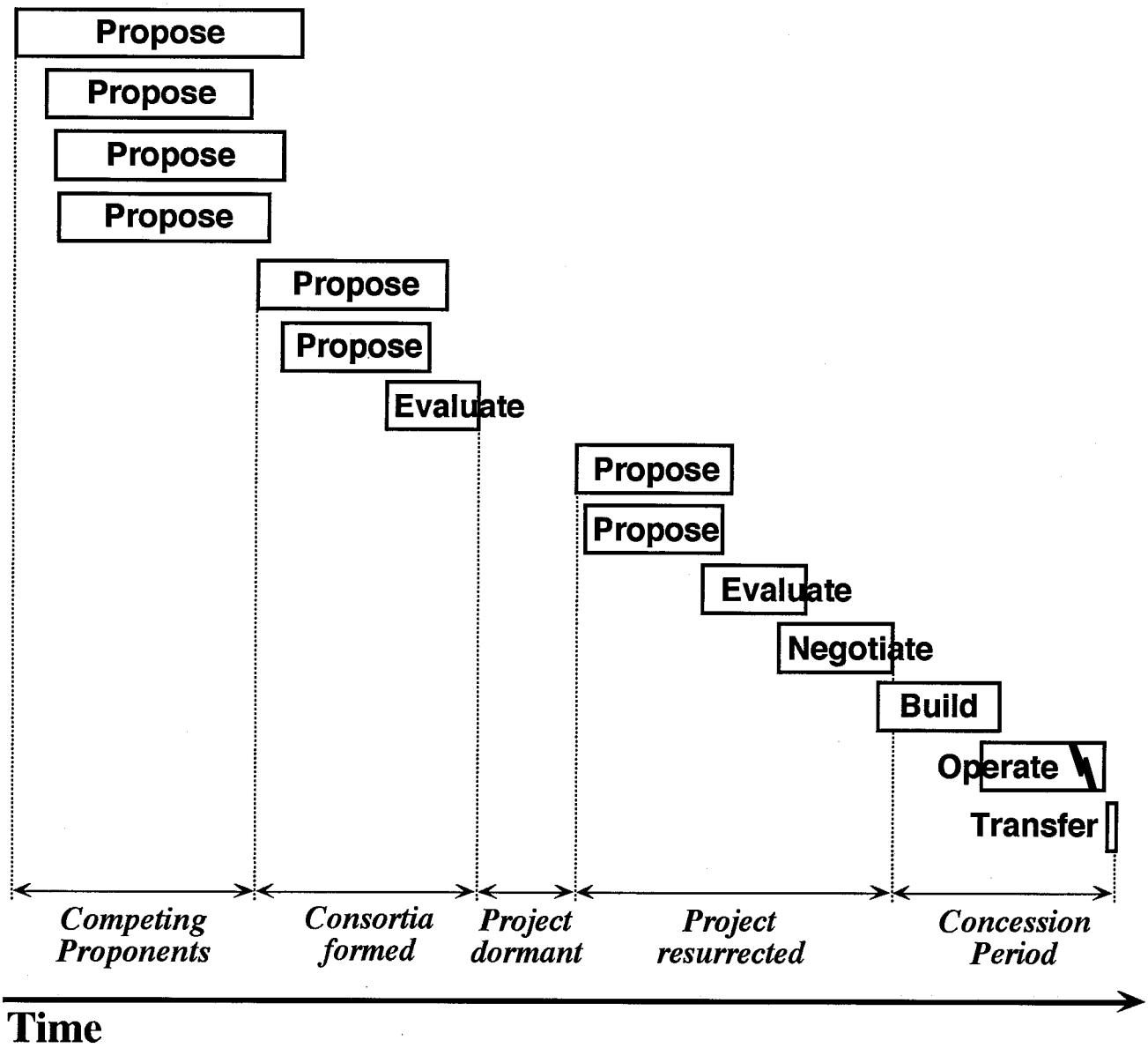

Figure 3.3 The Typical Repetitive, Overlapping Phases of the 'Propose-Evaluate-Negotiate-Build-Operate-Transfer' Approach

It is also important to note the often repetitive nature, the potential overlaps, and the prolonged nature of the 'PEN' phases, which once again, participants may find novel and often underestimate the fortitude necessary to see the project successfully through the 'PEN' phases. The salient features of each of the phases are described in the following Sections 3.5.2 through 3.5.7.

3.5.2 Propose

The idea for the project is born or resurrected, in the private or public sector. The idea may coalesce into a proposal advocated by a proponent or proponents. During this phase, private sector proponents identify participants, gather partners, and form coalitions or formal consortiums. Competing consortia may emerge, each promoting their own major or minor variation of the project.

This phase may be characterized by lobbying, public pronouncements and advocacy, and competing claims as to the merits and advantages of the consortia's schemes. If the idea for the project lacks government support, the consortia must lobby for both the project itself and the merits of their particular approach.

Participants find an increasing investment in time and money is required, often at the expense of the proponents' existing enterprises. Typically, the type of lobbying and long term strategic planning required consumes an inordinate amount of senior management's time and energies. A considerable investment of financial resources is required with a very uncertain chance of return.

As the phase evolves, contractual and financial arrangements are made, and additional information is sought regarding the feasibility and details of the financing, design, construction, and operation of the project, recognizing that many or all of these arrangements may continue to change through the course of the project. Thus, even in the first phase of the process, a long term structure for the project must be established in the face of very great uncertainty.

Consortia may formalize their commitments regarding the project through submission of an unsolicited or preemptive proposal requesting the granting of a concession, usually from the senior government or governments where the project would be resident. If accepted without a public proposal call, the phase may evolve into 'evaluate'.

Alternately, if the project proponents have remained in the public sector, the project may evolve fairly quickly through this phase to an announcement of a proposal call prior to the formulation of private consortia. This is rarely the case, for there is almost always some very early expression of private sector interest in the concept of the project, although it may be private lobbying of public officials.

However, unless criteria had previously been announced, the promotional efforts (including unsolicited submissions) of the consortia may result only in a formal public call for proposals. Partnerships and alliances may change and competing consortia may merge.

Lobbying may intensify, involving politicians and advocacy groups. Stakeholder groups' influence may be considerable. The senior body (or bodies) define the project's evaluation and selection criteria, which may involve a significant amount of internal discussions and conflict.

It is not unusual for the 'propose' phase to be very protracted and cyclical, as projects, proponents and consortia vie for government acknowledgement and support. The objectives respecting the project, and the government as ultimate owner, are often ambiguous and ill-defined. In response, the form of the project and consortia may evolve.

The phase nears an end with the official recognition of the project through a solicitation of proposals respecting the possible award of a concession, although this may not represent a commitment to the project on behalf of the government. Participants must judge if they wish to escalate their commitment through the preparation of a proposal, which must embody considerable detail and commitments regarding the project's financing, design, construction and operation. The phase ends with the submission of proposals for evaluation, although there may be further negotiations and amendments with selected parties, amidst much lobbying and advocacy.

As noted, the 'propose' phase may be cyclical in nature, with a project being proposed, perhaps not gaining acceptance or rejected, refined, and re-proposed a number of times over a protracted timeframe anywhere from several years to several decades (or several hundreds of years in the case of the English Channel tunnel).

3.5.3 Evaluate

The 'evaluate' phase commences with the acceptance by the government, or governments in the case of transprovincial or transnational projects, of proposals. The evaluation of proposals may involve two or more stages, with, for example a prequalification stage with only some consortia selected to submit detailed technical proposals, followed by the submission of financial proposals. As government objectives and selection criteria will be qualitative, possibly to a significant degree, lobbying, public critical review and advocacy on behalf of consortia, proponents and opponents will continue and may vary in intensity from period to period.

Consortia whose proposals may have been rejected in prequalification or other initial evaluative stages may nevertheless continue to seek consideration and reconsideration through lobbying, proposal revision or by forming alternate alliances. In some instances the government itself may request that competing groups consider merging. The organization and structure of the consortia themselves may evolve into single-purpose enterprises.

Proponents and other participants may also face uncertainties and frustrations arising from the absence of, or unclear definition of, the evaluation process or criteria. They may find the dimensions of the project and evaluation criteria, including the relative importance of each, somewhat fluid.

The 'evaluate' phase may also extend over a protracted timeframe (in the Northumberland Crossing project it has been over three years) and ends with the selection of one consortia, which still may not represent unencumbered government support for the project.

3.5.4 Negotiate

During the 'negotiate' phase, as attention is focused on the one successful consortium, many sociopolitical, regulatory, economic and technical hurdles are addressed. While the proposal has been selected, the concession has not been granted. Usually some formal expression of government sanction is necessary to enact the award of the concession, which may include hearings, environmental approvals, a public plebiscite or inquiry, enabling legislation, or treaties. Detailed negotiations with the selected consortium continue respecting the particulars of the concession and necessary procedures.

Lobbying from loosing competitors may continue and opposition from stakeholders may intensify. The influence of stakeholder groups may peak during this phase through the processes of public hearings, plebiscites, political lobbying of legislation, and environmental approvals. Delays originating in such processes are not uncommon.

The successful consortium must also proceed with the planning and design of the project, even prior to the formal granting of the concession, as well as formalizing the organizational, legal, and financial structure of the project. Once again, the participants must undertake escalating commitments in the face of potentially unpredictable public hearing or legislative processes which may result in delays, require changes to the project

or even lead to cancellation without compensation. Some, but certainly not all governments may accept the risk of project cancellation in this phase.

This phase ends with the passing of all enabling legislation and the formal granting of the concession. Financing, planning and design continues and construction can commence. The time requirements for this phase vary in accordance with specifics, however, two or more years is typical.

3.5.5 Build

Parallel with the finalizing of the structure and details of the concession, project engineering design, financing and other details must also be addressed, following which, the project is constructed. In some instances the operation of, and collection of revenue from, related facilities may commence.

The 'build' phase of these projects varies with their complexity, from less than three years up to seven years, and will end with the commencement of the revenue operation of the new facility.

3.5.6 Operate

During the 'operate' phase, the facility is operated and revenue collected to offset the implementation costs of the project. Revenue may be gained from tolls or utility charges, government subsidies and guaranteed payments to redress shortfalls, as well as related

development charges. In some instances, the operation of existing facilities, with their attendant revenues, may be granted from a time earlier in the concession period. The 'operate' phase will end with the expiry of the concession period, which may range from 20 to 55 years.

3.5.7 Transfer

Upon expiry of concession period, ownership is transferred to the government or governments. However, in some instances the concession may not have been granted outright ownership, or, for liability or other reasons, ownership may have reverted back to the government at some earlier date. Thus, the 'transfer' phase is more generally thought of as when the concessionaire's right to operate the facility and collect revenues expires. Those rights are transferred to the government or governments who granted the concession. The consortium may be granted a further operating lease, but under terms and conditions which are likely different from the original concession agreement.

Although the facility may have been transferred, the consortium's obligations may not be extinguished. The government, as owner of the facility, may require some form of security for the continued satisfactory performance or integrity of the transferred facility over its expected life. This continued obligation may extend 65 or more years beyond the transfer.

CHAPTER 4.
CASE STUDY OF THE CHANNEL TUNNEL BOT PROJECT

To illustrate the magnitude, complexity and the uncertainty of the risks associated with large and BOT projects, a case study of the English Channel Tunnel BOT project is presented. It is intended to serve as the backdrop for the formulation of a risk planning Framework, as presented commencing in Chapter 6.

4.1 THE EVOLUTION OF THE CHANNEL CROSSING BOT PROJECT: 1802-1991.

Engineers, builders, politicians and promoters had been actively talking of Channel crossing projects for many years:

> *"We are of the opinion that it is not an unreasonable proposition to drive a tunnel under the Channel, but that in some measure it must be a venture."* (Nature, January 20, 1870 (New Scientist, 1973))

Over a similar period, there has always been skeptics:

> *"That the Channel Tunnel would have been a big thing from the promoter's standpoint is not to be denied; that it would have paid anything like an adequate interest upon the capital sunk is a matter we regard as altogether doubtful...."*(Economist, 1884).

The current project, said to be the twenty-seventh proposed (Holliday, Marcou & Vickerman, 1991), commenced construction following a two-hundred year gestation period. Figure 4.1 illustrates this cyclical and start-stop nature of the project from 1750 to 1885; Figure 4.2 from 1885-1975 and Figure 4.3 from 1975 onward.

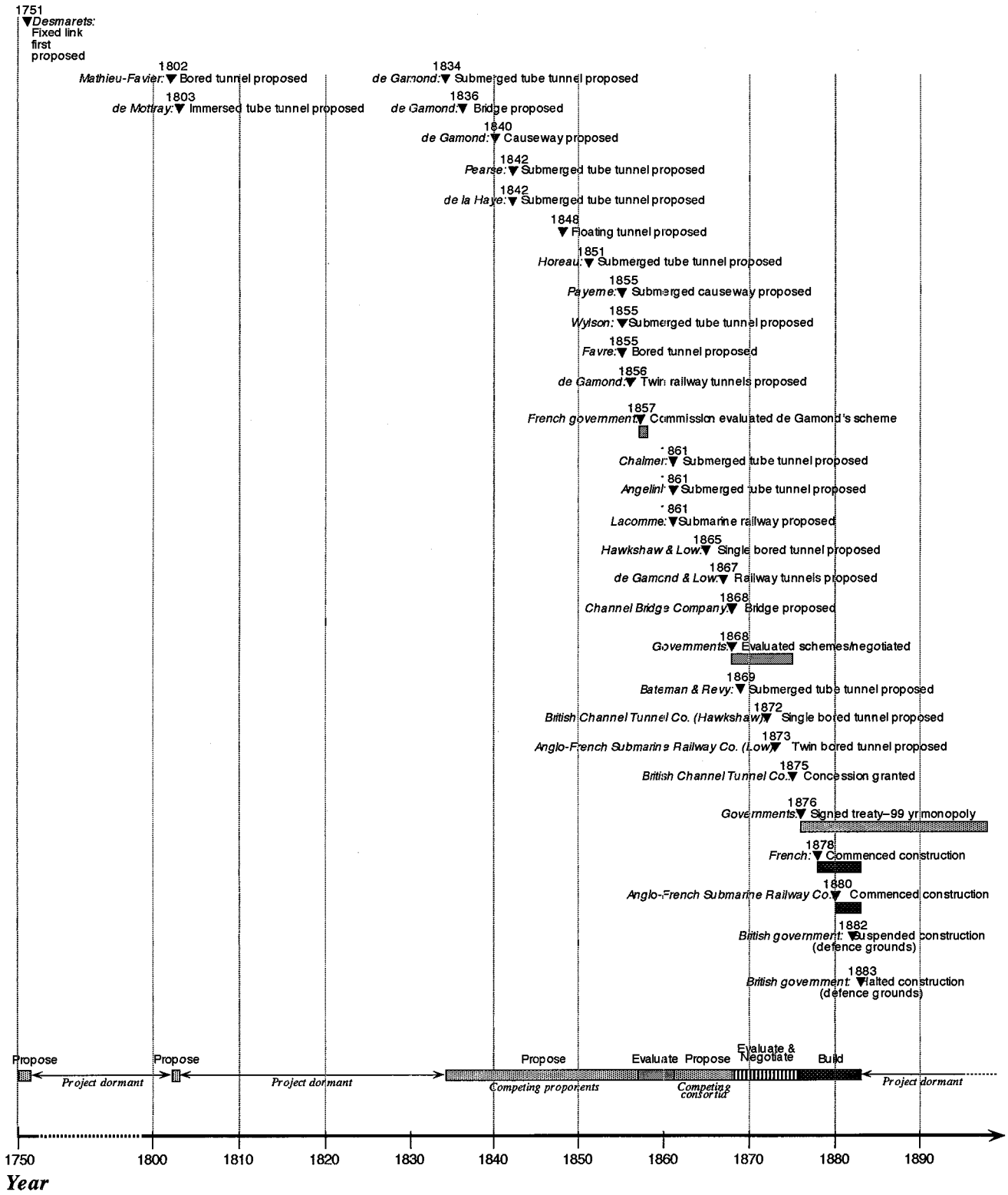

Figure 4.1 The Cycles of the *'Propose-Evaluate-Negotiate-Build'* Phases of the Channel Crossing Project: *1750-1885*

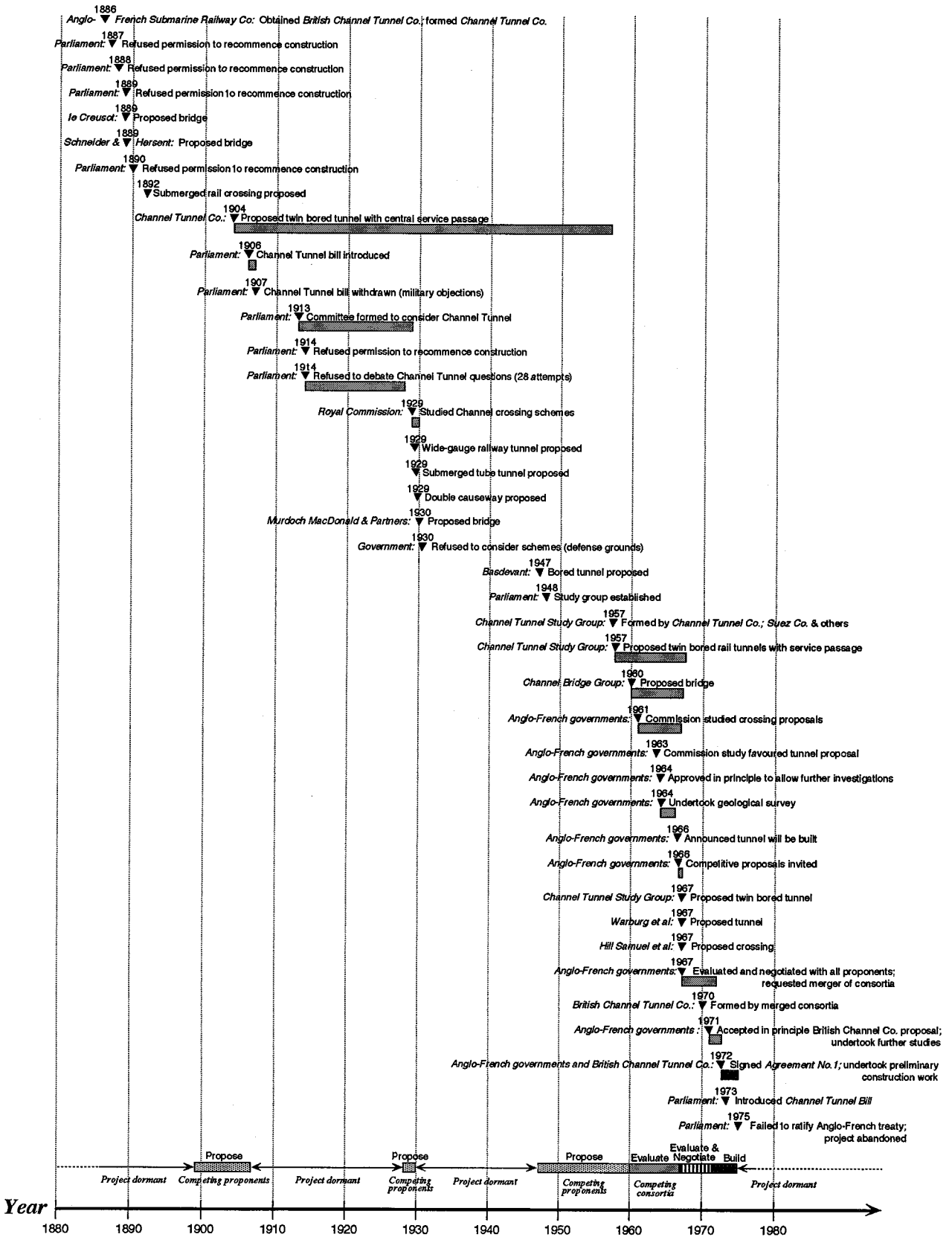

Figure 4.2 The Cycles of the *'Propose-Evaluate-Negotiate-Build'* Phases of the Channel Crossing Project: *1885-1975*

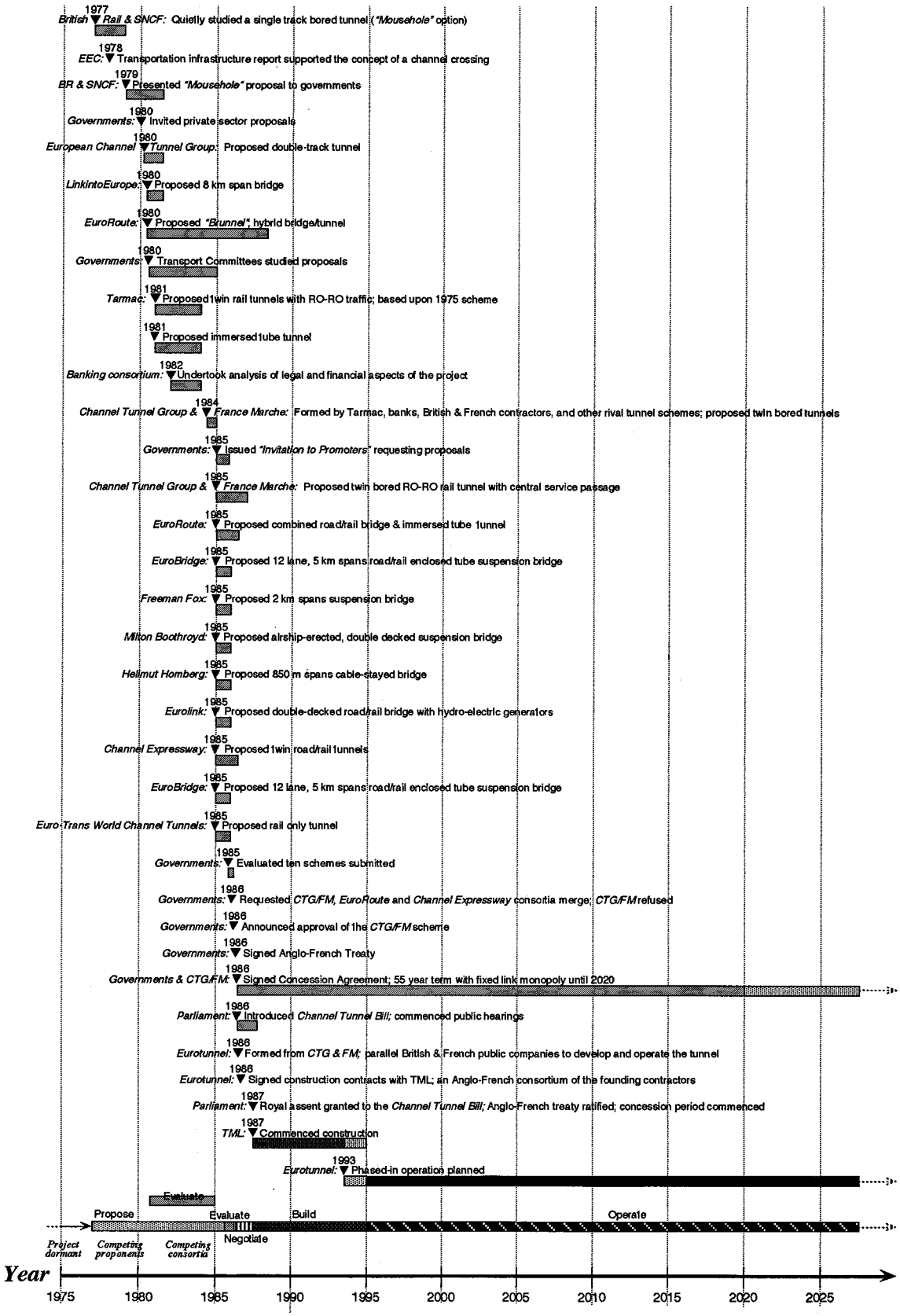

Figure 4.3 The Cycles of the *'Propose-Evaluate-Negotiate-Build-Operate'* Phases of the Channel Crossing Project: *1975-*

Having been first proposed in 1751, and again to Napoleon in 1802, interest in a fixed link crossing—a tunnel was not the only concept, although it may have been the only remotely feasible concept—was closely related to the state of Anglo-French hostilities. By 1875, an agreement had been reached between the two countries, whereby promoters estimated the cost of a twin-track railway tunnel at £10 million (Smith, 1988); given escalations that sum would be around £100 million today. The French government soon afterwards granted a 99-year concession with a thirty year competition-free period (terms similar to the modern concession) to the 'Association for a Submarine Railway' consortium, who promised to complete construction within twenty years (Economist, 1882, 1883).

Work commenced on both shores in 1878—although it lacked statutory authority in the case of the British works—and by 1882 over 1800 m of tunnel had been completed on the British side, where the unlined tunnel remains today (Kirkland, 1986; Sargent, 1988). Amidst intense public debate, the War Office suspended construction on defense grounds: *" ... are we deliberately to make England less safe in order that tourists may not suffer from seasickness?"* questioned an eminent minister of the day (Bonavia, 1987), but not before the Victorian promoters of the Channel Tunnel Company held candlelight dinners in the tunnel, courted royalty, politicians and the press, foreshadowing the intensity of the public relations and lobbying frenzies of one hundred years later. The French, frustrated (for not the last time) by the furious English debate and confused indecision about the desirability of a link, halted work in 1883, and in 1884, xenophobic British politicians soundly defeated the Channel Tunnel bill: *" ... we are quite content to see it rejected by a majority so great that it is not likely to be revived."* (Economist, 1884).

That is, until 1890, when the matter was again defeated in the House of Commons; reintroduced in 1906 buttressed by considerable engineering and economic studies, but withdrawn in the face of the reiterated military objections. Between 1914 and 1922, twenty-four unsuccessful attempts were made to reintroduce the matter to Parliament, even though the 1914-1918 war dramatically illustrated the military advantages a tunnel would have provided, which accorded considerable further impetus to the French desire for a tunnel. In 1924, defense objections again precluded consideration of the link and lead to an insufficient political will to reopen the matter despite being raised on an annual basis until 1929.

In 1930, a Royal Commission was appointed (felt by many as simply a further manner to avoid action) to study cross-channel links, including a proposal for a tunnel with a high speed electric railway linking London to Paris in $2^3/_4$ hours, remarkably similar to the modern project. Despite recognition of the wider range of potential economic benefits, the further consideration of a link was narrowly defeated, again primarily for defense reasons. Little attention was given to the project by British politicians for many years following.

As war loomed in 1939, the French Chamber of Deputies demanded construction of a tunnel, citing defense considerations (albeit the French defense), but received little action apart from two brief considerations of tunnel construction during the war: the first, a worried examination of the possibility of the Germans secretly completing the tunnel; and the second which studied if the British could quickly complete a tunnel to assist in the

invasion of the Continent. The answer to both investigations, not surprisingly, was negative.

Post-war, interest in tunnel schemes revived, including consideration for the first time of automobile drive-through proposals. In 1957, the original Channel Tunnel Company, which had held seventy-six annual meetings in the intervening years usually with little progress to report on construction of a tunnel, formed the Anglo-French Channel Study Group, with strong participation from the British and French national railways as well as the Suez Canal Company, who were searching for another equally dramatic and profitable investment following the nationalization of their primary asset (Gould, Jackson & Tough, 1975).

The Group undertook detailed technical investigations with renewed vigor, which culminated in 1960, with a report which served as the fundamental basis of virtually all following bored tunnel schemes. Although a range of fixed link crossing options were considered, including later revived tube tunnel, bridge and hybrid bridge/tunnel proposals, it was concluded that a bored tunnel (with an estimated total cost, including escalation and financing, of £160 million) was technically and economically most desirable. The consortium anticipated raising all necessary capital privately, but requested government interest guarantees and a ninety-nine year concession period (Bonavia, 1984).

When it became evident the government was favourably considering the tunnel proposal, competing consortia entered the fray, advocated their various schemes, including a

massive steel bridge. In 1961 the two governments responded with the establishment of a working group to study all proposals (Gould, Jackson & Tough, 1975). Their report in 1963 lead to a joint French-British announcement in 1964, which approved in principle the construction of a bored, twin rail-shuttle tunnel scheme—essentially an identical forerunner of the scheme resurrected twenty years later. However, the governments agreed further geotechnical investigations were required and favoured construction of the link by the private sector with government financing guarantees but operation by a public body (New Scientist, 1973; ENR, 1975).

On July 8, 1966, the Prime Ministers of France and Britain announced the tunnel would be built (Gould, Jackson & Tough, 1975), allowing one to speculate that perhaps the preliminary phase of the project had drawn to a close, after many starts and stops through a duration of 216 years from 1751 to 1966.

Such speculation, including the promises and pronouncements of a tunnel open by 1975, proved premature. At the British government's insistence, an action to be repeated some twenty years later, proposals were requested from all interested parties, although the Channel Tunnel Group had already submitted a well developed and robust scheme, This was somewhat to the distress of the French, who would have preferred to expeditiously award an exclusive concession, as they had 90 years previously (Gould, Jackson & Tough, 1975).

Further studies followed the submissions, interrupted by elections. A decision was further delayed by the governments' attempt to please all parties, as they requested the three competitors combine into one consortium (another action that would be repeated twenty years later). In response, the historic Channel Tunnel Group evolved into a new Anglo-French consortium, which included a number of banks, consultants, the national railways of both countries, and the Rio Tinto-Zinc Corporation, who acted as the project manager (Gould, Jackson & Tough, 1975). By 1971, the governments again announced an approval in principle, but to be followed by further studies. As planned in 1972, the total cost of the twin-tunnel project had grown to £365 million with an opening date of 1980.

On October 20, 1972, 'Agreement #1' was signed by the governments and the consortium, which outlined the geotechnical investigations and preliminary work to be undertaken as 'Phase I'. Amidst strong opposition, planning proceeded on a high-speed rail line from the tunnel to London as an integral part of the project. Planning also commenced for a high-speed Paris line; however, in contrast, the French link was welcomed (Economist, 1973).

The planned facility was to include twin rail tunnels with a central service tunnel, bored in a stratum of under-Channel chalk, held to be an ideal tunnelling medium by virtue of its impermeability and absence of fissures. Vehicles were to be transported through the tunnel on specially designed, enclosed rail shuttle cars running on a looped railway system between two terminals.

The total cost of the project was estimated at £464 million, which included a 10% contingency allowance but no escalation or interest costs. About 10% of the project's cost was to be provided as private equity financing, with the remainder government-guaranteed debt (loans and/or bonds). In return, the government was to receive a share of the operating surplus, ranging from 80% upon opening to 85% within twenty years.

The project took on the appearance of progress: 'Phase II' commenced in September 1973, and included further design and the test boring of two kilometers of tunnel (Kirkland, 1986). Treaty ratification was required by January 1, 1975, which would allow for commencement of 'Phase III'; construction.

As the test tunneling and design work continued, public and political opponents of the tunnel criticized the potential for ferry-related employment losses, the general idea of closer links to Europe and the Common Market, and particularly focused on the impact of the planned rail link to London—opposition their French counterparts did not face. Two general elections in 1974, which delayed the ratification bill, did not bode well for the prospect of the Treaty. Politicians viewed the rising cost estimates of the rail line to London with increased nervousness, which by then was estimated to exceed the cost of the tunnel (Economist, 1974a). The tunnel project was seen as another binational project similar to Concorde and therefore likely subject to the same skyrocketing expenditure estimates (New Scientist, 1973, 1974).

Not surprisingly, and to the intense displeasure of the French who had ratified the Treaty ahead of schedule, the January 1 British ratification deadline was missed (Economist, 1974b; ENR, 1975). The British government formally cancelled the project, and later cited the decision as a simple choice between the tunnel or Concorde. Participant investors and contractors were compensated for over £17 million in costs; the 350 m of bored tunnel remained (Economist, 1975; Tunnels & Tunnelling, 1975a, 1975b).

Within three years, the project was resurrected by the national railways, who realized the potential of the opportunity that had been lost (ENR, 1978; New Scientist, 1979). A single track rail-only tunnel, as a scaled down version of the cancelled project, was proposed and soon dubbed 'the mousehole'. The EEC transport commission became interested, for they viewed the project in terms of European-wide transportation infrastructure and hinted at potential financial involvement (Economist, 1978). The range of options advocated expanded to include single tunnels, double tunnels, road bridges and hybrids. Following the 1979 election of Thatcher and the Conservatives in Britain, in 1980 the government announced a desire to see a link built, but it must be privately financed (Economist, 1980b; ENR, 1980).

The race was on, once again: consortia were formed, and competing proposals vied for publicity and political favour (Engineering, 1980). In January 1981, a proposal for a twin-bored shuttle rail tunnel was advanced by the contractor Tarmac. The scheme, privately financeable and estimated to cost £1,730 million, was largely based upon the previously

cancelled project, and would evolve into the Eurotunnel project currently under construction (Engineer, 1981a; Engineering, 1981; ENR, 1981a, 1981b).

The governments announced more studies of the competing proposals would be required; the French were understandably reluctant to be too deeply involved without firm British government guarantees against another withdrawal. Nevertheless, the French government still favoured publicly financing the link, although the EEC subsequently made it clear they would not contribute towards funding, as once hoped (ENR, 1981b; New Scientist, 1985b).

In November 1981, the contractor Wimpey and two merchant bankers joined the twin-tunnel Tarmac consortium, and formed 'Channel Tunnel Developments' (Engineer, 1981b). The competing proposals, particularly the bridge schemes backed by large industrial concerns including British Steel, continued to fight a public relations war throughout early 1982 (Engineer, 1981c; 1982a), as civil servants and politicians studied the proposals (Economist, 1981).

In the midst of the Falkland war, March 1982, Anglo-French relations abruptly cooled, which prompted Thatcher to reportedly refuse to consider the project any further (New Scientist, 1982a). In what was considered a face-saving move for the French but a British delaying tactic, studies were nevertheless allowed to continue (New Scientist, 1982b; Economist, 1982a, 1982b). The French agreed to a private rather than public financed link, and five large banks commenced, in June 1982, a study of the legal and financial

feasibility of the proposals advanced to date. The banks were seen to have made the study offer to gain an inside track on any future project financing (Economist, 1983).

The completion of the report was promised, at regular intervals, throughout the remainder of 1982 (Engineer, 1982b), all of 1983, and the first half of 1984 (Engineer, 1984). There was little British action regarding a link in 1983, and, in the face of a general election, Thatcher told voters in the Port of Dover a link was "not a live issue" (Jones, 1987).

Proponents, nonetheless, continued to lobby and advanced their proposals. The popular bridge-tunnel scheme, 'Euroroute', gained French construction partners, while all the rival tunnel proponents merged and formed the 'Channel Tunnel Group' (CTG) (Economist, 1984b). By February 1984 the CTG consortium consisted of five British contractors, joined shortly thereafter by the National Westminster Bank, one of the authors of the still to-be-submitted report (ENR, 1985a).

The long-awaited bank report was released in May 1984, which concluded private financing would be possible but should be coupled with some limited government acceptance of the financial risk. Not surprising considering the National Westminster Bank's recent action, the report favoured the Channel Tunnel Group's scheme, and viewed the twin shuttle tunnel as the only technically and financially viable project (Economist, 1984a; ENR, 1984a). Also not surprising, the rival Euroroute consortium heavily criticized the report, calling it "outdated" and a "serious misjudgment" (Engineer, 1984).

In the following year, politicians announced criteria for the selection of a scheme would be formulated, as once again they opened the race rather than approve the reported preferable option (New Scientist, 1985b). Civil servants developed those criteria, and proponents announced improvements and advantages, real or otherwise, to their schemes (ENR, 1984c). Government actions culminated, in April 1984, with the issuance of an 'Invitation to Promoters'. Submissions were requested by October 31, 1984, and were to include details of the scheme's technical and economic feasibility, a commitment in principle regarding financing arrangements, and job creation benefits. Promoters were advised that apart from political guarantees against cancellation, which would only be applicable once the requisite legislation was passed, no other financial guarantees would be available from the governments (Engineer, 1985a; Economist, 1985a; New Scientist, 1985a, 1985b).

Soon afterwards, additional British banking participants joined the Channel Tunnel Group (Economist, 1985b). A French counterpart consortium was formed, 'France-Manche', which included five French contractors and three banks. Four of the five banks that undertook the financing study had by then joined the consortium; the last joined prior to the submission of the proposal (New Scientist, 1985c).

Amidst intensive publicity and lobbying campaigns that focused upon the benefits, employment creation and advantages of the schemes coupled with not very subtle attacks on rivals, ten proposals were submitted to the governments. The rivals were estimated to have spent £20 million on the submissions; £12 million by the 'Euroroute' scheme

promoters alone (Engineer, 1985b) compared with an estimated £5 million by the CTG consortium (Economist, 1985c). The leading contenders were thought to be the twin shuttle tunnel CTG/France-Manche proposal and the Euroroute bridge-tunnel (or 'brunnel') proposal. A government decision was promised by the middle of January 1985 (ENR, 1985b).

Of the ten schemes submitted, five were immediately rejected as not feasible, which included an airship-suspended bridge; a grandiose £115 billion tunnel; and a toll-free bridge incorporating hydro-electric generation and an international conference centre at mid-Channel (ENR, 1985b).

The more serious bridge contenders were felt to be 'Eurobridge', a four-level, twelve-lane, seven-span (5 km each) suspension bridge constructed with a new composite fibre 'Parafil'; a 48-span cable stayed bridge (850 m spans); and 'LinkintoEurope', a six-lane, 18-span (2 km each) suspension bridge. Each of the bridge schemes, but particularly the 'Eurobridge' and LinkintoEurope proposals, embodied considerable innovations of questionable feasibility.

Euroroute proposed a hybrid bridge-tunnel, the 'brunnel', whereby precast concrete bridges (500 m sections) connected two large artificial islands, located about a third of the way across from each coast, to the mainland. The large artificial islands incorporated a spiral roadway down to a submerged tube tunnel, which carried road and rail traffic underneath the main Channel shipping lanes, between the two islands.

The hastily assembled 'Channel Expressway' scheme proposed two large-diameter bored tunnels for vehicle traffic plus two bored rail tunnels. 'Channel Expressway' claimed to be by far the cheapest of all schemes proposed, due in part to having all work competitively tendered. Major problems not adequately addressed included how to avoid driver fatigue and how to provide effective ventilation through such a long tunnel.

The proposals were evaluated by a variety of government committees and departments, although not all were convinced of the wisdom in proceeding. The British Treasury consistently viewed all schemes with great skepticism—they believed the revenue estimates were subject to great uncertainties and all cost estimates were likely over-optimistic. They held such a combination could only result in some future government bail-out when construction funds ran out or future traffic did not materialize (Economist, 1985d).

By late in 1984, it was felt only two schemes were under serious consideration—the CTG tunnel and the dark-horse, 'Channel Expressway' proposal submitted at the last minute by Sealink Ferries, buttressed with intensive media blitzes and polls that claimed the public favoured the expressway alternative over all others by a large margin. The scheme was seen by some as an unrealistic spoiler attempt by a proponent with the most to loose, as a cross-Channel ferry operator, from the construction of a fixed link (New Scientist, 1986a; Economist, 1986a). Nonetheless, it was reported (and later borne out) that Thatcher favoured a drive-across link, due in no small measure to her dislike of the railways and specifically the rail unions (Economist, 1986a).

In an attempt to make their decision easier, the politicians asked the three leading rival consortia (CTG, Euroroute and Channel Expressway) to find common ground and combine. Feeling the front-runner, CTG refused, and advised the government their financial arrangements, seen as the furthest advanced of all the schemes, would not be transferable to other schemes or consortia (Economist, 1986a; Institutional Investor, 1986).

On January 20, 1986, Thatcher and President Mitterand announced official approval of the Channel Tunnel Group scheme (ENR, 1986a). It appeared, for the second time in fourteen years, the cross-Channel fixed link project might advance beyond a 236-year preliminary phase.

The approved Eurotunnel project consisted of 50 km (with 37 km submerged) of twin, single-tracked bored tunnels, 30 m apart, with a central 4.5 m service tunnel linked to the main tunnels at 375 m intervals. The rail tunnels were connected by pressure relief ducts every 250 m and two full-diameter rail crossover passages provided at 25 and 47 km from the British portal.

Terminals at both portals, linked with a looped railway, would accommodate truck and passenger vehicle traffic, transported through the tunnel on fully enclosed shuttle trains running at up to 160 km/hr. Additionally, passenger and freight trains operated by the national railways would provide service between London and Paris or Brussels at up to 200 km/hr.

Construction was planned to commence in mid-1987, to follow passage of the Channel Tunnel Bill, with a scheduled completion of May 1993. The total project budget, as of 1985, was £5,736 million, which consisted of:

Construction costs (constant as of 1985)	£2,725 million
Owner costs during construction:	£368 million
Inflation during construction:	£586 million
Capitalised interest during construction:	£1,057 million
Contingencies:	£1,000 million
TOTAL:	£5,736 million

Financing was to be accomplished through a combination of equity, bank loans and a stand-by loan facility. Equity totalling £1,000 million, was to be raised from three sources in three phases: £46 million contributed from the five bank and ten contractor founder shareholders; £204 million to be raised from an institutional offering planned for mid-1986; and £750 million from a planned public offering in mid-to-late 1987. The remainder of the project funding would be debt financed through a £4,000 million main bank loan supplemented by a £1,000 stand-by facility (Engineer, 1986; Euromoney, 1986; New Scientist, 1986c).

The Channel Expressway rivals refused to accede to defeat, and claimed with French elections looming, a change of government was likely and support for the CTG scheme would be withdrawn in favour of their Expressway proposal (Engineer, 1986). Following

the signing of the Anglo-French treaty respecting the tunnel construction on February 12, 1986, a new French government did indeed come to power but soon reaffirmed support for the project. Shortly thereafter, the Channel Tunnel Bill was introduced into Parliament, required to ratify the Treaty and grant wide-ranging planning permission, which allowed the project to proceed without a public inquiry (New Scientist, 1986b).

The Treaty, followed by the Concession Agreement (dated March 14, 1986), outlined the terms and conditions granted to the Channel Tunnel Group and France-Manche, which could not subsequently be altered without the consent of all parties. The Concessionaires were granted the "right and obligation" to construct and operated a fixed link during a concession period expiring on July 23, 2042, or earlier if the Concessionaires' default, at which time the ownership of the project and all facilities would revert to the governments with no further payment (New Scientist, 1986d; U.K. Parliament, 1986a, 1986b).

The governments promised not to finance or offer guarantees of any type to any other link during the concession period. The Concessionaires were granted full commercial and pricing freedom. If the governments were to interrupt the operation of the link, the Concessionaires would be paid compensation. In deference to Thatcher, the consortium would be required to submit, by year 2000, a proposal for a drive-through link, and implement such a link by 2010. If the Concessionaires did not undertake such a link, the governments may proceed with award to a third party, however, in no event would a competing link be constructed before 2020 (Engineer, 1986).

The British government justified the selection of the CTG/FM proposal on the grounds it offered the best prospect of attracting the necessary finance; it carried the fewest technical risks which might prevent it from proceeding to completion; it would be the safest project from the traveller's viewpoint; it would present no problems to maritime traffic in the Channel during construction or operation; it would be the least vulnerable to sabotage and terrorist action; and it would have an environmental impact that could be contained and limited (New Scientist, 1986c; Sargent, 1988).

On July 1, 1986, the binational 'Eurotunnel' public company was born, with an inseparable parallel structure in both countries. The founder shareholders were the five British contractors, five French contractors, two British banks and the three French banks of the CTG/France-Manche consortium, who together contributed a total of £46 million in founder equity (Stock Exchange Press, 1989). Soon thereafter, the two groups of contractors formed national joint ventures, 'Translink' (British) and 'Trans-Manche' (French); additionally, these two groups formed the binational joint venture 'TransManche Link' (TML), to undertake the design, construction and commissioning of the works.

Eurotunnel was seen to have faced a formidable task:

> *"To raise risk capital for a tunnel that may not be built, in a railway system that may not exist, paying tolls that have not been set, for traffic that can only be guessed at."* (Economist, 1987d).

In April 1986, the introduction of the Channel Tunnel Bill into Parliament served to focus the opposition on the project. Environmentalists and ruralists opposed the disruption of

the countryside and the environmental impact of the project and a high-speed London rail line, which, although strongly desired by Eurotunnel, was not as closely linked to the project as in 1974. Opposition politicians and some unions attacked the project, and claimed it would increase regional disparities and contribute to the loss of up to 40,000 jobs (New Scientist, 1986d). Harbour commissions and ferry operators, who had formed an opposition group 'Flexilink' in response to worries of the dramatic competitive advantage the tunnel would hold, mounted a vicious campaign against Eurotunnel. A vivid doomsday video was produced and distributed to MPs, which speculated about the effects of a fire in the tunnel (Management Today, 1986).

If that did not instill fear, Flexilink attempted to disrupt the raising of equity from institutional investors, and commissioned and widely circulated an analysis that showed the project would loose more than £250 million in the first years of operation, in stark contrast to Eurotunnel's estimation of a £300 million profit for the same period (ENR, 1986b). Flexilink maintained the project was not needed nor wanted (Hall, 1987); other opposition focused upon the projected significant loss of employment (Gibb, 1987). The ferry companies tried to delay passage, or at least amend, the requisite legislation. They facilitated the lodging of a record number of petitions that cited objections and sought to give evidence to the committee which considered the bill. They later admitted petition forms had been distributed to ferry passengers with offers to pay the filing fee and other expenses (Jones, 1987).

In the face of an increasingly vocal opposition, public opinion turned against the project. Whereas in late 1985, prior to the announced selection of the Eurotunnel scheme, 51% of the British public had supported a fixed link, by July 1986 only 31% favoured the project, with 46% opposed (Economist, 1986c).

Eurotunnel negotiations with the banks regarding details of the financing package dragged out and delayed, until fall, the planned £206 million institutional equity offering. The lack of enthusiasm for the project encompassed the investment community, too. A Financial Times poll revealed 40% of major institutional investors were not prepared to consider investing in the project: only 25% were, with 36% undecided. Sceptical investors cited the very long term before any projected returns, coupled with the high risk of the project, for should it fail to proceed because of financing, legislative or any other problems, the entire investment would be lost (Financial Times, 1986).

In August 1986, Eurotunnel and TML signed the main construction contracts. TML agreed to undertake the design, construction, testing and commissioning of the works, splitting the work into three portions:

1. *The design and construction of the terminal facilities and tracks; undertaken on a lump sum basis, for the amount £584 million plus Ffr5,024 million, January 1987 prices, subject to escalation and scope adjustments.*

2. *The design and construction of the tunnels; undertaken on a target cost basis, for the target cost of, including a 12.36% fixed fee, £719 million plus Ffr5,864 million, subject to adjustments for escalation and scope revisions. Final cost savings are to be equally shared; 30% of cost overruns will be assessed against TML, to a maximum of 6% of the target cost.*

3. *The design and construction of the locomotives and rolling stock; undertaken on a procurement basis, of a provisional amount £116 million plus Ffr1,322, including TML's procurement fee.*

If a fully operational system was not delivered on May 15, 1993, TML would be fined £354,000 per day for the first six months, and £536,000 per day thereafter, to a maximum of £165,000,000 . This pales in comparison to Eurotunnel's costs for loss of usage, estimated to be in excess of £2,000,000 per day. If intermediate Milestones were not met, Eurotunnel may issue public warnings to TML, require a detailed response as to TML's plan to return to the original schedule, and assess penalties against TML that could be earned back if later Milestones are met (Euromoney, 1987; Kirkland, 1987; Smith, 1988). The contract included provisions which prohibited TML from any media contact without Eurotunnel's permission.

Although TML would be undertaking the design, approval of all design details rested with Eurotunnel. An independent group of engineers, the *'Maitre d'Oeuvre'* have the

responsibility to oversee the project design and execution, to answer enquiries from the banks, governments and investors, and to act as independent arbitrators between Eurotunnel and TML.

The Eurotunnel-TML construction contracts were negotiated and signed prior to the issuance of the institutional equity. At that point, the company became independent of the founder shareholders and the members of TML lost control of the Board of Directors. The banks and investors voiced concerns regarding TML's conflict of interest and the manner in which the contracts were negotiated—essentially by TML, with TML. The bankers criticized the cap placed on TML's financial risk in terms of potential cost overruns and late performance. Even if they incurred the maximum penalties on the tunnelling contract, it would be difficult for TML to loose money (Euromoney, 1987).

At the end of October 1986, £206 million was raised by Eurotunnel, although only after some difficulty including a one-week deadline extension and Bank of England intervention that prodded investors (Economist, 1987a; Institutional Investor, 1987; New Scientist, 1986e).

The subsequent separation of the founder banks and contractors was described as "a painful divorce" (Economist, 1987a). The new shareholders (some 101 corporations and institutions) insisted Eurotunnel's few independent executives increase their influence and dilute the founders' control, as Eurotunnel struggled to grow and evolve from tunnel-building experts to a company that planned to finance and operate a complex cross-

channel service (Economist, 1987b; ENR, 1987a). Early 1987 was a time of turmoil and infighting on the Board; most Directors were replaced and Eurotunnel searched for a new British co-chairman.

At the end of February 1987, Alastair Morton was appointed co-chairman and soon announced the postponement, from July to the fall, of the planned £750 million public equity offering (Economist, 1987c). He set about resolving the major uncertainties that would impede the issue; attempted to gain government support, in both Britain and France, for a high-speed rail link; negotiated the toll agreement with the railways; and although an agreement in principle had been reached with 32 lead banks, finalized the complex details of the bank loan facility (Economist, 1987d).

In March, 1987 the Herald of Free Enterprise cross-channel ferry sunk with the loss of almost 200 lives. Ferry operators, who had been very vocal opponents on the basis of safety, clearly loose momentum, and safety issues become less contentious.

In May 1987 the European Investment Bank agreed to a credit facility of £1,000 million (Euromoney, 1987); in June, construction work commenced on the French side. Work on the British portion had to await legislative approval (Civil Engineering, 1987). The Channel Tunnel Bill slowly made its way through committee hearings overwhelmed by petitioners, and on July 23, 1987, received Royal Assent. Shortly thereafter, with the political risk of cancellation finally overcome, about 50 international lead banks agreed to underwrite the loan facility. After a world tour where Eurotunnel executives visited 531

banks encouraging participation, the final loan agreement was signed, and the loan eventually syndicated to a record 209 banks (ENR, 1987b; Institutional Investor, 1987).

The loan consisted of a £4,000 million main credit and a £1,000 million stand-by facility. Japanese banks contributed 30% of the original loan; British and French, 25% each, with only two of the banks American. The facility allowed Eurotunnel to draw upon it directly or to support other methods of financing should they prove less costly, and was composed of six tranches in four currencies (Sterling, French francs, Belgian francs and US dollars). Repayment had a term of eighteen years at 1.25% over the London Inter-bank Agreement Rate on the main facility and 1.75% on the standby facility. Upon completion of the project, the rate would drop to 1.00% over. It was intended upon opening to refinance the debt through the progressive issuance of long-term bonds, which would be repaid from a dedicated percentage of Eurotunnel's revenues (Institutional Investor, 1987).

Under the terms of the facility, Eurotunnel must expend £700 million of equity before the first tranche of the loan would be released. Twice per year, the banks would review a number of 'cover ratios', including the discounted future net income/total costs ratio, which must remain above 120%. If Eurotunnel failed to meet the minimum ratios, or did not have in place, at all times, adequate finance to complete the project, the banks could declare Eurotunnel in default.

With the loan facility arranged, Eurotunnel's attention turned to the previously postponed public equity issue, which required the raising of £750 million. One week after

international stock markets crashed (October 31, 1987), Eurotunnel proceeded nervously but undaunted, and released a share prospectus that downplayed the project's technical and economic risks but pointed out the project was three months behind schedule because of financing and other organizational delays, using half of the planned six-month slack (Investors Chronicle, 1987a, 1987c). Analysts debated the appropriateness and robustness of revenue and return forecasts, but nevertheless, in mid-November financial institutions agreed to underwrite the issue (Investors Chronicle, 1988a, 1988b). To encourage long-term holding, free travel for life through the tunnel was offered to original shareholders.

Estimating the project's return to shareholders was a unique challenge, involving a multitude of uncertainties, forecasts and assumptions. The project would rely both on diverting traffic from existing ferry and air services, and generating new traffic because of time or cost savings. The uncertainties associated with the traffic forecasts, their associated long-term growth over the concession period, and the behavior of the competition—all ultimately influencing revenue forecasts—were indisputably large.

Eurotunnel stated they hoped to carry 26.9 million cross-Channel passengers in its first year of operation, initially paying a return of around 16% to shareholders. Revenue and return would be heavily dependent upon interest rates during construction and inflation, with the worst scenario being high interest rates (escalating capitalized interest charges) but low inflation (depressing future revenue forecasts).

When the shares commenced trading on the London stock exchange one month after their issue, they immediately dropped 30% in value, attributed to dumping by institutions and underwriters (International Management, 1988; Investors Chronicle, 1988a). By year end share values had drifted to around two-thirds of their issued price.

With over £1,000 million raised in equity, Eurotunnel hoped it would not draw upon the bank loans until late 1988. Tunnelling commenced in December 1987, as Eurotunnel continued attempts to facilitate government participation in a high-speed rail link (ENR, 1987c). Stock analysts, in early 1988, recommended selling Eurotunnel shares amidst dropping ferry fares and a bout of price-cutting on short haul air fares (Investors Chronicle, 1988b).

In the first half of 1988, TML's tunnelling progress was slow, plagued by break-downs and exacerbated by difficult-to-resolve start-up problems. Although Eurotunnel had often cited the construction risks were low and based on proven techniques, it became clear the project was pushing tunnelling technology to the limits. The boring machines utilized had never been required to hold back such high water pressures, nor had the organizational challenges of operating twelve simultaneous tunnelling operations ever been met (ENR, 1988a; Matheron, 1987). By August 1988, TML had missed Milestones Two and Three, and it appeared unlikely to meet Milestone Four. Eurotunnel publicly served notice on TML and required a detailed plan indicating how TML planned to bring the project back on schedule (Investors Chronicle, 1988c).

While a good part of these public pronouncements may have been for the benefit of the banks and investors rather than TML, it did signal the start of Eurotunnel's (primarily co-Chairman Morton's) heavy public criticism of TML, who, subject to a contractual muzzling order, could not reply (Economist, 1988; Investors Chronicle, 1988d; Railway Gazette International, 1988a). However, the French executives of TML could only take so much, and later called a press conference where they expressed their "private", non-TML views of the situation (ENR, 1988c).

In early October 1988, with tunnelling behind schedule, the banks agreed to release the first £350 million tranche of the loan facility. Eurotunnel announced updated cost and revenue forecasts, anticipating 6% higher revenues once the tunnel opened but estimating construction costs at 7% higher, attributed to TML's inefficiencies and equipment and management problems. TML, in response, filed eighty claims for time and cost extensions and blamed Eurotunnel for financing and other delays (ENR, 1988c). By year end, tunnelling efficiency had improved but was still 30% less than required. As a result, the work was some five to six months behind schedule (ENR, 1988d; Railway Gazette International, 1988b).

In early 1989, jittery shareholders reacted to every bit of news about progress and costs, causing Eurotunnel share prices to see-saw: up 28% with news Milestone Four had been reached, albeit three months late (Investors Chronicle, 1989a); then soon down 9% with news the May 1993 opening might not be met (International Business, 1989).

In June 1989, after nine months of tense negotiations, Eurotunnel and TML agreed to a revised completion date of June 15, 1993, with additional incentive payments of £106 million if this date is met. The banks insisted more changes would be necessary if loans were to continue. Eurotunnel announced the estimate for construction costs grew to £5,500 million (ENR, 1989a; Investors Chronicle, 1989b). TML appointed a new head, an American who, over the next two years, successfully overhauled the management and organization, controlled costs, and boosted productivity (ENR, 1991c).

Although good tunnelling progress was maintained throughout the last half of 1989, relations between Eurotunnel and TML continued to deteriorate (ENR, 1989a). By October 1989, the banks refused to release more funds until the Eurotunnel-TML impasse was resolved. As construction costs had risen over 20%, Eurotunnel was technically in default of the loan agreement, which required sufficient finance for completion be in place at all times (ENR, 1989b). By this time, TML claims for increased costs due to design changes exceeded £500 million. The dispute went to arbitration by the independent *Maitre d'Oeuvre,* who, to the bankers' relief, ruled "broadly" in Eurotunnel's favour, although TML is expected to advance to international arbitration upon completion of the project (Economist, 1989; Investors Chronicle, 1989c). The banks sought a new accord, as TML's tunnelling contract had incurred every possible penalty with no incentives remaining (Economist, 1990a). Share values plummeted to 50% of their 1989 high.

Negotiations between the banks, Eurotunnel and TML continued, with Eurotunnel "on the brink of bankruptcy" (Economist, 1990a). In January 1990, a new accord was announced

by Eurotunnel (somewhat prematurely, it is later revealed), whereby the banks agreed to release £400 million in interim loans, and give Eurotunnel until May 1990 to arrange for a further £1,500 million in financing with a minimum of 25% in additional equity. Construction costs were again revised upwards and estimated at £7,200 million (Construction Weekly, 1990a; Economist, 1990a; ENR, 1990a; Investors Chronicle, 1990a; Time, 1990a) amidst some uncertainty, as the banks' technical advisors estimated final costs would be much higher, at £8.1 billion and a six month delay in the tunnel's opening (Grayson, 1990).

Many points of contention remained. In February, the Bank of England attempted to mediate the very public row, for TML refused to sign the new accord and threatened to abandon the project unless Eurotunnel removed co-chairman Morton (ENR, 1990b; ENR, 1990h; Construction Weekly, 1990b, 1990c); the banks refused to release further funds to Eurotunnel unless TML signed (Investors Chronicle, 1990b); and Eurotunnel, in response, withheld TML's monthly progress payments, despite being ordered, twice, by French courts to release them (ENR, 1990c).

By February 21, 1990, it appeared most disagreements were resolved (Investors Chronicle, 1990b). Eurotunnel agreed to remove Morton from dealings with TML; the banks released interim financing; Eurotunnel and TML agreed to design changes producing £100 million in savings including a reduction in the shuttle train speed—from 100 mph to 80 mph—with TML pushing for further speed reductions; and Eurotunnel trimmed its project supervision staff by 25%. Significantly, TML agreed to remove the

ceiling on tunnelling cost overruns, and would thus be liable for 30% of all overruns with no limit, although in return the base cost was increased by £87 million, the amount of the original penalty payable. Disagreements still remained as to the fixed price portion of the contract covering terminals and operating equipment, and the two parties entered arbitration (Construction Weekly, 1990b). Most claims were later resolved in TML's favour (ENR, 1991b; Construction Weekly, 1991b; 1991c) amidst much acrimony.

In mid-April 1990, Eurotunnel announced further cost escalations to £7.6 billion, and sought to raise a further £2,500 million in financing on top of the £6,000 million in equity and loans already in place (Economist, 1990c). Although tunnelling progress had improved to a record pace—amidst concerns about safety and a political outcry over a rising death toll (Construction Weekly, 1990f; 1990g; 1990h)—costs for construction were estimated to have increased by £500 million and thus invoked TML's penalty clauses (Construction Weekly, 1990d; 1990e). The escalations did not, however, include provision for over 100 potential claims by TML, valued at £1.1 billion (at 1985 prices); their resolution is expected to take years after the project's completion (ENR, 1990f; Construction Weekly, 1990h, 1991e; ENR, 1990h). To raise the extra equity, a further £2 billion in credit would be required in addition to a rights issue of £500 million (Investors Chronicle, 1990c).

Cost estimates continued to creep upwards, for by June 1990, the project's total cost was forecast at £7.66 billion, with the £530 million rights issue planned for the fall of 1990 to coincide with the breakthrough of the service tunnel (the central of the three tunnels).

Investors, however, noted dividends were now forecast to be paid starting in 1998, a dramatic change from the 1994 once predicted (Investors Chronicle, 1990d). Bank syndication of the additional £2 billion loan proceeded slowly, with almost half of the banks involved in the original financing loan refusing to participate further, raising concerns the rights issue might be delayed or indeed the project may be halted.(Globe & Mail, 1990a; Construction Today, 1990; Economist, 1990e; Investors Chronicle, 1990e). Technically, the project was in default, for the banks required sufficient finance for completion to be in hand at all times (Economist, 1990e). Share prices slipped to one-third their peak in 1989.

In early October 1990, the banks reluctantly agree to provide an additional £1.8 billion in financing (Financial Post, 1990), followed by the meeting of the French and British service tunnels at month-end (Globe & Mail, 1990e; Time, 1990b). New shares, offered at an unexpectedly low price, offered travel discounts to lure investors (Globe & Mail, 1990f) with some analysts predicting the "shareholders will be wiped out, and the banks will end up owing the Chunnel" (Time, 1990b). As the stock price continued to slide, others recommended buying, noting that although dividends cannot be expected before 2000, it should be profitable by then (Investors Chronicle, 1991a).

In May 1991, tunnelling was completed three months ahead of schedule on the north main running tunnel (ENR, 1991f), and one month later, the final tunnel was completed (Construction Weekly, 1991g). Attention then turned to the critical, and complex, electrical and mechanical installation work (Railway Gazette International, 1991a), which

was behind schedule (ENR, 1991j), reflected in the announcement of further delays in dividend payments (to 2000) and a phased opening of the tunnel in mid-1993, initially utilizing smaller and slower trains (Globe & Mail, 1991d). The delay in achieving full operation is primarily due to train shuttle design changes, expected to add US$187 million to costs, as well as resulting in over US$507 million in lost income and interest charges (ENR, 1991k). With interest costs projected at £2 million per day upon opening (Economist, 1990f), the project has many difficult challenges ahead; any further delays or cost escalations will have a major impact on the project's profitability, and further diminish the prospect of paying dividends. It again appears uncertain whether the project can be completed with the current financing (Globe & Mail, 1991d), quite apart from whatever further claims remain to be resolved. The contractors have stated in October 1991 they are "no longer willing or able to finance the epic project by swallowing cost overruns linked to changes in design or scale", stating they could not guarantee the tunnel will open on schedule, and hinted of further action, including work stoppages, unless a settlement is reached (Globe & Mail, 1991e; Financial Post, 1991; Construction Weekly, 1991k). Eurotunnel took the dispute into the courts in an attempt to prevent TML from stopping work (ENR, 1991k).

Two other components of the project, vital to attracting passengers and thus financial success but independent of Eurotunnel, are the high-speed rail links from the respective tunnel portals; 109 km to London and 333 km to Paris. While the French link is well under construction and will be ready for the tunnel opening (Railway Gazette International, 1991b); agreement on the routing of a prospective British link is elusive and

generating intense controversy (Railway Gazette International, 1991c). Plans for a private-sector link have stalled by rising cost forecasts and the lack of government subsidies (Economist, 1990b; 1990d). Political controversy has delayed route selection such that a link will be unlikely before 2001, with elections injecting additional uncertainty and prompting further delays during late 1991 and early 1992 (Railway Gazette International, 1991c). Four possible routes were proposed, studied and rejected amidst much debate.

As the banks nervously watch project costs escalate with the possibility of their loan commitments increasing once more, Eurotunnel must walk the fine line between avoiding default on the outstanding bank facility, persuading the same banks to lend even more, and putting on a brave front to bolster shareholder confidence in possible further investments. The unanticipated growth in cross-Channel traffic—Eurotunnel's 1993 projections were surpassed by 1989—has sustained the project thus far in the face of delays and rising costs (Economist, 1990b; 1990c).

Success is still not certain. The organizational challenges which still face the project are considerable and complex. As a recent example, in March of 1993, production of the shuttle train cars was halted by Bombardier and 500 employees laid off for an indeterminant length of time. Bombardier cited total congestion of the production line as the reason, brought about by the failure of TML to grant timely approvals and authorizations, as well as disruptions from "numerous and unpredictable requests for modifications" (Globe & Mail, 1993a). The claim was finally settled in December, 1993,

with Bombardier receiving $157 million in cash and 25 million Eurotunnel shares, to be issued sometime in the spring of 1994 (Globe & Mail, 1993d). Bombardier had previously written off $225 million of costs incurred on the project. As a result of the settlement, Bombardier has found itself evolving from a conventional supplier to that of one of the major shareholders of the project, with the result of a complete shift in attendant risks and uncertainties.

The origin of many of the project's problems can be traced to the manner in which the project was originally structured and organized contributed to an almost fatal conflict of interests amongst the participants. For example, while contractors advanced the initial proposal, they then negotiated the construction contracts, in effect, with themselves, amidst concerns from the financiers and investors about such a conflict.

The participants tended to focus on construction and tunneling risks, whereas the major risks, as became more apparent as the project progressed, were associated the design, testing, construction and commissioning of a new type of complex railway system. Early efforts also focused upon the equity issue rather than the vital planning and design issues. This rushed and inadequate planning, in response to an attempt to meet the window of political opportunity associated with the concession award, compounded the major problems with the project's organization, in terms of relationships and complexity. Participants had no experience in the hatching and the total organization from the ground floor up, of such a major enterprise (Jones, 1987).

The structure of the project, and the goals of the original contractor participants, can be sharply contrasted with those of the Dartford Bridge BOT project, whereby the participants formulated the project simply as a means to generate construction and financing returns, rather than operational profits. The project will be transfered to the government as soon as the consortium has recouped their costs (ENR, 1991a).

To some extent the weaknesses in the Channel project have been counterbalanced by the tremendously underestimated revenue potential of the project and the hard-headedness of Eurotunnel in negotiating and controlling costs with TML (Economist, 1990f), however, costs continue to rise and the completion date continues to be delayed. In April, 1993 Eurotunnel will reportedly require an additional £1 billion in financing with the tunnel opening delayed until early 1994. The total cost of the project is estimated at over £10 billion (Globe & Mail, 1993b) with total financing needs at over US$17.2 billion. A further issue of shares is planned for the spring of 1994.

Nevertheless, the banks are seen as having few options other than continuing to further lend all funds necessary less they loose their original loans (Economist, 1990e); receivership would offer few advantages to the financiers (at least, until the project is completed), as further funds would be required to complete in any event. Eurotunnel is also under pressure from TML, backed by threats to delay opening, to resolve the over £1 billion in claims. It would thus appear Eurotunnel has limited leverage with either the financing institutions or TML.

After 200 years, as the project nears its official opening date of May 6, 1994, the words still ring true:

> *"That the Channel Tunnel would have been a big thing from the promoter's standpoint is not to be denied; that it would have paid anything like an adequate interest upon the capital sunk is a matter we regard as altogether doubtful...."* (Economist, 1884).

4.2 A SUMMARY OF CHARACTERISTICS OF THE CHANNEL TUNNEL PROJECT

The Channel Tunnel project, as well as being one of the largest civil engineering projects ever undertaken, is the largest BOT project recently attempted. A summary of the project and relevant lessons is discussed in following sections.

A more detailed chronology and description of the financial milestones covering the period from 1802 to 1990 is provided in Appendix A and Appendix B, which summarizes information compiled from over 190 sources.

Appendix A will be of use, for example, to those seeking further sources of information respecting specific aspects of the project or specific time frames. Similiarly, Appendix B provides further details of cost estimates and sources of further information. Example entries from Appendix A and Appendix B are provided in Table 4.1.

Example entry from Appendix A, *Channel Tunnel Project Timeline:*

09/1883: Although the tunnel "scheme is shelved for the present"(78), discussions continue. The Association for a Submarine Railway estimates the costs of the tunnel railway at £3 million or 75 million francs. It was stated "the cutting of it through the grey chalk presented no difficulty, and nothing could be more easy than the ventilation."(78) Potential benefits were spoke in glowing terms; "From the standpoint of politics and political economy, no work more useful to humanity had ever been attempted; it was one of peace and civilisation, of international fraternity; it would save transhipment and insurance, and gain an hour for passengers, and two hours for merchandise."(78) Traffic capacity was estimated at 250 trains per day (78).

Example entry from Appendix B, *The Growth of the Channel Tunnel Budget:*

10/1988: **£5,227 million** construction costs, 7.2% higher than the November 1987 estimate (149). "Costs...are expected to be 7% higher, in large part because of the expenses associated with closer supervision of TML" (147). "£80 million of the new costs are put down to Eurotunnel's new project information system to monitor progress and cost."(148) "...higher costs reflect recruitment of American consultants Bechtel to strengthen Eurotunnel's project management, tunnelling delays, rising construction costs, and extra facilities now deemed necessary."(149)

Table 4.1 Example entries from Appendices A and B

The project's important characteristics, which can be surmised based upon the previous section's description of the project, are summarized in Table 4.2. The Channel Tunnel Project displays all of the important characteristics of large engineering projects—as outlined in Chapter 2 and used here with specific reference to the project—as well as many of the unique aspects of the PEN-BOT project environment.

- The project is unique and complex.
- The project presents appreciable organizational challenges.
- There are novel risk allocation considerations.
- Multiple stakeholders.
- Participants have adopted new roles and objectives.
- The risks are numerous and large.
- There are many new risks.
- The project has a very broad impact.
- The project is indivisibile.
- The project has a very long execution time.
- Participants are involved over a long time frame.
- The project requires large financial outlays.
- The project has a high vulnerability.
- There are difficult logistics.

Table 4.2 Characteristics of the Channel Tunnel Project

The project is unique and complex, by virtue of its size, scope and resource requirements. The large scope contributes to difficult logistics, in terms of personnel and materiel, as well as organizational challenges, whereby joint ventures, and joint ventures of joint ventures, became necessary. This greatly increased the number of participants, their diversity of perspectives, the potential for conflicts and significantly widened the range of objectives which must be satisfied and risks which must be identified and managed. Participants adopted many new roles and objectives; for example, contractors turned project owners/promoters.

The complexity of the project and the organization, and the fluidity of the organization are significant risks in themselves. Project teams were drawn together from the constituent organizations, but many of the assembled participants owed a first allegiance not to the project, but to their original firm. Additionally, the project placed great time demands on senior personnel, who were executives of the participant firms. They must balance the

intensive demands of the project with the normal demands of their firms' ongoing operations.

The project's multiple stakeholders have conflicting objectives, with some diametrically opposed and related to stakeholder economic and social well-being such as the ferry workers. Indeed, all the participants may not share a common project driven-objective; for example, the contractors who originally proposed the project did so as a method of generating opportunities for construction work but now have exposed themselves to complex financial, design and operational risks with which they have no experience nor had anticipated.

The risks are numerous and large, and many are novel. The project is non-repetitive such that losses cannot be balanced against gains on the next repetition. The participants, when considering risks can gain no refuge in 'average' losses or gains. The range of risks is large and varied; there are a myriad of legal, contractual, regulatory and institutional requirements.

The project has a very broad impact, contributing to a host of political, socioeconomic, and financial primary, and secondary ripple effects, with each effect potentially impacting upon or involving another direct or indirect project participant. Making risk planning difficult, the project is 'self-disturbing' in that it can significantly change its own environment in any area from demand for labour and materials to the socioeconomic environment of surrounding regions or indeed entire countries.

The project is unquestionably indivisible, such that it has no value unless completed virtually in its entirety. This indivisibility encourages potential distortions of project participants' perspectives. It may also distort the analysis of the economics of the project, which, with escalations, may defy rational explanation. Ever increasing efforts and resources are often required, with the success of ultimate completion eventually being measured using criteria other than normal objectives.

The project has a long execution time, particularly from the perspective of the project participants, who will have been involved in all phases of the project cycle, including planning, development, construction, and operation. There is considerable overlap of the project phases, and some phases had (and still have to some degree) competing participants undertaking parallel activities. There will also be a much longer than normal time between the large financial outlays and the revenue flows, necessitating considerable financial fortitude on behalf of the financing participants. These large capital outlays coupled with the long delay before revenues are realized, generate considerable financial pressures on the participants.

The project has a high vulnerability; protracted timelines also cause difficulties when attempting to move BOT projects from the propose-promote phase to award of an official concession, as the phases extend through the life of any one government. As major project advocates are often politicians, their political enthusiasm and resulting momentum of the project will vary greatly, usually in synchronization with general elections. The project is highly dependent upon global-scale externalities; thus it becomes very difficult to

forecast, with confidence, future demand, revenue and operating cost components of the project. To date, it has been the unforeseen, but large, increases in cross-Channel traffic, allowing substantial upward revisions in tunnel traffic projections, which have kept the project attractive to lenders in the face of substantial construction cost overruns.

It is suggested that one important dimension of project complexity may be the number and diversity of stakeholders, with their associated objectives, risk perspectives, failure and success criteria, and potential for conflicts. Often unidentified risks flow from stakeholder conflicts. It is noted the project environment is evolving and increasing in complexity, with the successful implementation of projects becoming more difficult: this may be due in no small part to the growth of the influence and the number of stakeholders.

Could the project environment become so complex so as to preclude the successful implementation of a project? That may be so; for example, it can be observed that the 'WHPPS' debacle demonstrated that the complexity of a project, in terms of its regulatory environment and technical requirements, can overwhelm the organizational capabilities of the participants (Leigland, 1987). Presently, the diversity and strength of stakeholder opposition have effectively halted the further implementation of nuclear power projects. Projects in less developed countries often fail because they exceed the country's institutional capacity for complexity.

Historically, an interesting question is how were the large projects accomplished—why did they not exceed the executional capacity of the time? The difference may have been in

terms of the project objectives, which were much simpler with fewer conflicting stakeholders and perspectives. Often the sole relevant perspective was that of the project proponent, who would have been the financier and owner. It was unlikely that competing criteria or objectives had to be considered or balanced to the degree they now must.

In the case of the Channel Tunnel project, it has encountered certain problems whereby it cannot successfully be accomplished in accordance with the original objectives. Accordingly, the criteria are changed and thus the measures of feasibility and success are altered. For example, the project cannot meet the target opening date of June 1993 (to say nothing of the target cost). In response, initial operations will now be phased, with partial operations commencing in June and full operations planned by the end of 1993 or even later. A further example of changing the criteria to ensure success can be observed relating to the shuttle trains. It had been discovered the shuttles could not meet the desired performance objective of 100 mph design speed, therefore, this performance criterion was reduced to 80 mph (ENR, 1990a) amidst pronouncements of no effect on revenue or operations (Time, 1990a), while some participants argued for still further reductions (ENR, 1990b).

While much of the uncertainty in the Build phase has been resolved, although significantly, issues of claims and thus final construction costs may not be settled for several years, the Operate phase presents the next challenges and new uncertainties. The initial payback has been delayed, and although the growth in cross-Channel traffic has been stronger than

expected, the market share that Eurotunnel can win from the ferries, and thus ultimately, financial viability, will remain uncertain for many years.

The stock markets reacted favourably as the Build phase was finally completed and the initial pricing structure for the Operate phase was announced (Globe & Mail, 1994). Many uncertainities with respect to claim disputes between Eurotunnel and TML (over construction costs), and Eurotunnel and the British and French railways (over delays in building new high-speed tracks and guaranteed levels of usage) are not yet resolved. Nevertheless, in late December, 1993, Eurotunnel settled a claim against the British and French governments in exchange for an a ten year extension of the Operate phase, which will now be 65 years. This extension of the payback period is another example of how the project's criteria was adjusted to help achieve "success".

CHAPTER 5.
HOW PROJECT PARTICIPANTS VIEW RISK PLANNING

The previous Chapters present a discussion of large projects and the evolution of the Channel Tunnel project as an example of a unique BOT project. Shifting from the perspective of the project, this Chapter examines primarily the perspective of participants and how they view and react to risk and risk planning issues.

In order to gain additional insights into such issues as they are perceived by professionals active in the engineering construction field, and further strengthen the understanding of risk planning issues and the foundation of the proposed framework, further data gathering and analysis was undertaken. This lead to the development of a number of postulates related to risk planning which are described in this Chapter.

5.1 THE PROJECT PLANNING ISSUES QUESTIONNAIRE

Gaining access to meaningful risk planning situations and participants is extremely difficult. Participants involved in ongoing BOT projects are particularly difficult to access due to the demands typically imposed by the projects themselves. Additionally, the nature of the risk planning information which was of interest requires considerable reflection on the part of participants.

A number of approaches to gathering information and project situations were considered. As previously noted, it was not possible to access a sufficient number of participants of ongoing BOT projects, so it was decided to access a group of project participants who

have significant project delivery experience in the infrastructure field. These candidates were selected for a number of reasons. First, the infrastructure projects they are typically involved with were judged to be good candidates at some point in the future for a BOT approach, and thus it was felt appropriate to examine their views of risk planning. Second, it was possible to gain access to a number of participants vertically through an organization, from a smaller number of participants (essentially members of the same project team) respecting the same projects and types of projects rather than from a greater number of participants, in a large number of organizations and thus dealing with many different types of projects. Third, the project participants which were ultimately selected had extensive experience on all phases of projects, as would be required by BOT participants, including project identification, planning, budgeting, design, construction and operation. Fourth, given the nature of the risk planning issues, a broader "mail out" approach may not yield sufficient completion rates. Fifth, one purpose of the questionnaire was to test the feasibility of the methodology for gathering information on risk planning issues.

The purpose of the questionnaire was to test the feasibility of gathering information on issues respecting project risk; to explore issues of project risk perception and propensity, and measures of project failure and success criteria; and explore the variability of attitudes and perceptions amongst the full spectrum of project participants and across levels of management responsibility and accountability, i.e. amongst participants who deal with the same projects but from different perspectives—senior management, project managers, designers and field inspectors.

A questionnaire exploring issues of project risk perception and planning, and measures of project success and failure, was designed and distributed in the summer of 1990. The questionnaire required about 30 to 45 minutes to complete; it originally consisted of 40 questions but was reduced to 27 questions after a pretest. The questionnaire was distributed throughout a section of a government department which plans and implements an annual engineering capital program consisting of over one-hundred, small to medium-sized municipal infrastructure projects. These projects typically require multi-year budgetary allotments and range in size up to approximately $5,000,000, with the largest project being around $25,000,000. Because most projects are located in northern and remote locations, in addition to logistical and climate challenges, the projects are faced with the additional challenges of cross-cultural settings; a rigorous regulatory environment; high public visibility and often, public criticism or opposition, and a high degree of political scrutiny at a number of levels.

The questionnaire was completed by eleven participants (an over 80% completion rate), which included the Department's senior management at the Assistant Deputy Minister and Engineering Director level; program and project managers, typically engineers; through to project designers and field inspectors, typically engineering technicians. Most had ten to twenty years experience respecting project implementation. The high response rate was a measure of the importance the participating Department placed on risk planning issues. Because of the small sample size no statistical testing was undertaken on the results.

The participants were responsible for a number of aspects related to the projects. There was a high degree of accountability respecting the perceived failure and success of the projects; as previously noted, the projects are delivered in a highly visible environment and promotions, terminations and increases in remuneration were generally seen to be performance-based. Project managers are typically responsible for all facets of the project, from prefeasibility planning, through regulatory approvals, design, construction and commissioning. Often there is ongoing involvement in the operations and maintenance of the project, so there is a strong motivation to deliver projects which can function economically and problem-free.

A copy of the questionnaire is included as Appendix C. The complete, detailed results are tabulated and included as Appendix D.

5.2 HOW PARTICIPANTS VIEW PROJECT RISKS

Most participants self-rate the projects undertaken as embodying medium risk—the middle choice between "not at all risky" and "extremely risky"—with perhaps a slight weighting towards "extremely risky". A "risky" project was thought of by participants as one which may fail, in terms of not meeting goals, objectives, financial and technical targets; one which embodied uncertainties or unknowns; or one which may not meet more qualitative goals, such as client or community acceptance. Senior management, as could be expected, tended to view riskiness more in terms of qualitative dimensions, while project managers,

and particularly designers and field inspectors, focused more on financial or technical aspects.

5.2.1 Sources of Risk

Important *sources* of project risk were cited as lack of time (e.g. haste, rushing, inadequate planning); lack of information (e.g. unknowns, incorrect assumptions); technical (e.g. poor design or specifications, material failures); outside factors (e.g. weather); the contractor (e.g. inexperienced, uncooperative, claims-oriented) and qualitative factors such as "political interference", improper planning (e.g. failure to establish appropriate expectations) and improper management of the project and resources.

These cited sources of risk could be compared to MacCrimmon & Wehrung's (1986) study of managerial risk, whereby the three determinants of risk were noted as "lack of control", "lack of information" and "lack of time". From an engineering project perspective, cited sources of risk such as "the contractor" could be viewed as a "lack of control"; "lack of time" was identified in terms of improper or rushed planning; and "lack of information" was cited in terms of unknowns or incorrect assumptions.

Of note, senior management identified "false/mixed expectations" (referring to those of stakeholders, the public or other participants including their political masters) as an important source of project risk. This highlights the importance of correctly identifying a

project's goals and objectives and ensuring all stakeholders share a common vision of the project.

Specific project risks which were cited included stakeholder reactions to the project; unknowns; third-party and regulatory approvals and relations; physical risks such as weather, soil conditions, technical performance of the project and safety; poor management and interpersonal conflict; unskilled and unqualified contractors (most often cited); and financial (overruns or insufficient funding). Overwhelmingly, the "most important" risk named was the "contractor", specifically in terms of performance or attitude; and the risk of "project management failures". Designers and field inspectors cited personal and safety risks (e.g. jobsite hazards) as most important.

5.2.2 Measures of Risk

Measures of project risks or indicators of a project's riskiness were varied. Senior management cited levels of public controversy, novelty of approaches and limitations on time or budgets; project managers tended to focus upon the management team and contractor's experience and track record, as well as cues from the number of bidders and bid spread. While a "risky" project is generally understood to be one which has a high chance of failure, or may not meet objectives or be accepted, developing measures of such riskiness, and relating them to historical performance data, is a difficult problem.

For example, there was little agreement on what would constitute an appropriate measure of a project's riskiness. When asked if the spread of bid prices is a good indication of a

project's riskiness—with a greater spread between the lowest bidder and all others indicating greater risks—there was little concurrence and a wide range of views were expressed, from agreement through indifference to disagreement.

5.2.3 Reducing Project Risks

When faced with project risks, specific actions to reduce risks on projects included: increase stakeholder consultations (perhaps oriented towards clarifying objectives and stakeholder support); reduce time pressures; reduce technical unknowns; increase management attention and control; risk-sharing through insurance and other strategies; and reduce financial risks through adequate budgets and project monitoring. In general, senior management actions tended to address their previously-cited sources of project risk; while project managers, designers and inspectors tended to focus on reducing risks during the implementation or construction phases. These perspectives reinforce the viewpoint that although project managers may appreciate major sources of risk arise from non-traditional sources, their actions and responses are, by and large, restricted to dealing only with risks from their limited perspectives—risks they feel most comfortable attempting to control.

When asked to what degree can control over the risks be exercised, there was somewhat of a dichotomy across the management structure: senior management felt "to a great degree", but project managers and designers tended to feel less control, mostly "to a moderate degree". This is somewhat interesting, in that senior management may be

placing more confidence in, and thus have greater expectations respecting the project management team's ability to successfully deal with risky situations. The divergence in perspectives is further emphasized by senior management's somewhat different view of major sources of project risks (qualitative, stakeholder-related risks) when compared to that of the project manager's (implementation and construction phase risks). This incongruity could prove to be a potentially major source of conflict within the organization.

5.3 MEASURES OF PROJECT SUCCESS AND FAILURE

Measures of project success cited included technical measures (e.g. performs and functions well, workmanship); financial (e.g. met capital and O&M budgetary expectations); schedule (e.g. completed on time) as well as a recognition at all levels of the importance of more qualitative aspects of success, such as acceptance, end user satisfaction, and meeting objectives (e.g. the intent of what was intended). One project manager noted it is not enough to successfully deliver a project; it is important that the project should have been undertaken in the first instance and that it properly meets a legitimate need. This may be interpreted as ensuring the objectives of the project are legitimate.

The named indications of project failure were generally the converse of the criteria for success—technical (e.g. fails to perform and unreliable; unsafe); financial (e.g. high capital and operating costs; poor budget control); schedule (e.g. significantly late completion);

and more qualitative issues (e.g. user dissatisfaction, non-acceptance, disputes and disinterest) including failure to meet expectations (i.e. objectives).

5.3.1 Precursors of Success and Failure

Many qualitative and management-oriented characteristics of a project which may contribute to failure were identified, generally similarly across all levels of the organization. This included poorly defined or unclear expectations; poor preplanning; lack of adequate definition of need, roles or scope; power struggles amongst participants; "political interference"; lack of communication; strained relations; and poor management team. In addition, project managers and field inspectors cited many characteristics of the contractor as contributing to failure, including inexperience, uncooperativeness, poor management, and too low a bid.

These observed characteristics, with an emphasis on management-oriented factors, generally agree with many of the "precursors of success and failure" previously discussed in Section 5.2 of the thesis. It is interesting to note, however, that again and again "the contractor" is cited as a major source of risk, and a major factor contributing towards the possible failure of a project. Yet because of the nature of the public tendering process and the principle of virtually always selecting the lowest bidder, this most important factor is one over which the project team can exercise a very small amount of control. These and other related considerations are further discussed in a following section.

5.3.2 Judging Success and Failure

A very high percentage of all projects executed were judged by participants as "successful"; ranging from senior management's view that 100% were successful, to a slightly less optimistic view by the project managers, who generally estimated upwards of 90% as successful.

When subsequently asked a similar question, participants felt that up to 50% of their projects were judged as only "marginally satisfactory", with most judging around 10% of their projects as marginally satisfactory but with a large spread—from 0.5% through to 50% of the projects—and around 90% judged as "satisfactory", again with a large spread, from 33% to 99.9%. Between 0% and 33% of projects were judged "not satisfactory", with most generally feeling less than 5% were not satisfactory.

The great spread of the replies, particularly with respect to "marginally satisfactory" suggests there is a large 'grey area' with respect to evaluating judgements of a project's "success" or "satisfactory" execution. This underscores the difficulty in choosing objective measures of success, and conversely, if the chosen measures are sufficiently subjective, a degree of "success" or "satisfaction" can be found in virtually any project. It is also interesting to note those directly executing the projects—primarily the project managers—tended to be far more pessimistic than senior management with respect to judging projects as "not satisfactory". This may indicate they are more critical of their own performance or respecting the manner in which the project was implemented; or they

are aware of problems on the project which senior management either is not aware or has judged not sufficiently important to threaten the project's success.

A series of questions were posed in order to examine the different perspectives on specific measures of a project's failure. Major dichotomies between the attitudes of senior management and project managers were revealed.

Senior management felt completing a project over budget (10% to 33%) was a moderately-to-extremely important indicator of project failure, yet project managers consistently displayed far less concern. This contrasts somewhat with senior management's previous assessment of a 0% project failure rate. Project managers, however, often informally adjust a project's budget before and during implementation, with considerable zero-sum flexibility between projects within the same program. Senior management's perspective may display a concern that budget overruns attract public scrutiny and criticism in the Legislature.

Conversely, project managers displayed more concern than did senior management respecting completing a project later than scheduled as an indicator of project failure. For example, completing a project one season late was considered by all except senior management, as an important to extremely important indicator of project failure, while senior management remained unconcerned, possibly demonstrating a preference to trade off late completion, with little or no budget increase, versus large budget increases to expedite a project's completion (reinforced in a later question). Also reflecting budgetary

and accountability concerns, small increases in estimated O&M costs were judged of greater concern by senior management; large increases (50% to 100%) were equally judged by all as an extremely important indicator of project failure. All parties were generally equally concerned respecting reductions in a project's planned capacity.

Project managers displayed somewhat less concern than either senior management or field inspectors, respecting several characteristics related to public scrutiny of projects as expressed through caseworks (formal Ministerial requests for information or replies to letters and questions); and criticism in the Legislature, by the media or by the public. Field inspectors displayed a high concern because they may personalize the scrutiny and criticism; senior management may display high concern because often they are the party which must directly answer any criticism. Project managers may be somewhat less concerned because they may have more confidence in their actions with respect to the project; as well, they are somewhat removed from direct criticism, although certainly not insensitive to it.

Project managers appeared to be much less concerned about late completion of projects in comparison with senior management and all others. For example, senior management felt a 10% chance of not completing a project on time was acceptable, in sharp contrast to project managers' view that upwards of a 60% chance (with a range from 5% to 90%) would be acceptable. Somewhat in contrast, however, project managers previously displayed more concern than others respecting late completion as an indicator of project failure.

Similarly, a marked dichotomy was also observed regarding project managers' attitudes towards completing a project over budget—project managers displayed much less concern than all others. For example, senior management stated only a 1% chance of a 25% budget overrun would be acceptable, in sharp contrast to the views of project managers, who felt up to a 50% chance would be acceptable. These attitudes are congruent with the project managers displayed less concern than others respecting budget overruns as indicators of project failure.

5.4 PROPENSITY TO ACCEPT PROJECT RISKS

With one exception, all those throughout the organization appeared well calibrated with respect to their own willingness to accept project risks compared with their supervisors, co-workers and others. However, one member of the senior management team consistently misjudged his own risk propensity when compared with the judgement of others. For example, the project managers uniformly self-judged themselves as "more willing to accept risks" than their supervisor, while their supervisor self-judged himself as "much more willing to accept risks" than the project managers which reported to him; similarly, he misjudged his propensity when compared to his supervisor.

5.5 BUDGET UNCERTAINTIES

Participants are responsible for preparing a "Capital Plan", which, once approved by the Legislature, establishes project budgets for the following five year period. Theoretically it

is subject to annual refinement, but often it is not adjusted, thus, because of its five-year nature, the capital plan tends to embody increasing degrees of uncertainty associated with future budgets.

When questioned respecting the chances of exceeding Year 1 (current) through Year 5 (far future) project budgets, there was considerable variability in attitudes throughout the organization. For example, senior management felt there should be about a 95% chance of not exceeding a Year 1 project budget, in sharp contrast to the perspective of the project managers, who felt there was generally about a 60% chance of not exceeding the budget—with a considerable range of responses, from 5% to 80%. Senior management displayed a similarly higher expectation with respect to Year 3 projects.

However, considering the Year 5, far future projects, senior management felt there was only a 5% chance of not exceeding project budgets, while project managers and designers uniformly demonstrated a great deal more confidence in the estimates, and felt there was generally about a 60% chance of not exceeding the budget, again with a considerable range of responses, from 20% to 80%. Generally, project managers and designers displayed a similar confidence in all present and future budgets, perhaps indicating that future unknowns were handled not with greater uncertainties and chances of exceeding, but with greater contingencies. If this is so, senior management certainly does not share this confidence, and these differences could foster a potentially dangerous source of organizational misunderstandings.

Similar dramatic differences between the attitudes of senior management, and project managers and others were revealed respecting late completions, budget overruns and project objectives, as illustrated in Table 5.1.

Respecting other attitudes and project characteristics, most throughout the organization shared similar views. For example, most agreed it is more important to maintain a project on budget rather than on schedule; and most agreed problems can be expected when the contractor bids too low.

Attitude & Characteristic of Project:	*Senior Management:*	*Project Managers:*
"Budget overruns can usually be justified."	• Disagree	• Agree
"Most reasons for budget overruns are usually out of my control."	• Disagree	• Indifferent/ Disagree
"Most projects, when completed, exceed their originally estimated budget."	• Strongly disagree	• Indifferent/ Disagree
"Late completion of a project can usually be justified."	• Disagree	• Indifferent /Agree
"Most reasons for late completion are out of my control."	• Disagree	• Agree
"End-user acceptance is the most important project goal."	• Strongly disagree	• Indifferent/ Agree

Table 5.1 Some differences in attitudes of senior management compared with project managers with respect to selected project characteristics.

How do such attitudes and perceptions compare to actual project performance? A review of the Department's historical project budget information revealed, on average, 28% of projects eventually overran their initial Legislature-approved budgets by an amount typically 10% to 15% of their original budget. However, more recently, the number and magnitude of overruns has been greatly reduced as formal program budget adjustments are made mid-way through the fiscal year. It could be argued that indeed, at least on paper, projects are not likely to overrun, but it is because of closer monitoring and budget adjustments rather than skillful project management and effective cost control. Other issues related to cost control and overruns are discussed in Section 5.8.

5.6 PROBLEMS ON PROJECTS

There was a wide range of viewpoints on the source of problems on projects—whether from events or scenarios that could have been anticipated or could not have been anticipated. Senior management felt the majority of problems arose from scenarios which *could* have been anticipated; project managers generally agreed, although there was a wide range of views (for example, project managers felt between 5% and 80% of problems could have been anticipated). Generally speaking, however, most project participants felt the majority of problems could have been anticipated.

Exploring which parties could have or should have controlled project problems, senior management felt control of problems is generally equally attributable between the contractor; the consultant; the government's project management team; other parties; and

outside the control of anyone. Project managers and field staff, however, tended to attribute control of around 50% of problems to the contractor; around 20% of problems to the consultant; slightly less to the government's project team, and smaller amounts about equally between third parties and outside the control of anyone. These attitudes reinforce the previously expressed viewpoints respecting the direct linkage between contractors and project risks and problems.

5.7 MINIMIZING RISKS: THE PROBLEMS OF CONTRACTOR SELECTION

An important source of project risk and potential problems, as revealed by the questionnaire, was the selection and potential performance of the contractor. Contractors were viewed, particularly by project managers and those who are directly involved in the implementation phase of projects, as a major unknown; a significant source of potential project failure; and the party which should or could control the majority of project problems.

The expressed (and observed) difficulty in addressing this perceived source of project risk is the dilemma inherent in the system of selecting a contractor by lowest public tender. The challenge becomes one of balancing non-financial, qualitative criteria such as those associated with contractors characteristics (e.g. possible performance, possible claims, workmanship and quality, possible insolvency, project management and inspection efforts necessary) with the traditional qualitative (e.g. financial) criteria. It should be noted there

are instances where award is not to the lowest bidder and other criteria may govern, usually associated with clearly defined schedule or methodology constraints.

Notwithstanding, award to the lowest bidder is an entrenched principle of publicly-funded tenders. Generally speaking, if any other than the lowest bidder is selected (other than for instances of incomplete or otherwise improper bids), the award decision must be made at the highest level in the organization (a Deputy Minister or Minister) or at the Cabinet, 'Management Board', or 'Treasury Board' level. This automatically results in a considerable delay in awarding the contract for a construction phase which is often already under time pressures. A decision at these levels requires substantial documentation including a comprehensive justification of the reasons. The process often results in vocal complaints and protests from those not awarded the contract (primarily from the lowest bidder); requests for political intervention; representations to a court; threats of lawsuits, and generally, much unpleasantness. Thus, it is not surprising that project managers become frustrated and seek to avoid award to other than the lowest bidder. Rejection of the lowest bid leads to questioning the legitimacy and fairness of the process. For example, based upon the author's fifteen years of involvement in public sector project management, it was only exceedingly rarely, and with the greatest difficulty, that the lowest bidder was rejected on qualitative criteria (e.g. potential poor performance, etc.), yet in about 20% of the projects the lowest bidder was greeted with trepidation and dread (i.e. another bidder would have been preferred even at a higher bid). In many cases, the trepidation and dread was borne out.

However, if there were a manner in which the important qualitative criteria of contractor characteristics could readily be made more quantifiable, it could facilitate and add credence to the selection and decision-making process yet not erode the principles of public tendering.

Such an approach would involve quantifying the risk associated with a number of contractor characteristics, allocating a "risk premium" or "performance rating" for each characteristic. The premium or performance rating, when combined with the financial aspects of the bid, would enable bids to be compared on an equitable, equi-performance level, accounting for qualitative issues related to potential performance and chance of meeting required milestones; potential for unwarranted claims; level of workmanship and possible poor quality; project and construction management efforts required; possible insolvency and issues of local hire, etc.

Integrating qualitative criteria in the selection process is also an important consideration in other situations, such as the awarding of BOT concessions; and selection of consultants. Such decisions are often substantially based on non-financial criteria and thus become subject to criticism from perceived inequities, political biases and other interferences.

The difficulty, of course, is how to document historic experiences and appropriately account for these risk factors. It may be somewhat easier to do so for traditional contracting approaches, in light of their repeatability, and in project implementation

environments where the participants are generally the same from year to year, than for 'one-shot' types of projects large or BOT projects.

The challenge essentially becomes how to quantify unknowns—how to quantify qualitative risks. Deviations against 'norms', expectations and objectives must be measured and documented, such as project management and construction administration efforts required (e.g. may be reflected in inspection hours, senior management attentions, etc.); level quality and workmanship, recognizing higher quality often translates into lower long-term maintenance and life-cycle costs; and unwarranted or dubious claims translate into higher administration, legal or construction costs.

Agencies and owners which could benefit the most, in the long run from the quantification of qualitative risks are those which undertake annual programs involving many projects of a similar type, such as the British Columbia government's Ministry of Transportation and Highways ('MoTH').

By way of example, MoTH, in late 1991 and early 1992, found it a formidable and challenging task to select and award a large number of highway maintenance contracts where qualitative criteria relating to potential contractor performance and responsiveness under a wide range of possible climatic and operational scenarios, are paramount.

The key to successfully approaching the quantification of qualitative risks lies in attention to clearly defining project objectives; participant objectives; and project and participant failure and success criteria. Through an understanding of such objectives and criteria,

tradeoffs amongst qualitative and quantitative criteria can more readily be accomplished. Project managers may find that while 'minimize project implementation costs' is a readily quantifiable objective, translated into accept lowest bidder; other objectives pertaining to project management, construction administration and inspection efforts may warrant consideration and quantification.

Objectives and criteria should also be periodically revisited, for adjustments to them may sometimes be warranted. For example, on the Channel Tunnel Project, adjustments were made to the train design speed objective, which was lowered in the face of substantially increased costs.

5.8 THE UBIQUITOUSNESS OF COST OVERRUNS

As discussed in Section 5.5, budget uncertainties and cost overruns are an important risk and dimension of project failure yet appear to be virtually universally accepted as inevitable on many projects. For example, Baum & Tolbert (1985) noted underestimating costs as well as the time required, is pervasive and attributed it to the optimism on the part of planners, found on all projects and in all countries. Morris (1985) cited common causes of overruns as technical problems and the tendency to underestimate costs.

It is useful to examine why cost overruns are so ubiquitous. Those undertaking cost estimating for a project may consciously or unconsciously inject an optimistic bias in assumptions and estimates, so that a series of positive assumptions may accumulate. The result may be an overall estimate which is too optimistic. Estimators must especially resist

the inherent human tendency to be optimistic respecting assumptions, particularly when generating single value estimates (Perry & Hayes, 1985). As well, cost estimates prepared in the earlier phases of the project may be inadvertently inaccurate and optimistic by virtue of their lack of detail, which may overlook all uncertainties, unforeseen risks and the complete range of possible cost generating factors. Optimistic estimates may also serve as a 'buy–in' for the project, for once the project gathers momentum it will be more resistant to cancellation as cost estimates become higher. Estimators and project participants may have an inherent interest in seeing the project go forward, or, seek to avoid negative reactions knowing how others may react to high, or higher than expected estimates. Social, corporate or technical cultural influences can also inject bias into considerations of and reactions to risk and uncertainties(Dingle, 1991).

The dramatic growth in costs of the recently-completed Coquihalla Highway System in south-central British Columbia, from an estimate of $500 million to an actual cost of over $1 billion was the subject of an inquiry (British Columbia, 1987). Increases were attributed to inaccurate preliminary estimates compounded by the initial incomplete scoping of the project, a failure to assess the impact on costs of scheduling changes and fast-tracking decisions, and, ultimately, a lack of planning in the crucial early stages of the project, resulting in commencement of the work based on low, 'buy-in' estimates with a reluctance to publicly increase them once the project gained momentum.

Not all cost overruns can be attributed solely to estimating errors. For example, Levitt (1981) noted critics cited enormous cost overruns on the Trans-Alaska Pipeline, which

started with a U.S.$900 million estimate, with no contingencies, and ended with a final cost of U.S.$8.5 billion. However, they overlook the major design changes imposed by regulatory requirements, inflationary increases resulting from regulatory delays, as well as political optimism in early estimates, which are cited as common for all major public projects.

The budget of the Channel Tunnel Project's has grown tremendously, as summarized in Appendix B. Some of this growth can be attributed by the tremendous degree of uncertainty which large and BOT projects face in their initial "Propose" phase; unknowns which translate into significant cost increases as the complexity and dimensions of the project becomes more apparent. Larger projects also require longer time frames, and escalation and interest costs become a more significant portion, as they have with the Channel Tunnel Project.

Hufschmidt & Gerin (1970) described a number of factors influencing errors in cost estimates. The majority of the cost overruns were cited as the result of exogenous factors, such as price escalations and scope increases; with the remaining overruns ascribed to engineering modifications, unforeseen conditions and planning inadequacies. They also suggested institutional biases fostering a consistent bias towards underestimating costs, may also be an influence. They reported other studies which cited consistent cost underestimation due to poor planning and management, cost escalations, and estimating errors.

5.9 INCONGRUENT PERCEPTIONS AND ATTITUDES: THE POTENTIAL FOR PROBLEMS

The questionnaire revealed a number of schisms, highlighting instances where perceptions and attitudes varied appreciably between differing levels of responsibility throughout the organization as well as amongst project participants at the same level. While differences are not unexpected, they can be sources of potential problems and foster an environment amenable for precursors of project failure.

The questionnaire demonstrated that even within a tight-knit organization where the parties have worked together on numerous similar projects for many years, there are still very different attitudes and perspectives respecting project risks, the relative importance of objectives, and other project characteristics. On large or BOT projects, where participants are brought together from a wide range of backgrounds and corporate cultures, the incongruities in attitudes could be expected to be even larger and of greater concern. Although the questionnaire was circulated in one government department, there is no reason to believe other multi-level, project-oriented organizations would not display comparable schisms and variations in characteristics.

Participants differed in their views of 'riskiness', with senior management focusing more on the qualitative aspects of the project. This dichotomy revealed differences between senior management and project managers respecting specific actions to reduce project risks (e.g. "consult with public" versus "ensure contractor compliance with contract"); differing views respecting the perceived degree of control it is possible to exercise over project risks (e.g. "a great degree" versus "a moderate degree"); measures of project

success—senior management again focusing upon qualitative aspects such as community and client acceptance, in contrast with project managers tending to view success largely in terms of schedule and budget parameters. Differences were also observed respecting specific measures of a project's failure, such as completion over budget or increased O&M costs (with senior management much more concerned); completion behind schedule (with senior management appreciably less concerned); and public scrutiny and criticism (with senior management more concerned).

It is also interesting to note that while most project participants felt the majority of problems could have been anticipated (perhaps in hindsight), clearly they are not. The questions which arise include why not—one reason could be related to inadequacies in the risk planning process. Particularly given some of the dichotomies as revealed by this analysis, participants would likely benefit through the use of a more comprehensive and rigorous risk planning process, such as that presented in the following Chapter.

The differences within the organization, respecting project risk perspectives suggest the various parties do not share a common vision of the project, its objectives and measures of success or their relative importance. Significant differences were also revealed respecting the confidence placed by the various parties in budget estimates, with senior management generally placing a much greater confidence in project budgets than did project managers. The expectations of senior management appear very different from those of the project managers and others; a gap which may not be serious when projects are smoothly

implemented but may be a serious source of conflict and recriminations when problems or difficulties emerge.

As one example of the potential for problems, project managers appear less concerned—compared to senior management—respecting budget overruns but more concerned about completion on schedule. Thus, project managers may be induced to partake of schedule versus budget tradeoffs which reflect very different priorities than those of senior management. As well, project managers may focus their management energies on issues reflecting their unique perspectives on projects' failure and success criteria, goals and objectives, which are demonstratively different from those of senior management.

The organization surveyed lacks, as do many, a mechanism to unify the participants' vision of the project. The lack of a common vision respecting objectives, roles and criteria can be overcome if risk planning is approached through the use of the proposed Framework as desribed in the following Chapters. Additionally, the use of a *'Risk Planning Brief'*, as described in detail in Chapter 10, could be one particularly useful method to help ensure all participants develop a harmonious common vision of the project.

In the particular context of the studied organization, every project is initiated through a 'Planning Approval Document' ('PAD'), which is used by senior management for the formal review, prioritization and approval of projects. Presently, PADs contain only limited information: a brief project description, rationale and justification of need, a budget, and timeline. Building on the format of PADs as a document participants

throughout the organization have experience with, but limited use for, PADs could readily be expanded to include a broader range of project planning information related to project objectives and other criteria (e.g. stakeholder roles and objectives).

It is also important that the roles and expectations of all project participants are clearly communicated and understood. The questionnaire revealed a number of areas where expectations clearly differed amongst the parties, for example, respecting the degree of uncertainty associated with budget estimates and the degree of control exercised over project problems. These differences can be a further source of conflict amongst members of the project team when problems arise.

5.10 FUTURE DIRECTIONS FOR DATA GATHERING

The questionnaire, by revealing a number of differences amongst the perspectives of project participants, emphasized the potential usefulness of the proposed risk planning framework. While the utility of data collection respecting risk planning issues was borne out, a limitation was that all surveyed participants were within the same organization. The surveyed parties could be regarded as emulating the perspectives and perceptions of some participants on a large or BOT project team.

For the purposes of further research, the questionnaire could be distributed to other participants outside the sponsoring organization, such as consultants, sub-consultants and contractors; and project stakeholders such as representatives of local governments and end-users. This may reveal other potentially serious dichotomies amongst such

stakeholders with respect to risk planning, and would likely offer additional insights into the usefulness of a Framework approach to risk planning, as discussed in the following Chapter.

Ideally, the cooperation of direct participants on BOT projects should be sought, but this has proved to be difficult. These participants tend to consider their views approaches respecting BOT projects as confidential and proprietary, and revealing them may affect their competitive position regarding projects they are actively pursuing. As well, many regard some of the information collected as very sensitive. Success in surveying the entire cross-section of the government organization, from senior management through to field inspectors, was possible only because a close working relationship had been developed with all parties, fostering an atmosphere of trust, confidence and openness. For future work, achieving similar universal and trusting access would be essential but a difficult challenge.

CHAPTER 6.
A HOLISTIC FRAMEWORK FOR RISK PLANNING: AN OVERVIEW

The previous chapters have provided the foundation for developing a holistic Framework for risk planning. The unique aspects of large engineering projects were examined so as to understand the project planning challenges which must be addressed. Special characteristics of PEN-BOT projects were particularly emphasized as a subset of large projects which are of increasing importance.

Risk planning, as previously noted in Section 1.7, is defined as a set of comprehensive, implementable protocols and activities with the goal of improving the project's success through management of risk. A risk planning *Framework* provides assistance by describing the manner in which these activities are organized and undertaken so as to increase their effectiveness. The Framework, by providing a generalized "map" of risk planning activities, can be utilized as a method for *participants* to "navigate" and organize their thoughts and approaches to planning for large and PEN-BOT projects.

The *participants*, who risk planning activities are described by the Framework, will have a number of perspectives. The Framework can be considered to describe, for example, the perspective of *participants* such as a project owner, proponent or contractor. Of note, *holistic* is used as a descriptor to emphasize the desirable, or rather, essential, characteristics of breadth, multiperspectiveness and range. These characteristics have particular relevance in addressing the specific challenges of large and PEN-BOT projects.

6.1 THE DEVELOPMENT OF THIS FRAMEWORK

The development of this Framework, as the essence of this thesis, was built in an iterative manner upon four major components, as noted in the following sections.

6.1.1 A Comprehensive Literature Review

The first cornerstone of the development of a Framework was a comprehensive literature review, which examined issues related to risk and risk planning within both the traditional and non-traditional context of engineering projects. This resulted in the identification of many of the ingredients which must be included in a Framework.

Risk planning is commonly practiced on projects in a more narrow manner and in a sequential fashion as a risk analysis activity, often following feasibility studies (Laufer, 1990a). The traditional approach on multiparty projects is for each participant to undertake their own risk analysis activities, usually sequentially and from their unique perspective. In such instances, Ward & Chapman (1991) noted risk analyses are undertaken at a number of separate locations within the project, which can lead to problems, exacerbated by organizational uncertainties and principal–agent conflicts.

The development of a Framework built upon the literature review commencing with a consideration of what are 'risk' and 'uncertainty'; a survey of which was presented in Section 1.6.2. This emphasized the importance of broadening the normal engineering and construction considerations of 'risk', and suggested the necessity for a Framework to

embody the various facets and dimensions of 'risk', and incorporate components related to various participant and stakeholder perspectives.

Section 1.7 reviewed a number of existing risk planning approaches, also with the conclusion that a comprehensive, holistic risk planning framework should not be limited in breadth. Existing approaches, including checklists and categorization of risks, as reviewed in Section 1.7.2, were incorporated into components of a Framework, as discussed in Section 9.2.1. The nature of large and BOT projects, with their novel risks, once again highlighted that the linkages of a Framework should be broad and iterative in nature.

As noted in Section 1.7.2, 'stakeholder management' has received relatively little attention, yet is important from a project risk planning perspective. Hence, a number of stakeholder and issue management components were incorporated into the Framework, as detailed in Sections 8.4, 8.5, 9.3.7 and 9.4.

A number of other Framework components can trace their development from the literature. The difficulty and importance of judging project 'success' and 'failure' was highlighted in Section 8.3.1, and drawing upon this advice, Framework components related to participant, and project failure and success criteria were developed, as presented in Section 8.3.

6.1.2 Case Studies of BOT Projects

Chapter 3 examined the BOT approach, including a brief case study of the Prince Edward Island BOT project. This study reinforced the importance of stakeholder and issue

management activities, which were subsequently incorporated into components of the Framework. The definition of the special characteristics of PEN-BOT projects, and a characterization of the phases of PEN-BOT (Sections 3.4 and 3.5) led to the development of most of the Stage I and Stage II components of the Framework. The unique cyclical nature of the PEN-BOT phases led to the development of many of the iterative relationships and linkages of the Framework.

A detailed history and case study of the Channel Tunnel project, as presented in Chapter 4, was developed so as to assist in the understanding of the characteristics of a very large PEN-BOT project. Many of the lessons led to Framework components, particularly those related to the definition of participant characteristics (roles, objectives, etc.); conflicts, and those components related to organizational challenges, structure and conflicts. Section 4.2 reviewed the characteristics of the Channel Tunnel Project; which, upon reflection, led to the development of many Framework components related to participants, conflicts, objectives, and importantly, the necessity to adjust objectives and success criteria.

Lessons drawn from the changing budgets and timelines of the project (summarized in Appendices A and B) suggested the Framework components vis-à-vis the provision of iterative linkages related to assessing/reassessing dimensions of the project's feasibilities; and Framework components related to adjustment of execution plans, roles, and approaches.

6.1.3 A Project Planning Questionnaire

A Project Planning Questionnaire, as discussed in Chapter 5, was utilized to gain further insights on the perspective and approaches of engineering practitioners to project risks. These insights were incorporated into the Framework by addressing the multiple dimensions of risk planning; components and linkages related to risk identification, and project success and failure considerations. The importance of qualitative aspects of risk was noted in Section 5.7 and reflected in Framework components and linkages related to project and participant objectives, and failure and success criteria.

Section 5.9, which highlighted incongruent perceptions and attitudes amongst project participants, again suggested Framework components related to a common 'project vision' respecting objectives, roles, risks and criteria. Foreseeing the usefulness of a Framework to overcome risk planning dichotomies amongst stakeholders also encouraged its development.

6.1.4 Reflections Upon Professional Experiences

Reflections upon personal professional experiences in the fields of project planning and delivery were drawn upon to gain further insights into these issues. A number of Framework components evolved from these reflections, including Stage III components and linkages respecting the design and adjustment of execution plans and Stage II and Stage III components related to the stakeholder involvement and issue management processes.

On a number of occasions, it has been observed that there may be a dichotomy between risks focused upon and those which are not. Participants may be tempted to examine some risks in detail because they are readily quantifiable or familiar, but downplay others because they are difficult to quantify or unfamiliar. These risks may actually be more prevalent contributors to a project's lack of success.

Furthermore, it was noted that risk planning by some participants is often episodic in nature. Scenarios which are most readily visualized may be granted the greatest credibility and thus a higher probability of occurrence. An additional observation is some project participants are guided by 'out of sight, out of mind' axioms; while for others, unless a response can be conceived to each and every scenario visualized, the uncertainties will overwhelm and amplify risk perceptions. Together these observations reinforced the need for a Framework.

6.2 FRAMEWORK OVERVIEW

The goal of a Framework will be to offer participants, such as project proponents, contractors or government agencies attempting to evaluate PEN-BOT project proposals, an organized approach to, and view of, risk planning which cover the main dimensions of a project, i.e. technical, environmental, financial, economic, social, political, legal/regulatory, and organizational.

Process definition and structuring of the Framework so as to provide a map of the risk planning process is the essence of the thesis. Additional contributions are offered

respecting some of the "softer side" issues of the Framework such as stakeholder, issue and conflict identification aspects.

The holistic risk planning Framework described in this Chapter offers project participants a map of a systematic process whereby they could gain a better understanding of objectives, criteria, stakeholders, risk and uncertainty, through their identification and assessment, analysis and management.

Although detailed information about risks will likely be lacking in the earlier planning phases, the process of risk planning itself can become as valuable to participants as the evaluation of specific inputs. Approaching risk planning through the use of a holistic risk planning framework will help ensure that the consideration of risks and scenarios are not implicitly limited or stifled through the actual process of risk planning, possibly through such mechanisms as negative group dynamics, inherent limitations to search horizons, or innate pre-judgments.

6.2.1 The Dimensions of the Framework

As previously noted, the Framework is designed to offer participants an organized approach to risk planning which cover the main dimensions which describe a project. Together, these dimensions should comprehensively define the project. They are:

"Technical", which are considered to include characteristics of the project related to design, constructability and performance: for example, the project's service life, throughput or capacity, technical performance, etc.

"Environmental", which are considered to include the specific characteristics of the project related to it's interaction with, alteration of, or impact upon the surrounding ecosphere: for example, contaminant discharges, etc.

"Financial" are considered to be those characteristics which are related to the project's financial parameters, such as cash flow, rate of return, etc.

"Economic" characteristics are those related to the project's behaviour and interaction with the economic environment external to the project.

"Social" characteristics are those related to the project's interaction with societal agendas, expectations and perceptions.

"Political" characteristics are those related to the project's interaction with governments of all levels as well as government and political processes and agendas. "Socio-political" characteristics may also be utilized to describe those related to the project's interaction with the broad range of societal and political agendas.

"Legal and regulatory" are those characteristics related to the project's reaction to or compliance with legally mandated performance, such as contractual obligations or those dictated by legislation or regulation.

"Organizational" characteristics are those related to the internal and external structure and relationships of the project and participants.

A *"feasibility analysis"* is defined in Section 1.6.1. It can be considered to be an evaluation, assessment or prediction of the project's behaviour or characteristics as related to the dimension of interest and as related to minimum thresholds of acceptability. This may include an estimation of the project's likelihood of achieving the estimated measures or of displaying the characteristics of note. A feasibility analysis may include, for example, the quantitative modelling and assessment of estimates of the project's IRR with a comparison to minimum or desired targets.

The challenge in assessing the project's feasibility as it relates to each of these dimensions can be significant. Some dimensions are more readily quantified (e.g. financial) than others (e.g. political), which present challenges in terms of defining the project's interactions with and characteristics of interest as they relate to the dimension.

Each stage of the Framework, illustrated in the following sections through a series of flowcharts, addresses these dimensions. The stages consist of highly-related planning activities, most of which are cyclical and iterative (these linkages are illustrated on the Framework flowcharts). They must be constantly revisited and redone with increasing levels of detail as more information respecting the characteristics become available, in response to changing conditions, or as the project progresses. In response, options must be 'pruned' selectively as an essential component of the assessment process and certain feasibility hurdles are passed.

It is not necessary for the resolution of uncertainty, and the assessment of the many differing dimensions of feasibility, to proceed with uniform detail in all areas. As

previously noted, some aspects of the framework (e.g. technical uncertainties) may be more conducive to addressing with greater detail than others (e.g. political uncertainties). As well, it should be noted our state of knowledge respecting the various Framework components is very uneven. Some aspects of the Framework, for example several of the feasibility assessment components, have a variety of well developed tools available. These tools and techniques will thus not be the focus of the thesis. Nevertheless, the previously-noted dimensions of a feasibility analysis (technical, economic, financial, etc.) are superimposed upon all facets of the Framework.

6.2.2 Operationalizing the Framework

Through the processes identified in the Framework, the judgments required of participants respecting the key challenges of how to respond to the information identified through the risk planning process are highlighted. These may include how to assess the impacts of identified conflicts; how to respond to organizational challenges; how to design strategies to address highlighted uncertainties; how to set feasibility thresholds; and how to evaluate the balance and robustness of the participants' perspectives, which often exhibit a danger of developing, through intense, introspective involvement on the project, less-than-desirable dimensions. Central to successfully responding to such information in a positive manner is the ability to assess the 'threat potential' of a number of the key aspects of the project.

The process of risk planning is structured through the Framework. To operationalize the Framework as an strategic planning tool, a *Project Risk Planning Brief* is proposed as an approach to structure the project's risk planning information.

Participants may prepare the Brief so as to provide all concerned with a unified, explicit statement of project risk planning information, including project objectives, participant roles, potential stakeholder missions, etc. The Brief would then act as a current, comprehensive picture of the project, so as to minimize the potential for risk surprises and reveal overlooked or overlapping areas of responsibility in the project's planning or execution.

While all participants would benefit from the Brief, the project's proponents would likely assume prime responsibility for the preparation and maintenance of the Brief. Government evaluators of potential projects; financiers and investors would also have a particular interest in the Brief and the record of the project which it presents.

The recommended manner in which the information in the Risk Brief be structured is presented in Chapter 10.

For example, there is very little guidance available to governments as they are increasingly faced with the task of assessing BOT proposals and projects. Adopting the perspective of a participant faced with the task of assessing BOT proposals, they are faced with the task of first identifying what information, processes and tools will be required to properly evaluate the BOT project. In this instance, the Framework would suggest an organized approach so as to:

- *minimize risks vis-à-vis participants;*
- *minimize risks from surprise scenarios (i.e. unidentified and unacknowledged risks);*
- *evaluate and assert the project's success.*

6.3 FRAMEWORK DESCRIPTION

The Framework presents three iterative and repetitive stages, described in the following sections and illustrated in a simplified manner in Figure 6.1, of:

1. *Definition of the Project's Environment.*
2. *Definition of the Project.*
3. *Processing and Adjusting the Project's Risks.*

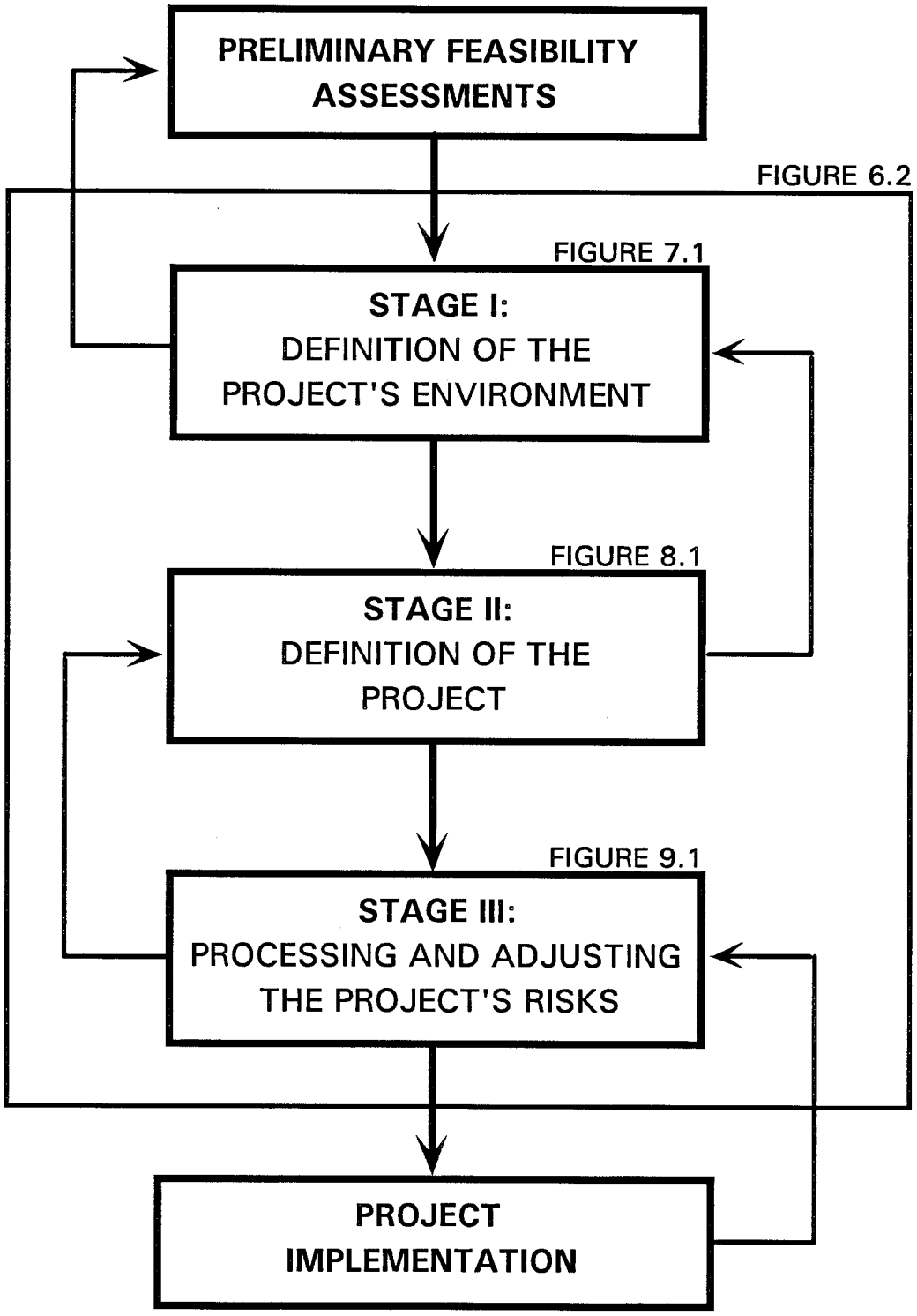

Figure 6.1 Simplified Overview of a Holistic Risk Planning Framework

Each of these three stages is presented in detail in Figures 6.2, 7.1, 8.1 and 9.1 as noted.

The flow of information between stages is represented by lines and arrows on Figure 6.1. In the early or less advanced degrees of a project's life, the Framework would approach the project's dimensions at a far more superficial level. As the project would pass the very preliminary feasibility thresholds, it would become essential that increasingly more formalized and detailed assessments be utilized, and iterations to previous stages would be necessary.

The Framework as described by these three stages would be most prevalent and useful in the *'Propose'*, *'Evaluate'* and *'Negotiate'* phases of the PEN-BOT model. Figure 6.1 illustrates how these three stages are preceded by *'Preliminary Assessments'* related to each of the previously-defined dimensions, which in itself may represent a considerable level of effort and require varying degrees of iterative information gathering. However, this, as well as the following *'Implementation'* stage are not the focus of the Framework, although it is important to understand the stages are related iteratively to the Framework.

The third Framework stage would, in those instances where the project proceeds, be followed by the project's construction and implementation through the *'Build'*, *'Operate'* and *'Transfer'* phases. While feedback and iterations will continue to be necessary and valuable, it is not the intention to expand the Framework for specific applicability into these construction and operation phases. The Framework is focused towards setting out the project's risk planning context and understanding how such a context may impact upon potential risks.

Figure 6.2 presents the Framework at the greatest level of detail, while the following chapters describe the features of the Framework stage by stage. The prevalence of iterative cycles (shown dotted) and the multitude of interrelationships and linkages in the process is evident from Figure 6.2.

The risk planning process commences with the identification of an opportunity and the need for a project. This is followed by the iterative actions of preliminary feasibility assessments related to some or all of the important feasibility dimensions. Thus, the risk planning process, as represented by the Framework, assumes the project would have passed a preliminary assessment of feasibility.

Components of the Framework related to "definition", "identification", "assessment" or other similar actions are represented by boxes on Figure 6.2. Iterative actions in response to such components, for example "adjustments", are represented by dotted lines and rounded boxes. Iterations would no longer be required when participants judge the information to be sufficiently refined or detailed, so that adjustments and refinements in subsequent components or stages of the Framework will not have a material effect on previous components.

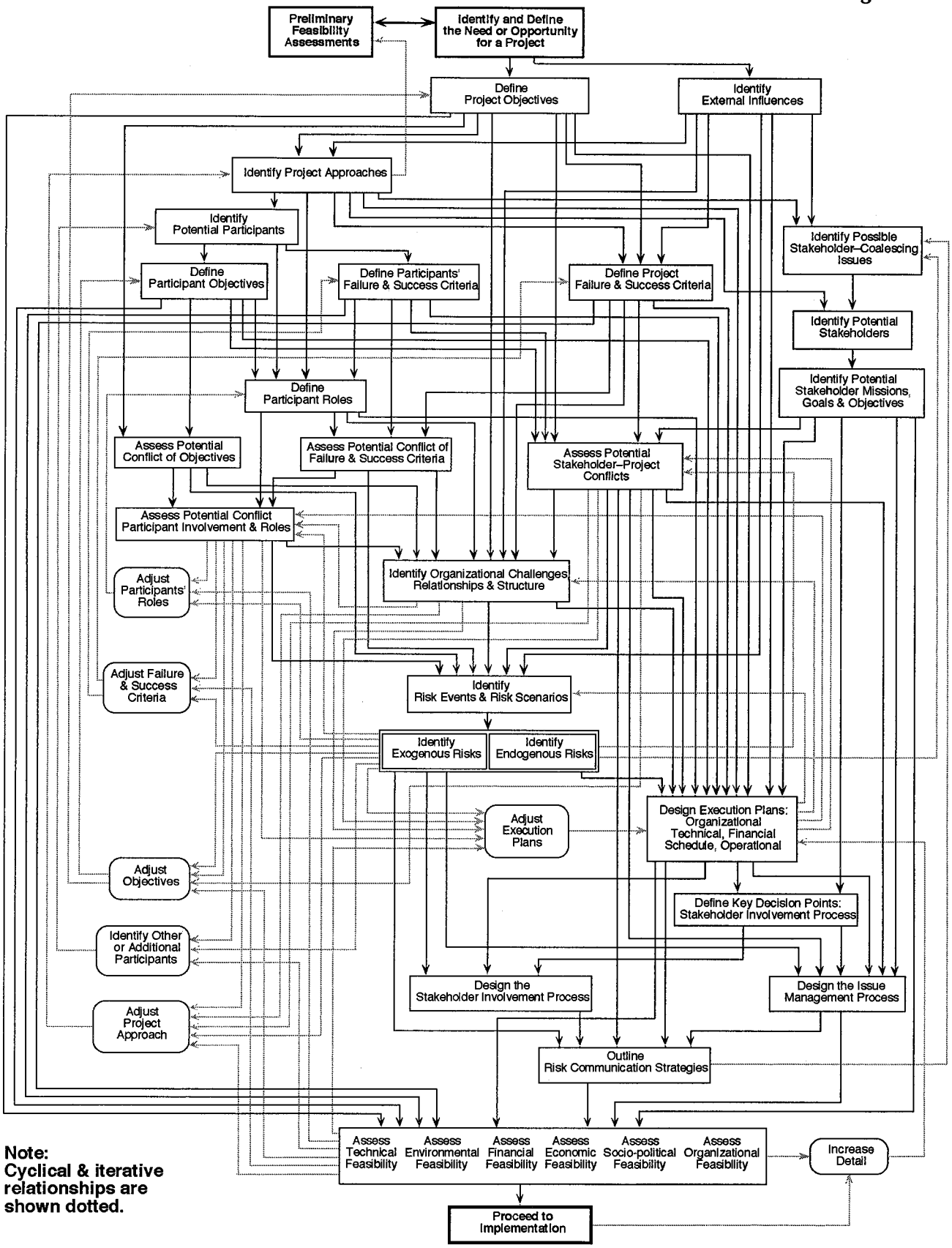

Fig. 6.2 A Holistic Risk Planning Framework

CHAPTER 7.
THE FRAMEWORK STAGE I:
DEFINITION OF THE PROJECT'S ENVIRONMENT

Stage I of this Framework proposes a series of processes so as to define the project's environment. The *environment* of the project is considered broadly as the circumstances and surroundings in which the project must exist, be influenced by, as well as influence. This environment is typically very dynamic as it includes all externalities, from those at a local level, to national political and social influences as well as those on a global scale. Considered in this context, a project's environment is much more comprehensive than embodied by an ecological or natural resources interpretation.

Figure 7.1 illustrates the Stage I Framework activities at the greatest level of detail. The prevalence of iterative cycles (shown dotted) and the multitude of interrelationships and linkages in the process is evident from Figure 7.1.

The risk planning process commences with the identification of an opportunity and the need for a project. This is followed by the iterative actions of preliminary feasibility assessments related to some or all of the important feasibility dimensions. Thus, the risk planning process, as represented by the Framework, assumes the project would have passed a preliminary assessment of feasibility.

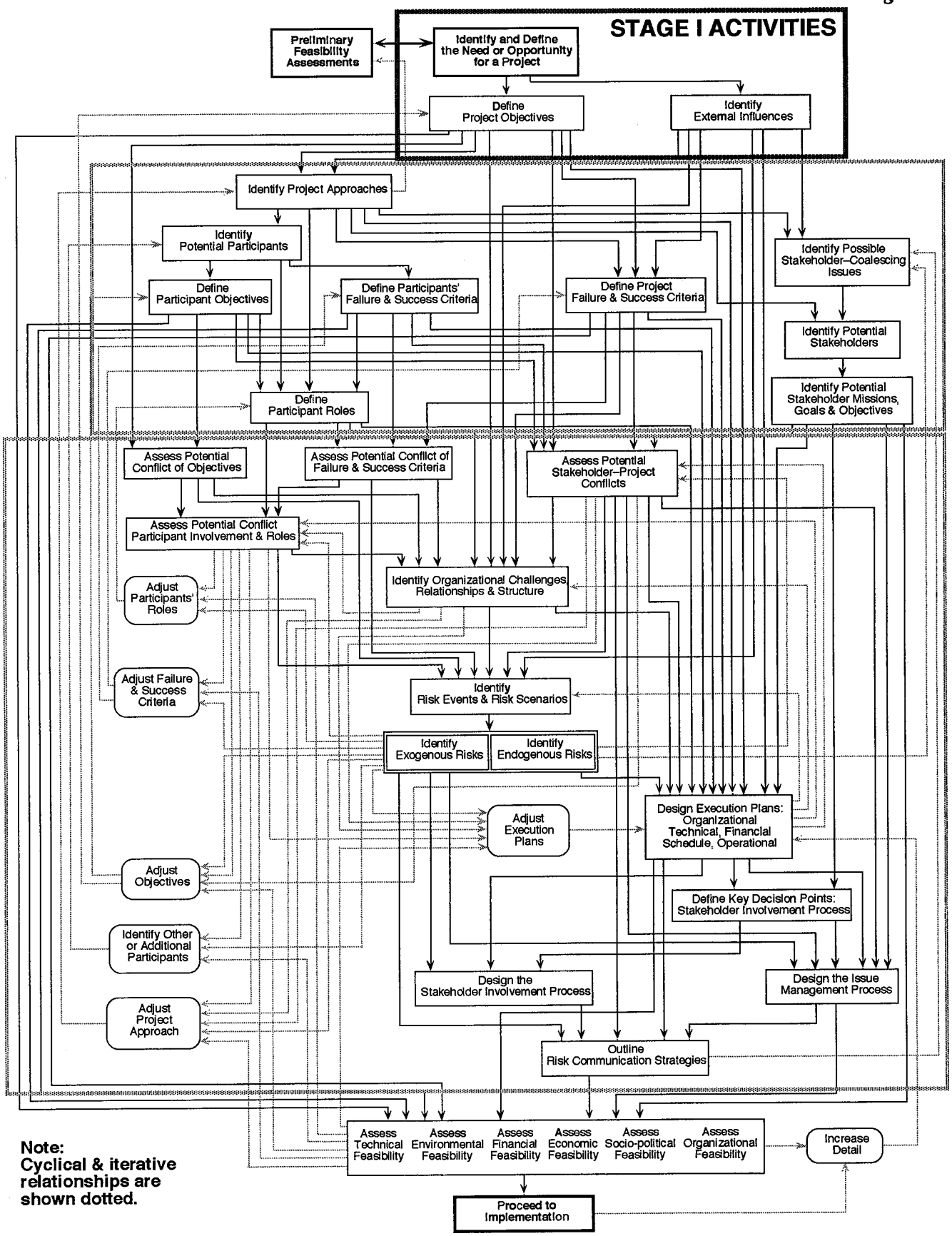

Fig. 7.1 Stage I Activities of the Holistic Risk Planning Framework

Stage I of the Framework suggests that participants define the project's environment through three steps:

- *Identification and definition of the need or opportunity for the project (e.g. the project's 'mission' and raison d'être).*
- *Definition of the project's overall objectives (e.g. project 'meta-objectives').*
- *Identification of the external influences (e.g. 'state-of-the-world' variables) and considerations which may in turn influence project approaches and objectives.*

7.1 IDENTIFY AND DEFINE THE NEED FOR A PROJECT

To suggest all projects must respond to an identified need may appear obvious but not universally practiced. Ideally, projects and particularly PEN-BOT projects must be need-driven; as expressed through the project's mission, purpose and *raison d'être* responding to a market need, an infrastructure need, or a service need.

Some projects are not developed in response to a need; rather, they are formulated in an attempt to mold the project into existing needs or to create a need. This transposition can become the source of potential risks if it is not clearly understood and enunciated through definition of the project's mission and purpose, and comprehensively acknowledged during preliminary assessments of the project's feasibility.

Thus, participants as a first step should define their understanding of what is the recognized and definable mission and purpose for the project—a statement as to why the project will be and why the projects should create change. This "broad brush" thinking will set the foundation for defining and planning the project with increasing levels of detail, as outlined in the following activities.

Participants must also scrutinize this first definition of the project to ensure it is complementary from the variety of perspectives they bring to the project. Early indications of inconsistencies can later spawn major sources of conflicts and risks.

7.2 DEFINE PROJECT OBJECTIVES

Flowing from an understanding of a project's mission is a definition of a project's objectives. Objectives are considered to be the quantifiable and operationalized statement of the project's mission. They must be consistent and accurate expressions of the project's mission and quantifiable through related failure and success criteria.

The process of defining objectives for the project can also reveal weaknesses in the project's formulation. It can be observed, for example, that large and PEN-BOT projects regularly have much broader, ambiguous objectives and criteria in comparison to normal undertakings.

It may not be an easy task to acknowledge and define the project's true meta-objectives in harmony with the project's mission, as distinct from the objectives and agendas of the project's proponents, which are sometimes confused as the same. For example, it could

be argued the true objectives of the Prince Edward Island Fixed Link and the Channel Crossing projects were political, and all characteristics of the projects, including their rationalization and justification, flowed from the political objective. Subsequent participants, however, introduce many different shades of objectives: contractors seeking work, investors seeking financial opportunities, and even government departments seeking mandates and projects to assure prominence or survival.

An examination and understanding of project objectives will facilitate the ability to adequately evaluate the appropriateness of proposed project approaches, and address their specific perspectives and objectives. As an example of the importance of this examination, Youker (1989) cited the lack of understanding, commitment and support of the project objectives as a major source of project failure.

This is also illustrated when participants react to perceived objectives with a temptation to hastily form alliances and formulate project approaches at far too early a stage, overlooking what the actual need (mission) is for the project and lacking the necessary understanding of the related project objectives. A number of authors have recognized the danger of such a reaction, and have noted both the difficulties and the importance of clearly defining project objectives as a significant precursor to facilitate success (e.g. Morris & Hough (1987); Skitmore, Stradling & Tuohy (1989); Sykes (1982); Baker, Fisher & Murphy (1983); Pinto & Slevin (1988b); Kelly & Morris (1981) and Baum & Tolbert (1985)).

Additionally, as previously stated, participants must carefully compare their perspectives on the project objectives to ensure compatibility of viewpoints with respect to what the project is attempting to accomplish. Inconsistencies and disagreements respecting project objectives can grow into major schisms.

7.3 IDENTIFY EXTERNAL INFLUENCES

Large and PEN-BOT projects exist in especially complex environments and are particularly sensitive to external influences (e.g. subject to global forces, political agendas, etc.) The large and PEN-BOT project environment has been observed to be undergoing dramatic, non-reversible changes in the past one or two decades (Horwitch, 1984). For example, participants must recognize large and PEN-BOT projects are now operating in a more rigorous environment of commercialization, and faced with multiple stakeholders in an open and diverse environment. This diversity breeds conflicts over many issues associated with projects and technology, many of which are complex and often escalate into overtly political contests between stakeholder groups and project participants (Clarke, 1988b).

The complexity of this environment of large projects, with wide-reaching implications and 'self-disturbing' characteristics should not be underestimated. As noted in Chapter 2 and 3, large and PEN-BOT projects are particularly complex, are highly sensitive to external and environmental factors, global influences and political factors. The projects are "self disturbing", in that they have a wide-ranging influence on their environment and hence on itself.

Conversely, the complexity of this environment is illustrated by the difficulties some projects encounter in forcing the requisite changes—policy reform through project agreements, for example—in their environment even if a project goal. The World Bank (1988) noted that often insufficient attention was paid to these environmental implementation requirements or implications, including cultural and social factors, and that more careful preparation and planning could have reduced risks.

The identification of these important external influences can be accomplished through the systematic consideration of the previously-noted major dimensions of the project. There is no all-encompassing checklist of influences; the comprehensiveness of the identified influences in many ways will indicate the understanding participants have of the project's environment, which will in turn relate to the identification of project approaches, organizational challenges, project failure and success criteria, stakeholder-coalescing issues, and the identification of risks. Additionally, external influences play a major role when designing the project's execution plans.

7.4 SOME LESSONS FROM THE CHANNEL CROSSING AND OTHER PROJECTS

An examination of the Channel Crossing project provides a number of lessons with respect to the need for clearly defining a project and identifying objectives. PEN-BOT projects such as the Channel project typically must meet many objectives. Promoter consortia must formulate their presentations to the concession-granting agency or government in

such a manner as to address the multitude of objectives, which may include environmental, economic, social, political and technical objectives.

Difficulties arise if this is not clearly understood. Traditionally, contractors are awarded projects based upon visible, easily quantified and understood objectives of cost, time or quality, which is typically the lowest tendered price which would meet acceptable quality and time to completion requirements; that is, we replace a multi-objective problem by a single objective, with the constraint set that defines thresholds which must be met.

For example, when originally promoted, the objectives of the Channel Tunnel project were many:

> *"From the standpoint of politics and political economy, no work more useful to humanity had ever been attempted; it was one of peace and civilisation, of international fraternity; it would save transshipment and insurance, and gain an hour for passengers, and two hours for merchandise ... the tunnel would be a guarantee against famine in England in case of war ... preserve England from the rivalry of Antwerp, Rotterdam and the German ports ..." (Economist, 1883).*

However, the objectives of the pre-1975 project were not so clearly enunciated, although it was recognized the tunnel had a capacity to achieve long-term transport planning goals, an objective that was later emphasized when the EEC contemplated participation. The proposed tunnel was viewed as a transportation project, and there was considerable discussion of the wisdom and long-term desirability of encouraging the growth of cross-Channel vehicular traffic. Critics of the planning process argued that the project could easily be formulated to achieve social objectives, such as switching traffic from road to rail (New Scientist, 1973).

Nevertheless, the *stated* objectives of the pre-1975 project were devoid of sociopolitical goals and represented criteria which could be readily measured and easily understood. The objective was to provide a link (Gould, Jackson & Tough, 1975):

a) *that could be built without recourse to untried technologies;*

b) *that would use only techniques that were reasonably easily available and whose consumption of resources was of acceptable proportions;*

c) *whose cost and time-table could be forecast with reasonable accuracy;*

d) *that could be financed and would be profitable with a combination of pessimistic assumptions on cost and growth rates;*

e) *that could be built without involving the agreement of the many nations whose ships pass through the Strait of Dover;*

f) *that would be environmentally acceptable;*

g) *that would be available to operate before the rapidly increasing cross-Channel traffic outgrew its present facilities, in other words, by the early 1980s.*

While the primary objective of the Channel crossing project was recognized and visible, i.e., to provide a tunnel, Morris & Hough (1987) noted that the difficulty and root of the pre-1975s project's demise was in the inconsistencies, conflicts and unrecognized 'secondary objectives' of the project's participants. This was exacerbated by the absence of identified and shared objectives, which was a major factor in the failure of the pre-1975 Channel crossing project, manifested by the lack of a project champion, and political and organizational problems (Morris & Hough, 1987).

When the project was subsequently resurrected in the early 1980s, there was little discussion of the desirability of road versus rail traffic; rather, it appeared the underlying

assumption had been made that road transport was accepted. One demonstrated objective of the link will be to encourage cross-Channel vehicular traffic, as Eurotunnel will be required, under the terms of the concession agreement, to develop a proposal for a drive-through link by 2000. Clearly, the objectives of encouraging cross-Channel road traffic, and the attendant benefits in terms of economic growth (Euromoney, 1987), outweighed, at least in the minds of the current governments, considerations of discouraging vehicle traffic growth. Environmental and social planning objectives were thus second (perhaps not surprising) to economic objectives.

Consortia responding to the 1985 Anglo-French 'Invitation to Promoters' were given little guidance with respect to project objectives—they were advised the link was to be fixed; undertaken with entirely private financing with no government guarantees; and the schemes must be robustly demonstrated as technically and financially feasible (Kirkland, 1986). Discussions of the link, and the various proposals, did not focus on 'why' or 'objectives'; it became more a question of 'which one'. It was acknowledged a link would be built, for to turn down all of the proposals submitted in 1985 was cited as "politically untenable"(International Management, 1986).

Once the choice of a link was made, the governments outlined, in broad terms, the objectives, as stated in the Anglo-French treaty:

> *"(the governments are) ... confident the Channel Fixed Link will greatly improve communication between the UK and France and give fresh impetus to relations between the two countries; ... (and they) ... desire to contribute to the development of relations and of exchanges between members of the E.E.C."(U.K. Parliament, 1986a).*

Nonetheless, unquestionably there were sociopolitical objectives to be achieved through construction of a link, primarily in terms of implementing a political philosophy of privatization (i.e. 'Thatcherism) (Institutional Investor, 1987); job creation; meeting the wishes of the E.E.C. for a tangible show of UK commitments; and addressing other Franco-Anglo disagreements and lingering resentments over the unilateral decision in 1975 to terminate the previous project (Economist, 1980a, Business Week, 1986). By 1985, faced with a run-up to elections, both British and French politicians viewed job creation as the major objective of the project (Economist, 1981, 1985b; ENR, 1985b; Business Week, 1986; Euromoney, 1987).

Eurotunnel, as the promoter of the project, spoke of lofty objectives:

> *"the Tunnel is in the national interest of the UK and France, and has an importance which will earn it a place in history books. ... (it should) encourage two-way trade ... provide a tremendous boost to economic activity ... and we must not forget the effect on attitudes towards the Community ... it will be far more dramatic for many people than our entry into the European Community itself." (Euromoney, 1987).*

Others felt Eurotunnel's objectives were far more pragmatic, and would foreshadow the roots of conflicts amongst participants:

> *"Most successful new businesses are started because someone spotted a gap in the market: a need that no one was catering for, or not catering for competently. Eurotunnel was born when work hungry contractors responded to a political initiative: it started looking for a market afterwards." (Investors Chronicle, 1987b)*

These problems were also noted in an earlier Chapter. In essence, for the Channel Crossing project as on many other PEN-BOT projects, participants formulated the project to meet their objectives (such as return on investment or construction work); then recast

the project, holding participant objectives as project objectives, so as to at least apparently meet the objectives of the concession-granter. It is unlikely the participants adequately developed an acknowledged statement of the project's mission from which complementary objectives for the project (and later, participants) could flow.

Developing a project mission and objectives in accordance with those of the concession-granter may be a difficult task, for the concession-granter itself, even if a government, is not a homogenized, unified body and may have a diversity of objectives within. Participants may be particularly bewildered by the challenge of addressing government objectives; for there is, in reality, not one 'government', but many; and not one set of 'government objectives', but many, including 'political' objectives; 'departmental' objectives and individual cabinet members objectives and regional objectives, all contributing to internal conflicts within the concession-granting agency. In the case of the Channel Tunnel, with two national governments evaluating the proposals, there is even greater scope for diverse and opposing objectives, leading to risks from conflict and hidden agendas.

The same could be said for the other participants. "Contractors", for example, are often consortia or assemblages of joint ventures, so they too may not universally share a similar perspective on project objectives.

For a further example of the diversity of perspectives which must be addressed within the concession-granters respecting the Northumberland Strait crossing project (the fixed link to PEI), consider that the concession-granting agency is the Federal Government.

However, while proponents may hope in vain for the 'one window approach', this concession-granting agency is far from homogeneous, for the concurrence of the provincial governments of Prince Edward Island and New Brunswick is required. As well, the federal government has delegated decision-making to a 'Project Planning Committee', which consists of representatives from *twelve* different federal departments or agencies; three provincial governments (Prince Edward Island, New Brunswick and Nova Scotia); and observers from the Federal Environmental Assessment Review Office (Feltham, 1989). Contractor participants have noted that the absence of clearly enunciated government objectives made the preparation of proposals more difficult and contributed to making the award what is seen as an "opinionated process" (Thompson, 1988).

The resulting lesson is projects without clearly defined objectives may be driven by or be seen to be driven by very qualitative ones, including political or sociopolitical, which can be, or can be viewed as, very arbitrary.

In late March 1993, with the Crossing project halted by court challenges, lobbyists continued to pressure for the project to proceed. With the economics of the project per se called into question, the mission and true objectives of the project came under scrutiny. Other possible objectives were cited, including linking the private redevelopment of the former Summerside military base with the construction of the bridge (Cameron, 1993). It would appear the project's mission must be recast, and objectives must be broadened and redefined for the project to continue. This may include resetting the feasibility thresholds with the further difficulties of the political agendas becoming fluid and more complex.

Having a multi-dimensional mission with broad, holistic objectives for such a major project is not in itself undesirable, however, the danger is if these are not clearly understood or apparent to the participants. Otherwise, the project's momentum may overtake a more rational analysis of the project, and objectives are altered to rationalize and justify continued participation. Opposition may arise from the appearance of political rationalization and hidden agendas.

Changing project objectives can in itself be a major risk. Morris & Hough (1987) point out that unrecognized change of objectives is a classic cause of catastrophic failure. Because of long duration and size, major projects are particularly susceptible to changes in the socio-political environment, which may fundamentally affect the project's original mission definition and objectives; or when a project's objectives change imprecisely without recognition of the change.

As previously discussed, the Framework presents a map of processes which recognize the importance in recognizing and addressing these changes. In accordance with the Framework, participants should define project mission and objectives in the earliest stages of the project. Project objectives will then form the foundation for project approaches, and the identification of organizational challenges and highlight the potential for risks from conflicts arising from a number of sources.

If in the later stages of the project's feasibility assessment, it should be suggested that some characteristics of the project must be adjusted to enhance its feasibility, the Framework depicts the cyclical and iterative activities which may be necessary and

desirable, including the re-examination and adjustment of project objectives. Should this be the case, project approaches and risks from conflicts must be reassessed—also as suggested in the Framework—otherwise, as Morris & Hough (1987) note, the project may be subject to significant risks of failure.

The Framework can also be used as guidance for the assessment process. Returning, for example, to the perspective of a government (as concession-granter) assessing a PEN-BOT proposal, the first critical hurdles the proposal must pass are a clear definition of the project's mission in response to a well defined need; and the development of complementary project objectives which are a comprehensive expression of the mission. If these building blocks are ambiguous or upon examination, reveal a dichotomy of dimensions or perspectives, further efforts are likely required to reformulate the project.

CHAPTER 8.
THE FRAMEWORK STAGE II: DEFINITION OF THE PROJECT

Following the definition of the project's environment (Stage I) is the definition of the project through identification of the key aspects of the project (Stage II). Presuming the project will have passed the Stage I scrutiny, Stage II includes the identification of possible project approaches which address objectives; definition of project failure and success criteria as quantifiable and achievable expressions of project objectives; identification of potential participants and their attendant objectives, failure and success criteria, and roles; and identification of potential stakeholders and their possible missions, goals and objectives. These Stage II components of the Framework and their interrelationships are highlighted in Figure 8.1: "Stage II: Definition of the Project".

8.1 IDENTIFY PROJECT APPROACHES

Project approaches are first identified at a conceptual level as potential ways in which each dimension of the project objectives can be met, acknowledging, adapting to and responding to the previously-identified external influences. They provide a further context in which to further define the project and assess how the approaches may meet the objectives.

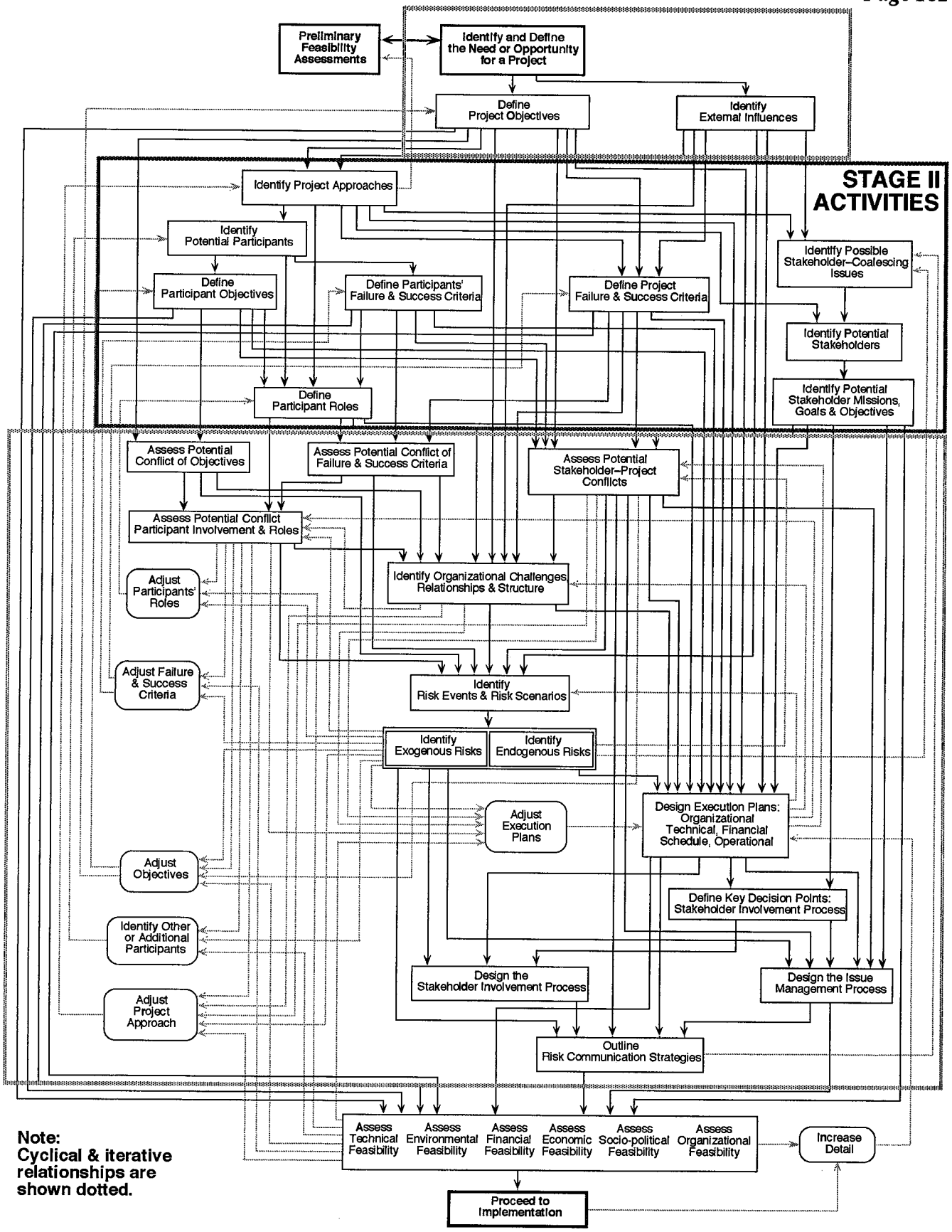

Fig. 8.1 Stage II Activities of the Holistic Risk Planning Framework

These processes should also be considered cyclical, for, as more information becomes available, potential project approaches are refined in further detail. Project approaches which are first conceptual become much more refined and provide the building blocks for the further planning of the project; for example, accomplishing the project's mission through a bridge crossing, leads to the refinement of approaches and identification of potential participants, with their attendant objectives and failure and success criteria, and thus roles. Such participants, and their corresponding objectives, roles and failure and success criteria, must be identified based upon consideration of their potential strengths and contributions vis-à-vis possible project approaches. Thus the clear definition and understanding of approaches, based upon the foundation of project objectives, is necessary at this stage, for it will assist in minimizing subsequent organizational conflicts and other risks.

Identification of project approaches can be accomplished by consideration of the wide range of options and approaches which meet the project's objectives. As previously noted, the project should be objective driven; i.e. a project in response to an opportunity, rather than approach driven; i.e. a project in search of a rationalized opportunity, which may tend to require unrecognized adjustments in terms of objectives and success criteria. The Framework suggests project approaches must flow from, and therefore should address clearly-defined objectives and respond to the specific external influences and the environment in which the project is planned, delivered and operated (e.g. global economic conditions, potential for technological change, etc.).

8.2 IDENTIFY POTENTIAL PARTICIPANTS, AND DEFINE PARTICIPANT OBJECTIVES AND ROLES

Potential project participants should be identified amongst those who would lend specific and necessary strengths to the project team. It should be recognized, when contemplating alliances and partnerships, that they must be long-lasting and endure much stress induced through organizational change, environmental turbulence, and overcome many technical, social and economic challenges. Thus, to minimize risks, an explicit and complete understanding of participant objectives and their failure and success criteria is necessary and crucial, followed by an unambiguous and comprehensive definition of participant roles, including acknowledgment and agreement by all participants.

As an example of the importance of clearly identifying participant roles, Morris & Hough (1987) noted the Channel Tunnel project of 1960–1975 (which was resurrected three years later) failed because the project lacked a "real owner" and an "effective champion". By extension, participant roles had not been adequately defined or understood, and it may have been possible to forestall the failure if the participants had done so, or at a minimum, acknowledged a champion was lacking and thus implement a structure and strategy which might have been able to address this shortcoming.

8.3 DEFINE PROJECT AND PARTICIPANT 'SUCCESS' AND 'FAILURE' CRITERIA

An important Stage II activity is the definition of project, and participant, failure and success criteria. While participant objectives, and failure and success criteria are closely related, it is useful to maintain the distinction. As previously discussed, project and

participant objectives are developed in response to the project's mission (and must therefore be congruent with that characteristic). Failure and success criteria flow from objectives as quantifiable parameters or characteristics by which to assess, on an ongoing basis, the project's feasibility and its relative "failure" or "success".

Nevertheless, there are instances when a project continues to proceed but the continued involvement of participants cannot be explained in a "rational" manner based upon an analysis of failure and success criteria. In these instances, adjustments are implicitly or explicitly made in the project's objectives, and thus new or adjusted failure and success criteria are introduced. The understanding and acknowledgment of these adjusted criteria—the relationship of which has been highlighted in the Framework through cyclical links—will assist participants identify and respond to risks and flag those problem instances where participant objectives, and participant failure and success criteria are not congruent with project objectives and criteria.

8.3.1 The Difficulty in Judging Project "Success" and "Failure"

Defining *'success'* and *'failure'* on large and PEN-BOT projects is in itself a difficult task but may be facilitated by considering such criteria as the quantifiable goals of the project's objectives.

Nevertheless, these projects, with many participants by necessity, must attempt to achieve numerous objectives and thus many measures of success and failure, with often many not explicitly identified or obvious. If not properly acknowledged in Stage I, some objectives

may be conflicting, contributing to difficulties in the establishment of appropriate failure and success criteria. For example, the World Bank (1988) stated over one–third of the most recent projects evaluated showed deficiencies respecting the statement of clear and acceptable objectives, i.e. those which were technically, administratively and financially feasible.

There is some guidance available to assist participants with these important processes. The first question to address is what are appropriate criteria for defining failure and success criteria.

Baker, Murphy & Fisher (1983) noted that 'success' would be more appropriately termed 'perceived success' and suggested that if the project meets performance specifications, coupled with a high level of satisfaction amongst key members of the owner, project team and users, then the project could be considered a 'success'.

Morris & Hough (1987) pointed out many different perspectives must be employed when judging 'success', and suggested three:

- *project functionality (e.g. financial and technical performance from the perspective of the owner);*
- *project management (e.g. on budget and schedule); and*
- *contractors commercial performance.*

Pinto & Slevin (1988a) noted the difficulty and ambiguity in defining 'success', and suggested evaluating the project from the perspectives of both the client (use, satisfaction, effectiveness) and the project (time, cost, performance). Conversely, Pinto & Mantel (1990) noted the difficulty in defining project 'failure', and suggest three aspects of the project's outcome which may define 'failure': the implementation process, the perceived value of the project and client satisfaction.

Success, Horwitch (1984) suggested, requires the difficult–to–achieve convergence of at least four crucial elements:

- *meeting societal cost–benefit tradeoffs;*
- *possessing effective bureaucratic–political skills;*
- *having appropriate managerial approaches; and*
- *fulfilling relevant corporate strategic goals.*

It is observed that it is particularly important to adopt broader perspectives when undertaking risk planning for large and PEN-BOT projects. Hence, acknowledging these broader measures, '*success*' in this thesis is considered in terms of meeting targets or measures in each important project dimension, such as technical and financial implementation targets (e.g. time, budget, and quality), achieving functionality and operational measures (e.g. commercial and technical), as well as those criteria measured against other, more qualitative goals (e.g. sociopolitical aspects) which may include important measures of participant and stakeholder acceptability.

The corollary is failure being the absence of success whereby the desired criteria are not achieved. The ambiguity with large and PEN-BOT projects is introduced because of the diversity and range of criteria adopted, and if targets are not achieved then often they are recast.

8.3.2 Precursors of Success and Failure: Guidance for Participants

In addition to observing the incidence of project success and failure (as discussed in Section 1.2), the literature also offers some attempts at analysis and guidance as to what may be considered precursors to project success or failure. These are presented to illustrate the typical breadth of this approach, which may be useful as 'checklists' but do not offer participants a coherent framework for risk planning. While some may be thought of as 'common sense', many of the identified precursors serve to emphasize the importance of approaching risk planning in the early phases of a project, where the ability to mold the project is highest.

The complete tables (14 in total) as distilled from the literature and as cited in the following discussions, have been included as Appendix E. An example table from the Appendix has also been included as Table 8.1 as part of the following discussion. To offer more focused guidance to participants and to provide a more useful risk planning tool as it applies to this Framework, lessons have been culled and interpreted from the literature and the tables, and have been summarized and presented at the end of this section.

Morris & Hough (1987) identified over eighty factors (Table E.1, Appendix E) which were noted as contributing to the successful implementation of major projects. It may be observed that the majority of these factors address activities which can or should be undertaken in the early phases of the project cycle, such as clear and comprehensive definition of the project and objectives. Many factors relate to the definition of project objectives, approaches, and external influences with many others directly or indirectly relating to stakeholder identification, participant objectives and roles, and other activities which should be accomplished within the risk planning Framework.

Morris (1986), based upon a review of the literature and case studies, identified forty-five broad lessons which may influence the success or failure of the project. Building on Morris' lessons, Skitmore, Stradling & Tuohy, (1989) noted human judgment can be subject to bias when dealing with uncertainty in project management situations, which can lead to project failure-inducing situations. They enumerated and further organized Morris' lessons in terms of "bias enabling conditions" (Table E.2, Appendix E), such as those which would likely introduce complexity, stress, and uncertainty into the project management environment.

This organization can be regarded as a useful terms of reference when participants judge, for example, the potential effectiveness of project approaches, organizational structures and execution plans so as minimize conditions contributing to judgmental biases. Once again, this emphasizes the importance of early, comprehensive risk planning processes as

defined by the Framework with one benefit being to mitigate these identified facets contributing to judgmental biases.

Other advantages of the Framework include minimizing opportunities for overlooking or neglecting risks. Sykes (1982) cited a number of 'neglected risks' and other aspects of large projects, and noted attention to these would help ensure the success of the project (Table E.3, Appendix E). These factors almost exclusively focus on defining appropriate participants, participant roles and a suitable organizational structure. The manner in which these are cited as "neglected risks" is telling: as has been previously noted, participants tend to focus on those aspects of the project which they perhaps feel are most in control (such as technical design details, for example). Participants likely feel they have much less control (and understanding) over aspects of the project related to participants (often mandated by what is available within existing organizations or management structures) and organizational issues.

It can also be interpreted that Sykes (1982) factors highlight the importance of minimizing the project's complexity, as complexity can mask risk; minimizing conflicts by maximizing participant compatibility, as conflict can lead to risk; and maximizing the effectiveness of participants and the project's organization, as flexibility must be assured to respond to uncertainty. Furthermore, as the uncertainties encountered will be multi-disciplinary, so should be the supplied management skills.

Baker, Murphy & Fisher (1983), based upon a survey of a large number of projects, identified a number of characteristics which strongly affect the perceived failure of projects

(Table E.4, Appendix E); the perceived success of projects (Table E.5, Appendix E), as well as factors related to both (Table E.6, Appendix E).

Many of these identified perceived failure factors are related to poor project management practices, highlighting the importance of properly considering the project's organizational structure, philosophy and procedures. Perceived success factors are somewhat similar, with many linked to project and participant objectives, roles and attitudes, which are often overlooked. This emphasizes the importance of comprehensively approaching a consideration of each participant's vision of the project, as enunciated through Stage II activities such as participant objectives, and failure and success criteria.

Baker, Fisher & Murphy (1983), studying public sector projects, identified a number of determinants of cost and schedule overruns (Table E.7, Appendix E) as a dimension of project failure. A number of their observations can be related to inflexible organizations and a lack of planning related to responsive backup strategies.

They also suggested a number of strategies to overcome potential problems on large projects, addressing preconditions which were found to be essential ingredients for project success (Table E.8). This table has been provided as Table 8.1 to serve as an example of the information provided in Appendix E. It can be concluded public sector projects often face organizational challenges which emphasize, once again, the importance of addressing not only participant goals, but objectives of the public as an important stakeholder. Consensus respecting goals is held to be of paramount importance, which again points towards the usefulness of comprehensive risk planning approaches.

Goemans & Smits (1986) cited a number of lessons which contribute to the successful execution and cost control on megaprojects (Table E.9, Appendix E). Their factors strongly suggest that considerable attention to early organizational and risk planning activities would be appropriate. The importance of sufficient attention to stakeholder objectives, and the potential for conflicts to arise as a result, can be noted as particularly important, and interpreted as emphasizing the advantages of a comprehensive approach as defined by the Framework in Stage II.

- Encourage openness and honesty from the start from all project participants and specifically seek to avoid and reject 'buy-ins'.
- Develop realistic cost, schedule, and technical performance estimates and goals.
- Seek to enhance the public's image of the project.
- Make prompt decisions regarding project go-ahead or contract award.
- Seek to establish definitive goals for the project and seek to establish a clear understanding and consensus among the principal project participants regarding the importance of these goals.
- Establish project team of adequate size with a flexible & flat organizational structure.
- Create an atmosphere that encourages healthy, but not cutthroat competition.
- Delegate sufficient authority to the principal client contact and let them promptly approve or reject important project decisions.

Table 8.1 Strategies for overcoming potential problems on large projects (Baker, Fisher & Murphy, 1983)

Leigland (1987) reviewed the failure of the Washington Public Power Supply System (WPPSS) program from the standpoint of organizational and management weaknesses, and drew lessons for managers of public enterprises (Table E10, Appendix E). The WPPSS failure was precipitated by massive cost overruns and schedule delays, and lead to the default of US$2.25 billion in bonds and the abandonment of four nuclear power projects under construction.

It can be observed many of the identified lessons are related to the criticalness of organizational structures and adaptability. These lessons are particularly useful within the context of large and PEN-BOT projects, whose organization is often assembled from 'ground zero' and consists of a considerable dichotomy of participants. Because of the size and complexity of the resulting consortium, particular attention must be paid to managing the organization's growth and the evolution of participants and participant roles.

The Channel Tunnel Project came close to succumbing to such a failure, as noted in the previous Chapter. Conflicts between participants, personalities and objectives very nearly led to the collapse of the Project in early 1987 and again in 1990, as the organization evolved and the participants attempted to adapt to their new roles.

Pinto & Slevin (1988b) identified a number of critical success factors for projects (Table E11, Appendix E), and determined the relative importance of each during the different phases in the project life cycle. While some factors are cited as external, most are within the control of the project team, particularly during the project implementation process. Early factors are important as they relate to a clarity of vision and share purpose amongst participants (as particularly suggested through Stage I and II activities). Subsequently, consultation and communication activities should continue to be important, which, it can be interpreted, will assist in addressing and minimizing inter-organizational uncertainties and conflicts.

Hayfield (1986) studied the reasons for project failure, and described project success or failure factors as 'technical' or 'non-technical' (Table E.12, Appendix E). Over 70% of

failure causes were estimated as 'non-technical'. Organizational and communication issues, as well as early project planning and risk analysis can be noted as important, which again reinforces the usefulness of a risk planning approach which can identify and acknowledge these hazardous 'non-technical' causes of project failure.

Murphy (1983) identified a number of 'groundrules' for participants on Third World macroprojects, many of which provide useful lessons to promote success on large and PEN-BOT projects (Table E.13, Appendix E). Lessons which can be drawn from these groundrules are those which emphasize flexibility amongst the project's participants and organization, with clear and ongoing communication with stakeholders, with the implied benefits of reducing uncertainties.

Kelley & Morris (1981) suggested management strategies for large projects must be evolutionary in nature, i.e. adaptive to the specific project needs and phased in concert with the life-cycle development of the project. A number of lessons become evident. In the early project phases, the project must have clear and attainable goals which are precisely communicated to all participants and monitored. Identifying stakeholder groups, gaining support or minimizing opposition are cited as key activities; stakeholders should never be ignored. Also related to risk planning, 'worse-case' scenarios should be identified, strategies designed, and, should the scenarios arise, implemented to avoid or manage the situation. Major project review points should be identified, and 'over-emotional' management commitments should be avoided. Maintaining maneuverability and flexibility is essential; planning must be progressive and ongoing. Management must

maintain control with comprehensive monitoring providing reliable information on all aspects of technical and non-technical issues. The project organization should be as simple as possible, with flexible agreements between key participants to allow future changes. Decision-making procedures should be simple, flexible, and well-understood. Staffing of leadership positions is crucial; successful projects invariably had a strong project 'champion'.

Examples of the critical need for a strong project champion can be found in the Channel Tunnel and the PEI Causeway Projects. On both projects, the seemingly boundless energies of a convincing advocate has been essential to maintain the project's momentum through stakeholder opposition, hearings and other obstacles. Particularly in the case of the Channel Tunnel Project, maintaining investor and financier confidence in the continued viability of the enterprise has been paramount. The PEI Project, in the late summer of 1993 arranged long-term financing but may face the similar challenge of maintaining confidence during future phases.

Baum & Tolbert (1985) cited numerous pitfalls and lessons from the successful implementation of World Bank development projects (Table E.14, Appendix E), noting that although many read as maxims of common sense, they are nonetheless often difficult to put into practice.

It can be noted these lessons highlight the importance of paying considerable attention to both project and stakeholder objectives with a flexible project plan. Technical problems are common, but it is can be observed that it is financial and managerial problems which

are usually more difficult to identify and address. The difficulty, but importance, in identifying and managing the wide range of relevant participants and stakeholders is a lesson with particular relevance for the PEN-BOT approach. Of further demonstration as to the difficulty in putting these maxims into practice, it has been noted that problems, as well as project failures on World Bank projects have been recently been increasing (Hossie (1992)).

The forgoing survey illustrates that comprehensive approaches to assist with the implementation of these lessons are needed. Common aspects can be drawn from many of these checklists, include a highlighting of the importance of attention to project and participant objectives; of addressing stakeholder concerns; and of effectively identifying and managing organizational conflicts and change. It is interesting to note the limitations of these lessons as presented through checklists. While they may be useful ingredients to the process of risk planning, they in themselves do not offer an operational or readily implementable approach to overcoming project problems, as proposed by the Framework. It is evident, however, that defining in a complete manner a PEN-BOT project's objectives, participant objectives, project failure and success criteria, and participant failure and success criteria is a difficult challenge.

To further illustrate and operationalize the Framework and to provide guidance for participants, Table 8.2 presents what are suggested as generic project objectives as related to each of six major project dimensions and feasibility categories, with examples of failure and success criteria congruent with objectives.

Table 8.2 illustrates for some feasibility categories it may be difficult, due to the qualitative nature of the objectives and criteria, for participants to adequately define expectations related to the project, in terms of specific objectives and related failure and success criteria. As defined by the Framework, the identification of the key project and participant characteristics (i.e. objectives; failure and success criteria; and roles) may suggest an adjustment in some or all of the characteristics is warranted. The Framework is thus cyclical or iterative: for example, potential inconsistencies which are uncovered because of inappropriate participant objectives can be addressed through an adjustment of the appropriate characteristics. Similarly, as illustrated through the iterative links of the Framework, it may be required to adjust project or participant objectives; failure and success criteria; or approaches so as to reduce the potential for conflicts, as discussed in Stage III of the Framework.

Feasibility Category	***Example Objectives***	***Example Failure & Success Criteria***
Technical	Implemented as planned/required. Performs as planned/required	Meets defined standards and targets of workmanship, quality, schedule. Meets defined performance specifications.
Environmental	Implemented and performs with minimal/acceptable environmental impact. Planning process appropriate and regulatory procedures followed.	Achieves defined environmental measures of impact. Required permitting received. Stakeholder opposition minimized.
Financial	Produces a planned/required financial return.	Meets required measures of financial return (e.g. IRR, sufficient cash flow).
Economic	Appropriately enhances and strengthens the participants' economically. Appropriate and cost effective use of private and public resources.	Achieves required cost-benefit and other economic measures. Level of public subsidies or guarantees required.
Socio-Political	Project congruent with and promotes complementary non-project related societal, political or private sector objectives. Project addresses a legitimate need. Project objectives are legitimate. Appropriate processes for planning and implementation followed.	Project objectives are congruent with societal standards and expectations. Enhances political or participant profile and capital. Project perceived to be a success. Stakeholder opposition minimized. User dissatisfaction and non-acceptance avoided or minimized.
Organizational	Enhances organizational capabilities and experience. Is congruent with participant organizational objectives.	Achieves strategic objectives related to enhancing competitiveness, market share, etc.

Table 8.2 Example Project Objectives and Failure and Success Criteria.

8.4 THE IMPORTANCE OF ADDRESSING STAKEHOLDERS

The multiple steps in the addressing of project stakeholders—in terms of involvement, potential for conflict, and potential influence on the project—is a vital but often overlooked component of the risk planning process. The Framework recognizes that addressing stakeholders is an integral part of the project planning process and suggests a number of important components.

Frequently the potential influence even a small or unknown group of stakeholders may exert on a large or PEN-BOT project is underestimated. For example, in March 1993 the Northumberland Strait Crossing project was temporarily halted (imparting significant costs to project proponents) by opposition from the "Friends of the Island". Weiner & Brown (1986) noted how these apparently trivial external forces, and their convergence around an issue—for which a large project often provides the catalyst—can create new constituencies, new conditions and catch companies off guard. To wit:

> *"the lobbyists, developers, lawyers and politicians who support the (PEI) bridge (were) a group that never believed a tiny band of fishermen, ferry workers and academics could derail the project. It was clear SCI's (Strait Crossing Inc.) supporters were overconfident." (Cameron, 1993).*

PEN-BOT projects in particular are heavily dependent upon project advocate stakeholders, which are often individual politicians or political groups. The Framework can help participants identify these dependencies; in response they can then design strategies to minimize this risk of dependency on an individual stakeholder.

Padgham (1991), for example, noted the specific recognition of stakeholders and their interests, and dealing with the resultant issues, was one of five key factors responsible for

the success of the Milwaukee Water Pollution Abatement Program, a US$2.2 billion complex, controversial, multi–participant project. Cleland (1990) cited a number of examples of projects which were successful, in large part, due to careful stakeholder management (e.g. NASA's Apollo program) as well as projects which were unsuccessful because inadequate attention was paid to stakeholders (e.g. the cancelled US SST program).

8.4.1 The Steps in Addressing Stakeholders

Addressing stakeholders entails more than dealing with adversaries and project opposition. Stakeholders—to restate, *those persons, groups, companies or agencies which have, or perceive to have an interest or involvement in the project or its outcome*—are clearly essential to the implementation of projects, and many, including those in the form of suppliers, user groups or customers may offer valuable support which would be required to ensure success. Large and PEN-BOT projects depend a great deal on constituency support (or at least lack of opposition) during the "PEN" phases, and thus should acknowledge, understand and foster such relations.

Cleland (1986, 1990) and Weiner & Brown (1986) described stakeholder analysis and management processes, and recommended a comprehensive, proactive approach to identifying and managing both internal (i.e. those which are subject to the authority of the project's management) and external stakeholders throughout the life of the project. Although *'stakeholder management'* and *'issue management'* are closely related with one arising from the other, the Framework adopts the perspective of issue management, with

the rationale that stakeholders coalesce around issues. Management of stakeholder groups per se should not be overlooked, but it is suggested within the context of the Framework that stakeholder management can be more readily approached through active management of the emergent issues.

Cleland (1986, 1990) outlined a multi-stage stakeholder management process, encompassing: identifying stakeholders; gathering information on stakeholders; identifying stakeholders' mission; determining stakeholder strengths and weaknesses; identifying stakeholder strategy; predicting stakeholder behaviour and implementing stakeholder management strategy.

The steps in stakeholder analysis will in itself uncover potential risks to the project which otherwise may have been overlooked. For example, Kelley & Morris (1981) suggested identification of stakeholder groups, and minimizing related opposition, are key activities.

Addressing stakeholder concerns, as practiced on many large projects, is nevertheless still seen by many participants as essentially a public relations process, in that stakeholders are 'managed' through the flow of positive information about the project. In contrast, for example, Weiner & Brown (1986) and Cleland (1986, 1990) illustrated a wider approach is required to reduce the potential for stakeholders to negatively affect the project.

8.5 THE FRAMEWORK'S COMPONENTS FOR ADDRESSING STAKEHOLDERS

In response to the sensitivity of large and PEN-BOT projects to stakeholder opposition, an even broader and, it is suggested, potentially more successful approach to stakeholder management is presented in the Framework. Stage II of the Framework presents a number of comprehensive risk planning activities related to stakeholders. As noted on Figure 8.1, the Stage II Framework components related to addressing stakeholders include:

- *identify possible stakeholder-coalescing issues;*
- *identify potential stakeholders;*
- *identify potential stakeholder missions, goals and objectives.*

Additionally, there are a number of Stage III stakeholder-related activities which follow in the Framework, building upon the previously-noted Stage II components of the Framework. These will be presented in Chapter 9 and include:

- *assess potential stakeholder-project conflicts;*
- *define key decision points in the stakeholder involvement process;*
- *design the stakeholder involvement process;*
- *design the issue management process;*
- *outline risk communication strategies.*

8.5.1 Identify Possible Stakeholder-Coalescing Issues

The identification of possible stakeholder-coalescing issues is an important, but sometimes difficult first step in this process. As illustrated by the linkages shown in the Framework, it flows from an understanding of the project's environment and project approaches, for it is important to recognize issues will be temporal and context sensitive. The relevancy of issues will likely change as the project may be resurrected and as it evolves through the PEN-BOT phases, thus issues should be revisited periodically.

While some issues may readily be identified, others may seem irrelevant or are not apparent to project participants. It is particularly difficult for participants to adopt the necessary broader perspective by stepping 'outside the project' to identify issues. It will likely be useful or essential to seek independent reviews and advice for this process to ensure the perspectives do not become too insular.

The Framework contains multiple, interrelated steps to this process so as to foster the adopting of a necessary broader perspective on issues and stakeholders. For example, if participants attempted to directly identify all potential stakeholders from the selection of existing groups, they invariably will overlook some of those who may coalesce on an ad hoc basis during various phases of the project, which is a relatively common situation. Therefore, where it is difficult to identify stakeholder groups, it may be somewhat easier to examine issues related to the project which may be of interest to various stakeholder groups, and by extension, lead to support or opposition to the project.

As a guide to assist project participants in identifying the range of possible stakeholders, Weiner & Brown (1986) described some of the reasons why stakeholder groups may mobilize around a particular element, issue or feature of a project. They further suggested the importance of stakeholder groups, once identified, is dependent upon their degree of access to the media; the government; their importance to the success of the project or organization; their authority to influence and determine decisions made by the project organization; and their history of successful challenges on similar issues.

As an example of the relevance and usefulness of the checklist of reasons identified by Weiner & Brown (1986), Table 8.3 expands the suggested stakeholder mobilization motivations by providing recent examples from the Prince Edward Island Fixed Link PEN-BOT project.

Stakeholder motivations may also be elicited through a rigorous scrutiny of each of the major dimensions to the project. In this manner issues can be enumerated and explored in a systematic fashion; for example, "environmental dimensions" (e.g. potential negative impact by the project on some aspect of the environment may lead to the formation of a stakeholder group to oppose the project); "socio-political dimensions" (e.g. the project may negatively impact on the employment conditions of an indirectly competing industry and thus lead to union opposition), etc.

The element, issue or feature of the project which may induce stakeholders to mobilize (Weiner & Brown, 1986):	***Examples drawn from the Prince Edward Island Fixed Link PEN-BOT Project:***
• Affects (or is perceived to affect) the personal health and safety of the group.	• Mariners and fishermen oppose the bridge on the grounds it is a hazard to navigation.
• Could result in economic losses or gains for the group.	• Fishermen oppose on the grounds fishing grounds will be damaged; ferry workers oppose because of job loss; tourism facility operators support as they benefit from the improved transportation link.
• May reflect a real or perceived change in the values of life styles characteristic of the group.	• Some PEI residents oppose on the grounds their "island" lifestyle will be lost.
• Could serve as a currency for exchanging support among groups.	• Lobby groups from Summerside, advocating the redevelopment of the military base support the bridge project and vice versa; both projects would benefit from each other.
• Is seen as important to constituency protectors, such as politicians or labour leaders.	• Politicians and labour leaders have adopted high profile roles.
• Could serve as a lightening rod for the disaffected.	• Fishermen have suffered a number of economic setbacks and may view the imposition of the bridge as a further example of big government versus the fishermen.
• Is of vital importance to those most directly linked to it—i.e. it goes to the root of their reason for being.	• Ferry workers and fishermen have been strong and effective opponents.
• Is seen as attractive to opportunists.	• The project has been driven by politicians.

Table 8.3 Stakeholder motivational features of projects with recent examples from the Prince Edward Island PEN-BOT project.

In addition to the reasons presented by Weiner & Brown (1986), it is suggested that project participants consider a broader range of potential stakeholder motivations. It is advanced that stakeholders may also coalesce not only in reaction to a project, but in

reaction to the process or a feature of the process. Irrespective of the robustness of the proposals or the fact they may not trigger a mobilization characteristic as suggested in Table 8.3, stakeholders may still resist aspects of the project if they do not have confidence in the proponents, participants or the processes. For example, some stakeholder groups may inherently distrust any proposal put forth by government, or particularly one by private sector developers (who may be painted with the "profit motive and thus not in the public interest" brush). They may also lack confidence in some (or all) features of the processes involved during the various phases of the project, particularly during the Propose, Evaluate and Negotiate phases. Stakeholder groups may not have confidence in or otherwise trust the government's impartiality in comprehensively assessing any potential environmental impacts (as is the case with the Prince Edward Island PEN-BOT project). Stakeholder opposition is rooted in these instances in opposition to the process rather than a specific outcome. Opposition may be further fostered by the perception of a lack of control over the process; the sense the outcomes are predetermined regardless of the views or desires of the stakeholders; or perceptions based upon or amplified from previous negative experiences.

A further example of the difficulties posed by the novelty of the PEN-BOT approach includes potential opposition arising from philosophical differences, such as opposition to the concept of private interests profiting through the provision of public infrastructure to a captive market. This novelty may also generate opposition through resistance to change, especially within certain elements of the public sector.

Table 8.4 presents a summary of these process-related coalescing characteristics with some examples. An important distinction with these process-related characteristics is that stakeholder coalescing, and subsequent opposition, flows from their perceptions related to the process rather than the project, which indeed they may ultimately support.

The identification of potential project and process issues will assist with the next step suggested by the Framework—that of identifying potential stakeholders. Participants must adopt as broad a perspective as possible so as to identify all imaginable issues and avoid dismissing issues as irrelevant or unimportant. While they may appear so from the perspective of the participants, they may display one or several important characteristics as summarized in Table 8.3 and Table 8.4, and therefore should be viewed as potentially resulting in the formation of opposition (or support) groups.

It should not be overlooked that from within the project's organization, the perceptions and judgment respecting stakeholders may not be totally accurate or complete. In such instances—which are in themselves particularly difficult to recognize—the participants may be well advised to utilize external, unbiased groups, or form alliances with others who may offer a more complete perspective on the often 'fuzzy' potential risks associated with ad hoc, adversarial or other stakeholder groups. Often the novelty of the participant alliances and the PEN-BOT approach itself makes this task difficult.

The element, issue or feature of the process which may induce stakeholders to mobilize:	***Examples related to PEN-BOT Projects:***
• Lack of confidence and trust in the proponents or participants; negative perceptions or previous experiences with participants or proponents .	• Citizen groups distrust governments or private developers based upon past experience whereby commitments were not perceived to have been fulfilled.
• Lack of confidence in processes; outcomes perceived to be preordained.	• Even if provided with the opportunity to provide input, it is seen that the outcomes are already decided or the project is driven to benefit the proponents' agenda, not the public interest.
• Perceived lack of input or control.	• Decisions affecting stakeholders are seen to be made "behind closed doors" with no reference to public views.
• Philosophical or ideological contrarieties.	• Groups oppose the PEN-BOT approach because private profits flow from providing needed public infrastructure to a captive market.
• Resistance to change.	• Fear by some Prince Edward Islanders that the "island way of life" will be lost if the Fixed Link PEN-BOT project proceeds.

Table 8.4 Stakeholder motivational features of processes, with examples from PEN-BOT projects.

Other possible stakeholder-coalescing issues can be identified with an examination of possible project approaches and external influences. This examination should lead to concise definitions of potential strategic issues related to any aspect of the project, including the direct or indirect underlying elements associated with the issues. This should include an examination focused on the previously noted dimensions of the project: socio-political, financial, economic, technological, environmental and organizational aspects,

followed by an identification of possible stakeholders who may react to any facet of any of the issues (Weiner & Brown, 1986).

As stakeholder groups may coalesce around any facet of any issue, it is important for participants on PEN-BOT projects not to overlook the prospect such issues may lead to the emergence of ad-hoc, previously inactive or unknown groups. Surprise scenarios and unanticipated risks can often originate from such acknowledged or unanticipated stakeholder groups motivated by the factors noted in Table 8.3 and Table 8.4.

Consideration of possible issues and stakeholders can be facilitated by an analysis of the project in terms of its strategic components; each of which may present issues which concern stakeholders. As an example of large project influences, Cleland (1986) cites a number of important strategic components associated with a nuclear power project, which may include (1) passive safety; (2) system reliability; (3) licensing procedures; (4) power costs; (5) waste management; (6) financial risk; and (7) public acceptability. Each strategic component generates different issues and thus may affect different stakeholders.

An analysis of a large or PEN-BOT project would reveal a similar number of strategic issues which should be addressed, such as employment creation/displacement; environmental effects; property value impacts; regulatory procedures, etc. The PEI Fixed Link project, as an example, generated significant opposition respecting each of these strategic issues. This resulted, in June 1993, in a temporary and costly halt to the project.

It could therefore be argued that these strategic issues were inadequately addressed or overlooked in the course of the project's risk planning process, and a more rigorous

approach such as that presented by the Framework (such as those related to addressing stakeholders) may have forestalled some issues or diminished the severity of others (such as the unexpected court challenge and the unexpected success of the court challenge).

8.5.2 Identify Potential Stakeholders

The types and number of stakeholders may vary greatly from project to project. To assist with the identification of stakeholders, the following discussions presents a generic checklist of potential stakeholders to assist participants ensure this aspect of the risk planning activities of the Framework is as comprehensive as possible.

An important characteristic of PEN-BOT projects is their feature of a much-greater-than-usual number and diversity of project stakeholders. As well, within the following stakeholder categories, many changes in roles and relationships will evolve over the PEN-BOT phases of the project. The diversity of stakeholder groups, and particularly the diversity within the stakeholder groups themselves should be highlighted. These diversities give rise to a significant potential for uncertainties, conflicts and risks respecting stakeholder objectives, roles, and failure and success criteria. These stakeholder groups may include:

Project executor stakeholders:

Owner: The ultimate owner of the facility, which may or may not be the party advocating its construction. For example, the ultimate owner of the Channel Tunnel will be the

French and British governments; the ultimate owner of the Prince Edward Island Fixed Link will be the Canadian government. As previously noted, even the "government" as an owner will not be a unified, homogeneous body, which in itself presents significant possibilities for conflicts.

Sponsor: The party or parties responsible for the planning, financing, implementation and operation of the project. This may or may not be the owner of the project; it may be a development corporation or other enterprise. In the case of the Channel Project, the project sponsor is "Eurotunnel", an enterprise formed for the express purpose of executing the project.

Proponent: An advocate of the project, which may or may not be the same as the project sponsor. In the case of the Channel Tunnel, the project proponent evolved from a group of British contractors, "CTG", into a binational "CTG/FM" consortium, and ultimately into "Eurotunnel". In the case of the Prince Edward Island Fixed Link project, the original proponent was Public Works Canada and has now evolved into multiple proponents, including Public Works Canada and Straits Crossing Inc. The question associated with who exactly might be considered the "proponent" is illustrated by the fact the respondents to the early 1993 court challenge to stop the project included the federal government, Straits Crossing Inc. as well as the governments of Prince Edward Island and New Brunswick.

Project financing stakeholders:

Financier: The group or consortium providing credit financing for the project, often a large group of banks.

Guarantor: The agency, usually government, which provides loan or credit guarantees to the financiers providing project funding. Government may also be involved in the financing. While no government guarantees were provided for the Channel Tunnel project, in the case of the Prince Edward Island Fixed Link project it has been revealed that the Canadian government will provide unlimited guarantees for overruns and defaults (Cameron, 1993).

Investor: The group of agencies or individuals providing equity financing of the project, e.g. buying shares or bonds.

Government and quasi-government stakeholders:

Regulators: A wide range of government and other agencies which have some regulatory function, either directly or indirectly, with respect to the project. This could include environmental approvals, land use approvals, etc. The regulatory process may further expose the project to a significant degree of public scrutiny and opportunity for intervention (e.g. through a referendum or public hearings) and opposition.

Legislators: In addition to regulatory approvals, a project may require special legislation, governmental agreements, or international treaties, which exposes it to political lobbying

and posturing. In the case of the Channel Tunnel project, a binational treaty was required in addition to legislative approvals from both British and French elected legislators.

Consultant stakeholders:

Project Manager: A group or agency responsible for the overall management and implementation of the project. They may be engaged at different stages of the process, or may change as the project phases evolve.

Specialist Advisors: A group or agency which may be engaged by another stakeholder, to provide independent advice, project oversight or supervision, or other related functions. In the case of the Prince Edward Island project, a number of independent advisors and consultants have been engaged to give advice to the government respecting, for example, the project's economic feasibility or the potential environmental impacts of a generic crossing. In the case of the Channel project, a group of advisors—the *Maitre d'Oeuvre*—are to provide independent advice to the governments, financiers, and investors, and act as arbitrators between the project sponsor and the project constructor stakeholders.

Designer: The consultant responsible for the design of the project, and may include a wide range of sub-consultants and specialist designers. Depending upon the structure of the project, the project sponsor may be called upon to assume significant design risks.

Construction Manager: The group or consulting agency responsible for the management of the execution phase of the project. This party may or may not be the Project Manager, and may or may not directly engage the designers and/or contractors.

Construction Stakeholders:

Contractor: May be a consortium assembled solely for the purpose of the project's construction who may or may not have worked together previously. A variety of legal and corporate structures are possible, as are contractual arrangements. The novelty of relationships and the various perspectives and roles can lead to significant conflicts.

Labour: Organized labour directly and indirectly involved on the project clearly plays a major role. Special agreements may be sought, or the project may be used to resolve issues or force concessions on unrelated matters.

Suppliers: Direct and indirect suppliers and manufacturers of supplies and materials required for the project. They in themselves may attempt to lobby and influence the design or alternatives selected; for example, suppliers of a particular material. On a major project, their nationality, capacity and capabilities may play a significant role in the successful execution of the project.

Public Interest Group stakeholders:

Advocates: May include political or other advocates of the project; parties which may or may not have a vested interest, directly or indirectly, in the project; or groups which may or may not be directly or indirectly impacted by the project.

Opponents: May include political or other opponents of the project, which may or may not be considered an end user. They may include industry segments adversely affected by the project, directly or indirectly, or a potential competitor of the project, including competing proposals. They may include residents impacted by the project. Opponents may include a range of ad hoc single-issue assemblages in addition to more formal organizations. Their vocalism, zealotry and extent of wide-ranging support will also vary. In the case of the Prince Edward Island project, a loose coalition of fishermen, ferry workers and other residents formed *"Friends of the Island"* in opposition to the project. The group launched the legal challenge which temporarily halted the project in March, 1993.

End Users: May include customers or end users of a facility, and may include various factions and interest groups. Furthermore, they may advocate positions, and thus influence the project in the early phases of the project.

8.5.3 Assess Potential Stakeholder Missions, Goals and Objectives

An understanding of possible stakeholder reactions, missions, goals and objectives is the next activity, as suggested by the Framework. Often this understanding can flow from an

understanding of stakeholder strengths and weaknesses. For example, Cleland (1986, 1990) suggested stakeholder (both support and opposition group) strengths may emanate from the availability and effective use of resources; political alliances; public support; quality of strategies and dedication of members. Conversely, stakeholder weaknesses may originate from the absence of such factors such as a lack of political support; disorganization; lack of coherent strategy; uncommitted, scattered membership; and the unproductive use of resources.

To assist with this process and to build upon the identification of possible issues and potential stakeholders, it is suggested that project participants should gather information respecting the missions and their 'stake' in the project; objectives; strengths and weaknesses; and potential strategy and behaviour of all stakeholders. Some missions, as previously noted, will be adversarial or directly related to the project; others, supportive, or only indirectly related to the project.

Techniques such as market research, polling, focus groups and other practices may be helpful to identify issues and assess their importance to various stakeholders. Participants must adopt very broad perspectives so as to identify in a useful manner, the concerns and fears, real or perceived, of stakeholders in order to then develop strategies (through project approaches, execution plans, participant alliances, etc.) which can address such issues. These processes can also be utilized to assess the perceptions of project benefits and advantages, and likewise identify strategies to maximize or enhance perceived benefits.

Gathering and analyzing information respecting stakeholders (particularly those which are potential project opponents or competitors) has the potential to become an extremely sensitive issue. Any 'intelligence gathering' strategies should focus around issues as opposed to groups. Gathering information on stakeholders can destroy relationships and credibility, and erode support if such knowledge leaks out, which may be inevitable. Some organizations, particularly those operating in a regulatory environment, consider all internal communication and information as 'potentially public' and instruct all participants to govern themselves accordingly.

Identifying potential risks to the project can be facilitated by consideration of the possible stakeholder behaviors and reactions during each phase of the project. As risks can originate from potential stakeholder-project conflicts, understanding these possible stakeholder reactions is an important facet of risk planning. These conflicts can be a not uncommon source of surprise scenarios.

In order to understand stakeholder behaviour, it should be recognized it can be expected to exhibit varying form and content depending upon the phase of the project. For example, in many ways, the most difficult challenges in terms of understanding and addressing stakeholder behaviour will be during the Propose phase, whereby opposition may come from competing proponents, and a wide variety of other stakeholders. The proponents must sell their specific proposal competing against opposition to the project in general as well as opposition from competitors, who will be attempting to convince the public and governments by deriding competitors' proposals without criticizing the concept

of the project or the processes and thereby adding credence to the positions of potential opposition groups.

Participants should adopt a strategic view of the project's phases, characteristics and the processes necessary to move the project successfully into the next phase. They should consider both the stakeholders' potential 'medium' and their possible 'message' during each phase. For example, during the Propose phase, certain stakeholders may concentrate on maximizing media attention. Their past behaviour may yield clues on their possible approaches and techniques. Participants must understand beforehand what the potential issues may be *from the perspective of the stakeholders* (related both to the project and processes), which will permit conjecture on what reactions and behaviour to expect.

For example, proponents should, prior to a public hearing on any facet of the project, undertake the effort necessary to identify how groups may respond; what issues they may raise; what weaknesses of the project, processes or participants they may attempt to criticize or exploit; and what perspectives they are adopting when they view the project.

In order to understand these multiple perspectives on the project; participants must be open-minded when assessing how others perceive. They may solicit impartial outside advice to examine the past record and behaviour of stakeholder groups; for example, what steps and actions did environmental groups undertake on previous projects, and what "buttons" did they push with the public. It will likely be very difficult for proponents to adequately envision the perceptions stakeholders will seize upon and react to.

Once a stakeholder's mission, strengths and weaknesses, and possible behaviour are envisioned, project participants can then assess the impact and respond to potential risks, as suggested in following components of the Framework. Guidance for these activities is lacking in the literature; for example, Weiner & Brown (1986) offered little advice once stakeholders are identified and their importance gauged. They suggested the rest of the stakeholder management process depends upon the project participants' skills as communicators, arbitrators and problem solvers. Cleland (1986, 1990) suggested developing implementation strategies for dealing with stakeholders is useful as an ongoing activity.

In response to the general lack of advice in the literature, guidance for these activities is offered in Chapter 9. Chapter 10 describes the operationalizing of the Framework through the tool of the Risk Planning Brief.

CHAPTER 9.
THE FRAMEWORK STAGE III:
PROCESSING AND ADJUSTING THE PROJECT'S RISKS

The third cyclical Stage of the Risk Planning Framework, following the definition of the project's environment and the project itself, is the processing and adjusting of the project's risks. Illustrated in Figure 9.1, this Stage includes a number of important components, including the iterative processes of assessing potential conflicts and adjusting approaches as necessary; the designing of detailed project execution plans; and the identification and assessment of risks associated with risk events and scenarios. Each are discussed in the following sections, along with a presentation of some tools and techniques which may be useful to participants.

Subsequent activities, although not the focus of this thesis, are briefly discussed in Section 9.5 of this Chapter.

9.1 ASSESS POTENTIAL CONFLICTS

As previously noted, the risks arising from conflicts on a PEN-BOT project can be significant. They are often difficult to foresee and may be overlooked in favour of what are more readily-defined and are often perceived as greater risks—for example, risks related to the project's technical or financial feasibility.

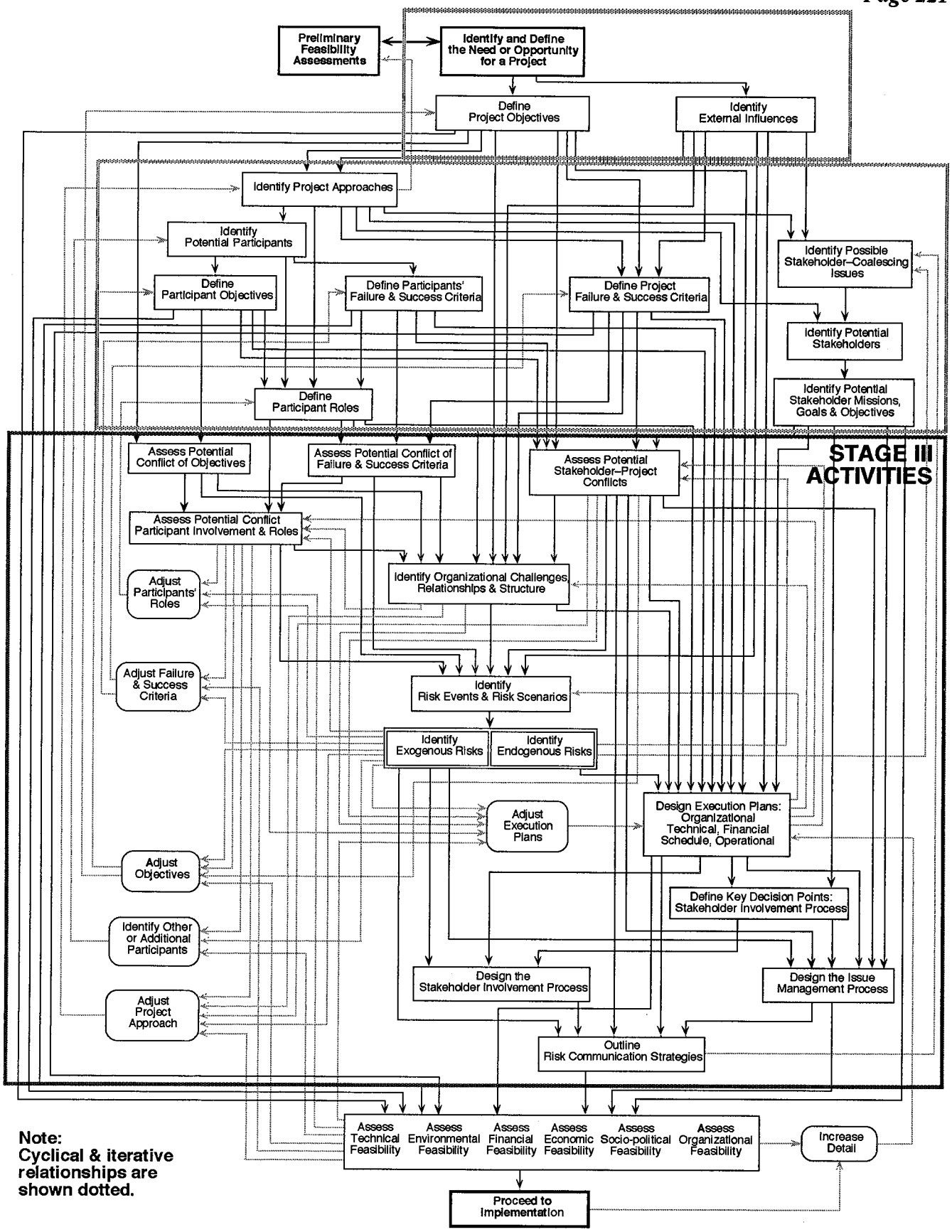

Fig. 9.1 Stage III Activities of the Holistic Risk Planning Framework

Sources of these potential conflicts include:

Amongst participants:

- *conflicting objectives;*
- *conflicting roles;*
- *conflicting failure and success criteria;*
- *inconsistent objectives versus failure and success criteria.*

Between stakeholders and the project and/or participants:

- *conflicting objectives.*

Between stakeholders and the project and/or participants:

- *conflicting failure and success criteria.*

Between stakeholders and the project and/or participants:

- *conflicting roles.*

The Framework can offer a "map" to participants to aid addressing the risks associated with conflicts, and by providing a structured method in which to acknowledge and assess the potential for conflicts. The purpose of the Framework is to alert participants to recognize, as early as possible in the project planning process, the potential risks which may arise from conflicts, so they may subsequently be addressed. It is particularly important to acknowledge and address, on PEN-BOT projects, the risks from these conflicts due to the characteristics of these projects, which tend to be especially sensitive to such risks.

For example, the Framework suggests, through the identified linkages, that participants examine each of the previously defined project and participants' objectives; failure and success criteria; and roles. If these characteristics were defined and organized, in the Risk Planning Brief, in a consistent manner, it would be possible to identify any incongruities

and thus highlight those which suggest a potential for conflict. In particular, roles should be completely defined and complementary; those which are not may be a source of significant conflict.

Conflicts may also flow from incongruities amongst a participant's objectives and failure and success criteria. As noted previously, participant's failure and success criteria can be considered as measurements of attainment of a participant's objectives, and thus should be complementary, yet on a PEN-BOT project this may not always be the case and there may also be conflicts introduced between short and long term objectives and failure and success criteria. For example, the ultimate criteria for success of a contractor participant is financial success; in the long-term, the involvement on the project must result in a positive financial return and strengthen the financial health of the participant. If the participant cannot survive financially then little is gained by achieving other objectives. However, this may conflict with other shorter term objectives and criteria—e.g. participation in the initial stages may be predicated on the expectation of an assumed long-term return; as the project proceeds cost overruns may significantly erode the return (as in the case of the Channel Tunnel project), yet participants continue to justify their involvement based upon a shift of emphasis to other criteria.

Ambiguities can also lead to conflicts between participants or between participants and the project. As previously noted, those respecting objectives, criteria or roles can grow to be sources of significant organizational challenges and thus risks.

The potential for conflicts as revealed through an examination of the key project and participant characteristics in the earlier stages of the Framework (i.e. objectives; failure and success criteria; and roles) may suggest an adjustment in some or all of the characteristics is warranted. The Framework is thus cyclical or iterative: for example, potential conflicts which are uncovered because of inappropriate participant roles suggests this be addressed through an adjustment of roles. Similarly, as illustrated through the iterative links of the Framework, it may be required to adjust project or participant objectives; failure and success criteria; or approaches so as to reduce the potential for conflicts.

Ad hoc assemblages of participants, as is typically the case for PEN-BOT projects, can be particularly prone to conflicts and sensitive to the subsequent risks. The parties may not have had the opportunity to work together previously. Often participants are working in a high-stress, high-pressure competitive environment, which further exacerbates the potential for conflicts. Participants which may be cooperating on a PEN-BOT project may historically be competitors, including on other ongoing projects.

These potential conflicts often are unacknowledged until they cause major problems. For example, on the 'Chunnel' project, extreme conflicts over participant roles and objectives emerged in late 1986, between the concessionaire ('Eurotunnel') and the contractors ('TML') who were also equity investors. These conflicts escalated to serious in-fighting and delays, and necessitated a renegotiation of the construction contracts and a substantial restructuring of the project's organization.

In response, the Framework also recommends that participants examine the proposed project organization, with a similar assessment of the potential for conflicts and risks which may arise out of the organizational structure and relationships. The key characteristics of a PEN-BOT project structure are its flexibility and ability to evolve and accommodate change, particularly as the project evolves through the different phases. The Framework explicitly recognizes that participant and project roles, objectives and failure and success criteria may also change, and thus should be examined and adjusted as necessary.

Roles and objectives of the individual participants may also change, further adding to the potential for conflict and challenges. For example, Sykes (1982); Baker, Murphy & Fisher (1983); Leigland (1987); Hayfield (1986); Murphy (1983); and Kelley & Morris (1981) noted the importance of a flexible, responsive project organization and well-defined roles. Morris (1985) emphasized that unrecognized, unmanaged change is one of the strongest determinants of project failure. Dallavalle (1991) noted the importance, and difficulty, in recognizing and managing change in project organizations. As previously noted, because these are difficult to quantify, participant and project characteristics should not be a reason for participants to downplay the potential for significant risks to originate from these characteristics.

9.2 IDENTIFY RISK EVENTS AND SCENARIOS

The identification of risks related to a project is rarely an easy task; were it so, the need for the Framework would be greatly reduced. For example, Hayes, Perry, Thompson &

Willmer (1986) noted risk is rarely considered in a consistent and logical manner, and there may be considerable benefits from the discipline in the process of risk identification itself. Wideman (1986) noted the responsibility for identifying and assessing risks on a project is often so pervasive it is rarely given central authority. Perry & Hayes (1985a, 1985b); Morris & Hough (1987) and Hayfield (1986) also described the importance of adequate risk identification and assessment.

The Framework can help participants through the previously described, systematic delineation of the project parameters such as objectives, participant roles, project approach, external influences, conflicts, and organizational challenges, which will enable participants to systematically and comprehensively identify:

- *risk events and risk scenarios;*
- *risks endogenous to the project (i.e. those originating from within the project);*
- *risks exogenous to the project (i.e. those originating external to the project).*

And, in response:

- *design of project execution plans;*
- *design appropriate stakeholder involvement and issue management processes.*

The design of the project's execution plans is typically provided in increasing detail and consists of a number of components, including organizational, financial, technical, scheduling and operational plans. Execution plans are designed in response to identified risks; and risks are identified from consideration of the specifics of execution plans. Thus, risk identification and the design of execution plans, with increasing detail, are interactive and iterative processes.

Many participants will find this component of the Framework particularly challenging. Large and PEN-BOT projects are by their nature, unique, and thus rife with novel risks, which by their definition of novelty can be difficult to identify. A further impediment is participants, when active on a PEN-BOT project are often involved in areas outside their domain of familiarity.

It therefore often becomes a challenge to adequately identify appropriate risks, scenarios and options. Strategies to enhance creativity and foster the flow of ideas therefore become an important part of the risk planning process. 'Creativity' can be considered as the thinking process that helps to generate ideas (Majaro, 1988) and is particularly useful when tackling difficult problems (Kim, 1990). Participants may wish to review VanGundy (1988), who for example, presented 105 techniques to assist in problem definition, and idea generation, evaluation, selection and implementation with respect to addressing ill-structured problems.

Given the inherent long-range characteristics of large and PEN-BOT projects, identifying risks through consideration of scenarios, options and forecasts under conditions of

uncertainty is crucial; therefore the important activities in this stage of the Framework become the identification of risk events and the identification of risk scenarios. If participants have been fastidious with respect to the components of the previous two stages of the Framework, many risk events and scenarios will have been identified. The following sections highlight a number of approaches and techniques, from the literature and elsewhere, which may further assist participants with these tasks. This is not intended to provide an exhaustive compendium of techniques, but rather, illustrate the range of tools which may be appropriate and which could serve as a useful starting point for project participants. Once again, it is recommended that the outputs of the processes as defined by the Framework be organized through the Risk Planning Brief, as discussed in Chapter 10.

Once risks are defined, participants have traditionally approached the management of risks through such strategies as avoidance, prevention, retention, transfer and insurance (Al-Bahar and Crandall (1990)). As illustrated by the Framework, risk management is approached not as a separate activity, but is embodied throughout, in such essential activities as:

- *adjustment of roles;*
- *adjustment of objectives;*
- *adjustment of failure and success criteria;*
- *adjustment of project approaches;*

- *design of execution plans;*
- *adjustment of execution plans;*
- *design and implementation of the issue management process;*
- *design and implementation of the stakeholder involvement process.*

It is highlighted that risk management, within the context of large and PEN-BOT projects is thereby approached more broadly, incorporating the design and implementation of risk minimization, management and mitigation strategies in each of these previously noted activities and indeed throughout the previously discussed two Stages of the Framework.

9.2.1 Checklist Techniques for Identifying Risks

Participants can be aided with respect to the risk identification aspects of the Framework by consideration of the source of the risk. It is suggested that participants consider 'endogenous risks' as those originating from within the project, which are often considerable but sometimes overlooked (e.g. design errors, organizational conflict, managerial problems, etc.); and 'exogenous risks' as those originated from sources external to the project which are often difficult or impossible to control (e.g. political turmoil, inflation, global risks, and other 'state of the world' influences). While the exogenous risk event itself may not be controllable, the impact upon the project certainly may be in terms of adjusting approaches or execution plans.

Participants may consider a number of techniques to aid in the process of identifying these risks. For example, as previously noted in Section 1.7.2, Perry & Hayes (1985a); Wideman (1986), and Erikson & O'Connor (1979) suggest a checklist approach, and provide lists of possible risks related to construction projects. Kangari & Boyer (1987); Kangari (1988) and Kangari & Riggs (1989) described an expert system to assist participants with risk identification and assessment; as do Ashley & Perng (1987) and Ashley, Stokes & Perng (1988).

In addition to the broad categorization of the origin of risks as endogenous and exogenous, it is recommended that the classification of risks be approached utilizing the major dimensions of the project, as previously discussed.

Others have suggested a categorization of the types of risks, including Wideman (1986); Perry & Hayes (1985a); Perry & Hayes, 1985b; and Al-Bahar & Crandall (1990), however, no single categorization proposed in the literature is all-encompassing. It is felt the Framework approach can provide more comprehensive guidance to participants, although it is recognized no technique can provide an exhaustive enumeration of all possible risks related to the project, however, their value can be viewed in terms of stimulating the process of identifying project-specific risks. Participants can build upon the foregoing components of the Framework supplemented by the checklist or other approaches as a method in which to assist in organizing of and in the presentation and summary in the Risk Planning Brief.

9.2.2 Consideration of Scenarios

Checklists, as noted in the previous Section, can be a valuable tool if used by participants to stimulate their thinking about potential project risks. Although each checklist approaches the categorization of risks slightly differently, such diversity can be used to advantage by adopting multiple viewpoints on how risks may originate.

However, in many cases specific risk events pertaining to a PEN-BOT project cannot be envisioned or all possible cause–and–effect linkages cannot be assessed. This may be a major problem in that it may lead to the incomplete acknowledgment or recognition of the magnitude of risk events or those which inadvertently escape identification.

A technique which may be particularly helpful in assisting participants identify risks and linkages for the Risk Planning Brief is *scenario generation*. In these situations future states of the world are envisioned, from which possible risk events may be identified. Scenario approaches are useful to blend both quantitative and qualitative forecasts and to explore multiple, highly uncertain states of the world. They may include 'situational scenarios', which are 'snapshots' of future situations or states of the world; or 'developmental scenarios', which includes different trains of events leading to situations, which may also include 'contrasted scenarios' which are the purposeful exploration of extreme themes or trends (Godet, 1987).

Large and PEN-BOT projects can particularly benefit from identification of risks through generation of scenarios; for example, Wiig (1982) described the usefulness of utilizing multiple scenarios when planning for uncertainty on projects. Scenario generation may

help respecting the major risk of 'change', which, as previously noted is one of the most difficult to identify. 'Change' can be considered in the sense the entire premise of the project may shift, or major, strategic underlying assumptions and conditions pertaining to the project may change or be subject to discontinuities.

For example, in the Risk Planning Brief, assessing the financial risks pertaining to a transportation infrastructure PEN-BOT project would depend heavily upon future traffic forecasts, which in turn would be related to a wide number of global influences such as the price of oil, economic conditions, travel and leisure behaviour, mode choice, the emergence of alternate technologies, and many others. Forecasting trends for such influences over the operating phase of the project, which may be fifty or more years, is difficult, if not impossible to do in a meaningful way. Some influences belie trends and may introduce discontinuities (e.g. innovation and alternate technologies; political disruptions, etc.; also noted by Godet (1987) as 'crises' and 'technological waves').

PEN-BOT projects, which are planned and constructed in the present, must rely upon revenues and operational characteristics far into the future. In these cases, it is suggested that participants utilize scenarios to identify risk events which may emerge and to estimate the potential consequences on the project, although probabilities associated with the scenario and events may be very difficult to reliably assign and the scenarios considered may not represent the entire range of possible futures. Participants may wish to consider a number of techniques described by Godet (1987), many of which could be useful within the context of large and PEN-BOT projects.

Often future scenarios (i.e., 'states of the world'), which can combine the occurrence or non-occurrence of a number of events affecting the project are of interest in risk planning. Scenarios are potentially useful as they allow the impact upon the project of a wide range of qualitative events, perhaps in combination with quantitative measures, to be considered. Schwartz (1991) stressed the purpose of generating scenarios is not to attempt to produce an accurate picture of the future, but rather, to make better decisions about the future. Schwartz (1991) also noted how important it is to discard mind-sets, prejudices and assumptions which may prevent participants from seeing the 'right' future.

Merist (1989) noted that when planning in a 'turbulent environment' (i.e. one where the complexity of the environment grows and the rate of change increases) over long time ranges, the possibility for unexpected events increases. Noting the differences between forecasts and scenarios, as summarized in Table 9.2, Merist (1989) recommended the use of multiple scenarios rather than forecasts, whereby mutually exclusive, diverse futures are generated, each portraying essentially different future trends, events and environments. Merist (1989) noted scenarios need not have probabilities of occurrence attached to them, are likely mostly qualitative in nature, and are a useful 'thinking' tool for expanding one's awareness about the future. Often efforts are best spent on developing surprise scenarios ('threat' or 'opportunity' scenarios, as opposed to 'base-case', no-surprise futures), focusing on possible changes and discontinuities. Because of these characteristics, the approach of considering scenarios is recommended as a valuable tool for participants on large and PEN-BOT projects.

Forecasts:	*Scenarios:*
• Statistical summary of expert opinion.	• Mostly verbal descriptions of archetypal futures.
• Sources of uncertainty not specified.	• Focus on key variables and relationships.
• Efficient but impoverished summary of expertise.	• Information–rich but inefficient summary.
• Directly usable as an input to the decision process.	• Require further judgments and translation.
• Can be tested for accuracy (in the long term).	• Hard to test: more a thinking tool.
• Assumes it is useful and possible to predict the future.	• Assumes the future cannot be predicted, or it is dangerous to do so.

Table 9.1 Features of forecasts versus scenarios (Merist, 1989).

Nair & Sarin (1979) noted the importance of generating and evaluating scenarios, as a component of strategic planning, and outlined a scenario-generating and strategic planning approach. Chen, Jarboe & Wolfe (1981) described the construction of long-range scenarios, particularly those respecting technology assessment, and noted the generation of long-range (25 years or more) scenarios is challenging.

They noted the five basic attributes which scenarios, as 'snapshots' of the future, should embody, which it is held, provides useful advice to PEN-BOT project participants:

- *an emphasis on covering a wide range of plausible futures and internal consistency within each scenario;*

- *be specific with respect to the technology being assessed (i.e. the project) and include all significant factors which may affect the technology;*
- *combine appropriate intuitive qualitative judgmental aspects and rigorous quantitative aspects;*
- *as basic societal forces, values and institutions generally are slow to change, provide for a common point of departure with a gradual divergence, such that the contrasts between scenarios increase over time;*
- *the basic approach is top-down, such that holistic scenarios are disaggregated into specific variables and the required qualitative and quantitative descriptions.*

It is important to include both qualitative judgment and quantitative analysis to guard against the pitfall of leaving out unquantifiable but significant variables in the scenario. Schwartz (1991) also described eight general steps in developing scenarios.

Arbel & Tong (1982) noted options generation is an extremely important component of the decision-making task, and suggested a number of issues should be recognized when generating options, including the importance of goals and objectives; the value of structuring the major decision influences; the impact of questioning and framing; the ability to highlight critical events; and the essential nature of iteration and feedback.

Volkema (1983) examined the difficulties in formulating planning problems, and noted problem formulation often occurs in the early phases of planning and design, and potentially affects the direction of all succeeding stages, for a strong relationship exists between the manner in which a problem is represented and the ideas or solutions the representation can produce. Volkema (1983) suggested often too little time and energy are devoted to the formulation process of the problem, sometimes resulting in solving a sub-optimal or the 'wrong' problem.

The lesson for project participants is that it is a worthwhile planning practice to take the time to formulate problems, options and scenarios properly and expansively. The atmosphere of the organization is an important determinant in order to best generate the options. Nagel (1984), for example, suggested the organizational climate for strategic decision making is one of the most important factors in determining the effectiveness of strategic management, noting there must be scope for alternatives and an organization with 'strategically capable' managers.

Millett (1988) also suggested the use of scenarios is particularly appropriate for longer time frames (5 to 20 years) in highly complex situations involving unquantifiable, highly uncertain situations. Millett (1988) noted a number of valuable insights are possible from scenarios. Although they have been proposed from the perspective of a business enterprise, because of the nature of large or PEN-BOT projects, most of the insights have parallel project related applications.

First, scenarios can be useful as a tool to evaluate future demand, and thus serve as the focus for contingency plans to meet possible variations in demand. Second, they can be utilized to evaluate whether market conditions are becoming more or less favourable for existing products or activities and thus again acting as the catalyst for strategic planning and third, to examine the scenarios for opportunities for new products or activities. Fourth, they can examine possible changes in modes of generating products or services in light of new and emerging technologies; fifth, they allow insights relating to competitors and competitive strengths and weaknesses; and sixth, they can explore the amount of uncertainty the enterprise may face in the future and the degree of flexibility required when choosing strategies (Millett, 1988).

As large and PEN-BOT projects can be considered as major business enterprises themselves, scenarios can provide valuable insights into future demand, new opportunities, the impact of technological change, competitive forces, and degree of future uncertainty the project may face. Millett (1988) suggested the process of generating the scenarios themselves can be valuable for the strategic and planning process, and they can stimulate creativity about the future by allowing consideration of low-probability outcomes and disruptive events.

Huss & Honton (1987), Adelman (1987) and Keller & Ho (1988) discussed a number of approaches for generating options and scenarios. Jain (1984) noted the usefulness of, and described the application of 'environmental scanning' as a technique to generate scenarios respecting the social, economic, political and technological environment the enterprise

may be faced with. Allaire & Firsirotu (1989) highlighted the necessity and suggested approaches to planning for uncertain environments. Tushman & Anderson (1986) discussed the effect technological change and discontinuities (i.e., evolutionary change in a technology or process until marked by a major advance or significant innovation) can have on the organizational environment.

As previously noted, participants may find some of the most valuable uses of the forgoing tools and techniques will be for their use in stimulating creativity and to ensure the range of scenarios and outcomes considered is appropriately broad. They can be utilized at a number of stages in the Framework, and although no one technique will be universally applicable, participants can regard the forgoing discussion of tools as an appropriate start.

9.2.3 The Consideration of Rare Events, Escalations and Surprise Scenarios

One lesson the previous discussion of tools and techniques emphasizes is that PEN-BOT participants, faced with long time horizons, must examine—through scenarios and other approaches—the potential impact technological change and discontinuities may have on the project. The Risk Planning Brief also provides an organizational and informational technique so as to provide a common vision to all participants of the project risks so identified.

Other difficult risks to identify, which nevertheless should be described and addressed in the Risk Planning Brief include those which may arise from rare events, escalations and surprise scenarios.

'Rare events' can be considered as events which may impact the project but which, up to the time of the undertaking, may not have occurred or occur very rarely. As large and PEN-BOT projects are, by definition, unique undertakings, many of the risks which participants must consider will in fact, be rare events.

The Framework attempts to provide some assistance to participants in the identification of these events by means of the staged and holistic approach to risk planning, with an emphasis on those aspects of project risk planning which might normally be overlooked.

If a rare event can be envisioned by participants as possible but no judgment can be made with respect to its likelihood, the process itself, directed at consideration of the scenario and associated mitigation plans and contingencies, may be enough to deem the risk acceptable. If the risk event can not be acceptably defined, attempts should be made to decompose the situation into more readily assessable events for which it may then be possible to estimate likelihoods or design suitable contingency plans.

The phenomena of *'escalation'* can be considered as the tendency to become overly committed to escalating situations or to persist beyond an economically rational point (Ross & Staw, 1986). This is manifested through the difficulty in ignoring 'sunk costs', which in rational decision making should be abandoned and decisions made based upon future possibilities and probabilities (Dawes, 1988). Participants on large and PEN-BOT projects, it is held, must be particularly sensitive and wary against succumbing to escalation.

Escalation in projects can be induced, and participant behavior can be affected, by the manner in which the project is economically structured; psychological determinants, e.g. degree of commitment and self-justification, persistence of beliefs and other information-processing biases; social determinants, e.g. loss of 'face' or credibility; and structural determinants of the project, such as organizational embeddedness, momentum and political commitments (Ross & Staw, 1986).

Project participants must also remain particularly vigilant, in the environment of large and PEN-BOT projects, against the escalation of events into *'disasters'*. Turner (1976) highlighted how rigidities in institutional beliefs, decoy distractions, multiple information-handling difficulties, a tendency to minimize emergent dangers, and other phenomena can contribute to a lack of foresight, allowing undesirable events to escalate into disasters. Events may not be noticed or misunderstood because of faulty assumptions, difficulties in handling information, an evolving environment, or a reluctance to fear the worst outcome. Mitroff, Pauchant & Shrivastava (1988) noted that organizational impediments to important warning signals; a lack of preventative and preparatory mechanisms and no tested, in–place damage limitation and recovery system, are factors which are strongly conducive to fostering a disaster from which the organization may have difficulty recovering.

PEN-BOT projects can also be subject to *'surprise scenarios'*, which are those events which may unexpectedly impact upon the project in a significant manner. Surprise scenarios may also include *'inconceivable events'*, which are those surprises which are

generally rare, difficult to predict, highly uncertain, and within the context of large projects, may lead to catastrophic outcomes. Ostberg (1984) observed that their inconceivable nature lies not in the low probability of occurrence, but rather, in that such events seem to be classified in the mind of the believers to be deterministically impossible. This is a key characteristics vis-à-vis participants on PEN-BOT projects.

Mitroff, Pauchant & Shrivastava (1988) discussed 'crises' as surprise scenarios, described in terms of types, causes and sources (i.e. technical or economic; and people, social or organizational causes, external or internal to the organization; e.g. faulty organizational controls, unanticipated or unanalyzed environmental conditions, undetected defects) and preventative organizational actions. They noted many crises are dealt with reactively rather than proactively, and suggested that the more potential crises an organization can envision and prepare for, the more successfully they will recover from any that do strike, for the planning process itself is beneficial. 'Political risks' often give rise to surprise scenarios and crises, due in some part to difficulties and inadequacies in identifying or planning for such risks (e.g. Siegwart, Caytas & Mahari (1989); Ting (1988)).

Ostberg (1984) noted that inconceivable events are normally 'soft' and are often rather fuzzy and considered to be only of marginal importance in the first approximation, and it is difficult to account for such events in models. Often, human error may play a major role in the event. Ostberg (1984) suggested a holistic, open-ended, skeptical environment; one which puts very little restrictions on the thinking and formulating of ideas about the phenomena in question, stimulating an examination of such potential events, even if such

examinations do nothing other than increase familiarity and enhance awareness. The modelling system must be open, so that inconceivable events are not screened or shut off.

Sampson & Smith (1982) noted the lack of historical statistical data respecting catastrophic events makes it difficult, if not impossible to use a conventional analysis to assess the likelihood of the event's occurrence. Fairley (1981) described potential problems associated with the assessment of catastrophic risks, such as the possibility of errors due to model assumptions (e.g. an 'aging' or deterministic process may lead to very different results than a 'purely random' process) when interpreting a record of zero occurrences; selectivity biases associated with a short experience horizon; and possible counting biases. Zero occurrences are cited as 'cold comfort' by providing only vague prior information, as data can neither establish a very small probability or rule out catastrophic events.

Freudenburg (1988) noted low-probability estimates are extremely vulnerable to hidden flaws, and demonstrated how unidentified potential risk factors (and overconfident assessment of other risks) may readily dominate the ultimate assumed probabilities, leading to an actual risk much greater than calculated. Fairley, Meyer & Chernick (1986) also described a number of problems intrinsic to risks respecting low-probability, high-consequence events, including the sensitivity to adversarial bias; the potential for appreciable cost-of-error and other value-related biases, and the inherent difficulty in quantifying catastrophic risks of complex new technologies.

When considering risks to projects from low probability, high consequence events, participants may wish to address several questions. At what small probability does the event become an acceptable *de minimis* (i.e. insignificant) risk? For example, Spangler (1987) examined the question in the context of catastrophic technological risks and policy issues. The degree of acceptable risk, balanced against potential benefits, may vary from project to project and be greater than *de minimis* risk.

Secondly, the related question is at what small non-zero probability does the participant or stakeholder, within the context of project risk planning, consider essentially equivalent to zero? There is little counsel in the literature with respect to this issue. A related issue is the difficulty participants and stakeholders have when contemplating very small probabilities.

By way of general guidance, Apostolakis (1990) suggested failure probabilities less than 10^{-5} are often regarded with skepticism (except if supported by strong statistical evidence); human error probabilities less than 5×10^{-5} are highly unlikely; annual frequencies less than 2.5×10^{-10} could generally be considered meaningless, and estimating geological event frequencies of less than 10^{-11} annually are virtually impossible, considering the age of the earth.

Nevertheless, sometimes the mere existence on a PEN-BOT project of a rare or inconceivable event may be significant and must therefore be acknowledged and addressed. There are instances where the project may not go ahead, if the possible consequences, however remote, are considered too great. For example, the Federal

Environmental Assessment Review Office (1990) recommended against proceeding with the Northumberland Strait Crossing Project, partially on the basis that the potential adverse impact of the project (not the probability of the impact) upon the coastal micro–climate and marine ecosystem was too great. Starr (1987) cited an instance of a court challenge of a novel project where the project opponents sought proof that the hypothetical worst case scenario would not happen. Providing absolute proof in such cases is a difficult if not impossible undertaking given normal technical and scientific uncertainties.

In summary, large and PEN-BOT projects, by virtue of their novelty, complexity and longevity, are more susceptible to phenomena such as escalation, disasters and surprise scenarios, than traditional projects and approaches. It is useful to consider if it is possible to identify any warning signs for surprise scenarios. Certainly one may be the lack, in the risk planning process of the projects, of creativity-stimulating processes and attitudes, the antithesis of those suggested by Ostberg (1984), i.e. a holistic, open-ended, skeptical environment—and as fostered by the Framework.

9.3 CHALLENGES IN ADDRESSING RISKS

Participants will inevitably face a number of challenges when assessing, evaluating and communicating information about project risks; amongst participants and amongst stakeholders. Often PEN-BOT projects are subject to complex regulatory processes which tend to focus upon risks, definitions of risks and the acceptability of risks. Participants are also very diverse on PEN-BOT projects, and in these instances it is

particularly important for participants to be aware of their range of interpretations of risks between, for example, regulators, financiers, stakeholder opponents and enthusiastic proponents.

Discussions of risks will also be a major part of the issue management process and affect the design of the stakeholder involvement process. The degree of involvement of the stakeholders, and at what stage, will depend upon stakeholder and project objectives and potential for conflict, and could range from one-way communication (i.e. notification) to comprehensive consultation and approval mechanisms; with the caveat that a considerable number of projects have been derailed by ineffectual stakeholder involvement and inadequate issue management processes, which has allowed opposition to ferment and gain substantial momentum.

Issue management can be helped by the enumeration and linking, in the Risk Planning Brief, of identified risks to stakeholder perspectives, objectives, and roles, suggesting potential conflicts and issues which may arise and thus must be addressed through a proactive, rather than a reactive response. In this way, the Risk Planning Brief can serve as a tool to assist in the formulation of an issue management and risk communication strategy by revealing what risks and issues are potentially of most concern with which stakeholder groups.

The following sections outline some of these challenges participants will be faced with, when defining risks, describing them in the Risk Planning Brief, as well as presenting to or discussing risks with the public and regulatory bodies.

9.3.1 Expressing Probabilities

When discussing risk, failure and success criteria, and other important project characteristics, project participants often utilize linguistic descriptors of probabilities, potentially introducing a great deal of fuzziness. For example, Lichtenstein & Newman (1967) described the scaling of over forty probability phrases, revealing the overlap and wide range of phrase interpretations. Beyth-Marom (1982) also noted considerable disagreement in the interpretation of most verbal probability descriptors, and suggested communication problems may be common from the usage of such ambiguous terms, for example, when associated with forecasts. Even the use of terms in a specific context did not decrease the range of interpretation. Beyth-Marom (1982) felt the use of some specific terms should be avoided, because they are descriptors which indicate the probability is not zero but provide little information on how probable it actually may be (e.g 'not inevitable'), or they may be words which may confuse probability and desirability (e.g. 'good chance'). The use of a categorized scale was recommended to increase clarity and consistency.

As an illustration of the wide range of interpretations of common verbal probability descriptors that participants employ, Figure 9.2 combines the results of the above-noted work. The descriptors presented in the figure are often employed by a variety of participants when communicating about a project's risk or when assessing and evaluating events which may impact on the project.

The purpose of presenting Figure 9.2 is to emphasize the importance of avoiding ambiguous descriptors; the difficulty in interpreting and translating verbal descriptors into subjective evaluations of probability and, if such descriptors cannot be avoided, in choosing consistent descriptors. For example, the descriptors 'possible' and 'uncertain' describe virtually the same probability; and others, such as 'poor chance', are associated with a wide range of probabilities.

Budescu & Wallsten (1985) described similar results and also reported while variation amongst individuals is appreciable, individual assessments and phrase rankings appear relatively stable over time. Winterfeldt & Edwards (1986) noted verbal descriptors of probability are appealing because of their vagueness, as they inherently transmit uncertainty. Brun & Teigen (1988) noted, however, that most people are not aware of the inherent ambiguity of the terms and may underestimate the degree to which individuals vary in their interpretation of such terms.

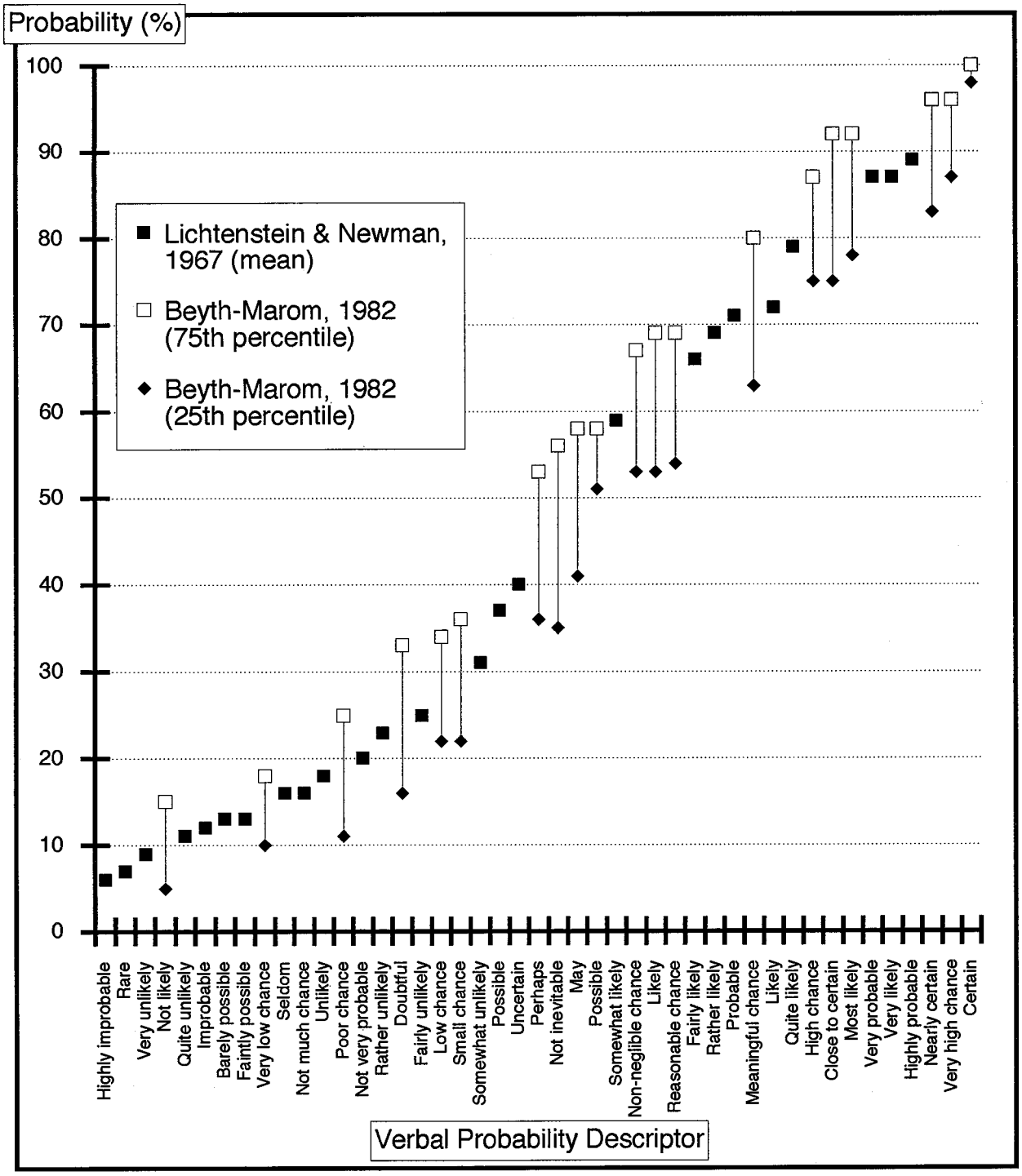

Fig 9.2 Numerical Scaling of Verbal Probability Descriptors

Based upon evidence from the literature, it is clear project participants should make considerable efforts to ensure the use of consistent terms when describing probabilities, frequencies, forecasts and risks. Linguistic descriptors may appear, on the surface, as an attractive means to transmit uncertainty, however, the participant reading or interpreting the linguistic term can inherently add a further bias based upon the strength of their own beliefs. This, in turn, can introduce a significant source of conflict into the project.

It is recommended, therefore, that participants adopt a uniform and unambiguous vocabulary related to descriptions of probability and risks related to the project or employ, whenever possible, appropriate quantitative assessments. Any vocabulary should be concise and readily understood.

It is recognized in some instances this may be a difficult task, given the multi-national and therefore multi-lingual makeup of many projects, however this emphasizes the importance of this task. This vocabulary could be developed as a component of the risk communication strategy and included in the Risk Planning Brief.

9.3.2 Subjective Judgments

Inevitably, when project participants are analyzing and assessing risks, subjective judgments about probabilities, scenarios, and forecasts will be required. Often experts are consulted about these judgments, but they invariably disagree. There are a number of possible strategies for dealing with such disagreements, including statistical averaging of forecasts; face–to–face discussions until consensus is reached; the Delphi procedure

(repeated rounds of individual estimation followed by anonymous statistical feedback); and the estimate–talk–estimate procedure (Fischer, 1981 and Morgan & Henrion, 1990). Mahmoud (1984) described a number of quantitative and qualitative forecasting techniques in terms of accuracy. He noted simple techniques often work as well as sophisticated approaches, and combining techniques improves accuracy. Winkler (1986), Clemen (1986), French (1986) and Morris (1986a) suggested approaches to expert calibration, judgment aggregation and resolution. Bunn (1988) surveyed techniques for combining expert forecasts, and identified limitations to such approaches.

Berenstein, Kanal & Lavine (1986) discussed the difficulties in aggregating expert judgments into a probability distribution and suggested consensus rules. Chatterjee & Chatterjee (1987); Gupta & Wilton (1987); Cooke (1988) and Cooke, Mendel & Thijs (1988) presented variations and extensions to methods for combining expert opinions.

Apostolakis (1986) noted the inappropriate use of judgment in risk analysis may lead to the formulation of biased probability distributions and other potential errors. Parry (1986) outlined the difficulties in using judgment to represent uncertainty in risk analyses. Hofer (1986) noted the importance of surveying expert opinion if including subjective judgments in analyses and discussed sources of bias. Reaven (1987), however, argued that pooling the opinions of experts will be no more successful than selecting the judgment of a randomly chosen expert. Booker & Meyer (1988) noted potential subtle correlation problems may underlie multiple expert judgments. Berman (1988) discussed a number of biases and potential problems influencing expert judgments in the form of 'personal

opinion probabilities'. Mullin (1989) suggested techniques for expert knowledge elicitation. Keeney & Winterfeldt (1988, 1989) discussed how expert judgments can be improved and used in a more effective manner.

The lessons to project participants are there is considerable advice and guidance available in the literature respecting the use of subjective judgments in activities as suggested by the Framework. No one approach or technique will universally be appropriate for PEN-BOT projects, but a combination of techniques is likely best.

When using sources of expert subjective judgments, the elicitation method must be carefully chosen to minimize introduced biases. Experts which have an interest, either directly or indirectly, should be utilized with caution, for they may introduce serious bias into their judgments (as previously noted in Section 5.9 respecting bias in cost estimating). Techniques which stimulate creative thinking and gather multiple perspectives on the judgment will likely be more suitable for large and PEN-BOT projects.

9.3.3 Risk Biases

Participants should also be cognizant that many aspects of risk assessment and perception respecting large and PEN-BOT projects is subject to bias and other judgmental influences; factors which induce selective processing of information (Evans, 1989). This section highlights these biases based upon a considerable amount of work, as reported in the literature in non-engineering related fields from which participants can draw valuable lessons.

Tversky & Kahneman (1982a) and Slovic, Fischhoff & Lichtenstein (1981, 1982) noted that some of the heuristics (i.e. judgmental and inferential rules) employed when evaluating risks can lead to large, systematic and persistent biases with serious implications for decision making. Chan (1982) discussed biases in relationship to the diagnostic errors they may induce in expert judgment. Jacob, Gaultney & Salvendy (1986) discussed the roles of biases in risk, and suggested biases can have a profound effect on the outcome of decision–making processes. Many of these biases can be important, from the standpoint of large and PEN-BOT projects, when considering risks.

Some of the bias-inducing heuristics described by Tversky & Kahneman (1982a, 1982b); Fischhoff (1982a); Taylor (1982) and Slovic, Fischhoff & Lichtenstein (1981, 1982), include 'availability', whereby the perceived frequency of an event or risk is judged likely or frequent if it is easily imagined or recalled. Thus, the discussion of a low-probability event may, in accordance with the availability heuristic, increase its memorability and imaginability, and hence its perceived riskiness regardless of evidence. Covello (1984b) noted providing information to assure stakeholders about risks, because it heightens imaginability and thus the perceived probability of the event, may actually work at cross-purposes.

On PEN-BOT projects, a great deal of public discussion is typically generated respecting seismic events and seismically-induced catastrophic failures. Little, if any of the discussion is related to the estimated frequency of the event; discussion focuses on the consequences of the event. The more intense the discussion is, the more real the scenarios become in the

public's view, and hence their reluctance to embrace the risks associated with the project grow. Project proponents who wish to be proactive about such scenarios, and for example arrange expert testimony at a public hearing, may be puzzled at the response: concerns over the risks become heightened (as the risk becomes more vivid and imaginable) rather than diminished from expert reassurance.

Availability also leads to the overestimation of the number of deaths from dramatic and sensational causes (e.g. accidents, floods, homicides) with a corresponding underestimation of the number of deaths from unspectacular causes (e.g. diseases, strokes). Similar biases were observed in newspaper coverage (Slovic, Fischhoff & Lichtenstein, 1982). Winterfeldt & Edwards (1986) described the bias as a retrieval and scenario–based availability heuristic, whereby people overassess the probability of easily retrieved events and fail to recognize that is an error.

Milburn (1978) suggested an 'optimism' prediction bias in that positive events such that positive outcomes are seen as increasingly likely in the future, with negative events seen as decreasingly likely further in the future. Svenson (1984) noted events occurring in the future (more than ten years from now) were judged only about one-third as important as if the same event occurred today; people will tend to make riskier decisions the more distant are the negative consequences of those decisions. Boniecki (1980) suggested ten to fifteen years is about the most distant horizon that people considered practical, and planning for longer horizons is unlikely to be endorsed by the public. Project participants, planning for very long horizons, may therefore encounter these potential biasing

phenomena when perceiving or communicating with respect to project risks (Svenson, 1991).

Dawes (1988) outlined biases due to 'vicarious availability' (i.e. generalizations from limited or vicarious experiences) and 'availability to the imagination' (i.e. imagining or generating scenarios or instances). Biases of 'retrospection' are detailed, as current beliefs and feelings influence the recollection of past experiences, and sometimes consequences are viewed as inevitable results of choice, thus a false coherence is created (i.e. what appeared to be 'wisdom' in past decision-making may be reinforced in believing it was wisdom, and what appeared to be 'folly' may be reinforced as such, in the event of, for example, a poor decision process leads to a 'good' or desired outcome). A somewhat similar bias, 'illusory correlation' is described by Tversky & Kahneman (1982a), whereby the frequency with which two events co-occur is significantly overestimated. 'Representativeness', (the potential misjudging of sample size to population relationships) may also lead to biases in the intuitive judgment of probability (Bar-Hillel, 1984).

Evans (1989) described the inferential error of 'confirmation bias', whereby people have a fundamental tendency to seek information consistent with their current beliefs and avoid the collection of potentially falsifying evidence.

Slovic, Fischhoff & Lichtenstein (1982) noted individuals' judgments are also biased by a predilection to view themselves as immune to hazards, as risks look very small from the perspective of each individual's experience ('it won't happen to me phenomena'). Bjrkman (1987) noted the difficulty for individuals to envision and evaluate future events

as compared with events close in time and space to themselves. It was noted the cognitive time continuum is limited, and future events appear increasingly unlikely the further their distance in time, suggesting that the importance of distant low–probability but high–consequence events may be underestimated.

Douglas (1985) described the 'subjective immunity' phenomena, whereby most common dangers tend to be ignored and infrequent, low-probability events downplayed. She noted, however, that if risks are thought to be inflicted by a powerful minority upon a helpless majority, subjective immunity is not invoked and risk perception may be influenced by 'attribution theory'. Non-voluntary assumption of risk may lead to an attribution of responsibility and blame, with a heightening of blame if it is suspected others are benefitting from their assumption of risks (Douglas, 1985). In this manner, attribution theory may explain, in part, periodic bellicose reactions and risk perceptions of stakeholder groups to some facets of large and PEN-BOT projects.

Individuals are also lulled into complacency by 'out of sight, out of mind' heuristics, whereby often the limitations and incompleteness of the available information respecting the event is not appreciated (Slovic, Fischhoff & Lichtenstein, 1982). They also noted people typically have great confidence in their judgments. A key element of this overconfidence was cited as the lack of awareness that an individual's knowledge may be based upon assumptions which quite often can be tenuous. Overconfidence is also displayed in 'hyperprecision', whereby people feel they can estimate values with much greater precision than is actually the case; it is attributed to reliance on anchoring and

adjustment heuristics. Experts are also cited as prone to overconfidence and hyperprecision. For example, Slovic, Fischhoff & Lichtenstein (1982) suggested risks may be commonly underestimated by experts due to a number of phenomena: (1) a failure to consider the ways in which human errors can affect technological systems; (2) overconfidence in current scientific knowledge; (3) a failure to appreciate how technological systems function as a whole; (4) a slowness in detecting chronic, cumulative effects; (5) a failure to anticipate human responses to safety measures; and (6) a failure to anticipate 'common-mode' failures.

Freudenburg (1988) described a number of problems amongst experts which may lead to 'human errors' in the risk estimation process, including a failure to foresee all factors which may introduce errors into estimates (e.g. failure to foresee all possible interactions, the overlooking of the 'non-technical' aspects of technological systems, or oversimplification); overconfidence; or the failure to appreciate the statistical vulnerability of low-probability estimates. Hofer (1986) noted overconfidence can be fostered through the expectations of others, particularly if the admission of uncertainty is confused with incompetence. Countering overconfidence, Hofer (1986) cited possible biases of 'hedging', whereby too great a range of values is given in an attempt to avoid a commitment; and 'influence of consequences', where liability considerations enter the judgment process such than probability distributions are induced to shift towards safer (i.e. involving less liability) values.

The manner in which risks are presented (which is further discussed in a following section) is described as an important influence on risk perception and behaviour (Slovic, Fischhoff & Lichtenstein, 1982; Tversky & Kahneman, 1981). Duchon, Dunegan & Barton (1989) also demonstrated the manner in which information regarding uncertainty was framed influenced decision–makers.

Citing the probability of a facility failure from the perspective of the entire lifetime of a facility as opposed to a daily, monthly or annual failure probability, would likely lead to a different perception of the risk by participants and stakeholders. For example, if a facility is designed for a 100 year life (typical for many PEN-BOT projects), the annual probability of encountering a 'design' earthquake event (one with a return period of 475 years) is 0.21%. However, the probability of encountering at least one design (or greater) earthquake event during the facility lifetime is 19.0%. Thus, when considered from the facility lifetime perspective, the failure risks may be perceived quite differently.

The 'pseudocertainty effect' (or certainty effect) is described by Slovic, Fischhoff & Lichtenstein (1982) and Thaler (1983), whereby risk reduction and risk elimination are viewed differently; outcomes which are merely probable are underweighted in comparison with outcomes which can be obtained with certainty. Thus, it is noted, manipulations of descriptions of protective actions would be possible (e.g. insurance coverage) and have potentially important implications. 'Anchoring' is described as another possible presentation bias, whereby judgments tend to be anchored on initially presented values (Tversky & Kahneman, 1982a; Slovic, Fischhoff & Lichtenstein, 1982 and Winterfeldt &

Edwards, 1986). The most common anchor is cited by Dawes (1988) as the status quo; e.g. changes to existing policies or courses of action are more readily envisioned than innovative new ones.

Winterfeldt & Edwards (1986) also summarized a number of similar 'cognitive illusions', i.e. systematic human errors of judgment, respecting probabilistic reasoning. 'Hindsight' bias is described as the tendency to consistently exaggerate what could have been anticipated in foresight; people believe others should have been able to anticipate events much better than was actually the case (Fischhoff & Beyth, 1975). Such a bias may make it difficult to learn from the past; for example, when evaluating risks (Svenson, 1991). Björkman (1987) described how individuals display the 'illusion of control', whereby they are often over–confident in their degree of control over a situation which involves risk.

Mosleh, Bier & Apostolakis (1988) described two judgmental biases as particularly important: (1) the possibility of systematic overestimation or underestimation, and (2) overconfidence, i.e. estimation of overly-narrow confidence intervals, which is essentially unaffected by the estimator's degree of expertise. They noted a tendency to overestimate extremely small risks and underestimate extremely large risks.

Haley & Stumpf (1989) suggested stress in decision-making processes may induce biases through 'snap judgments' and other intuitive behaviour, and that biases in managers' cognitive trails (linked to personality types) may infiltrate strategic processes, accounting in part for organizational difficulties in adopting to environmental changes. Stallen & Tomas (1984) also discussed the role of stress reactions to risk.

Thaler (1983) described the 'endowment effect', where an individual will demand much more to give something up than to acquire it, a cognitive illusion which can have a significant affect on policy decisions. He suggested that when coupled with the certainty effect, it demonstrates why people are least willing to pay to decrease existing risks and demand large compensation for the introduction of new risks.

Slovic, Fischhoff & Lichtenstein (1982) highlighted that while the public may perceive some risk issues well, their perspective is often very different from that of the experts. They suggested strong fears and resistance to projects and the reassurance of experts, proponents and other participants may be traced to a sensitivity to the potential for catastrophic events, their awareness of possible expert disagreements and uncertainties, and their knowledge of past mistakes and miscalculations. Within the context of large and PEN-BOT projects, stakeholders may lack confidence in the process, thus will lack confidence in the discussion of risk issues.

Clarke (1988b) noted social and political forces can lead to biases in expert judgment and risk assessments, and suggested attention should focus from public bias mechanisms to the biases and distortions of those making decisions regarding risks; the mechanisms through which powerful interests allocated hazards in society; and the influences of political context and social conflict on risk assessments and the risk 'drama'. Renn & Swaton (1984) suggested general sociopolitical attitudes become closely related to risk perception if risk conflicts become polarized and political (e.g. 'environmental consciousness' is closely correlated to perceptions of risk–benefit attitudes respecting new technologies).

Kahneman & Tversky (1982b) and Fischhoff (1982b) described approaches for debiasing and corrective procedures. The choice of an appropriate technique would be based upon the underlying sources of bias; i.e. faulty or misunderstood tasks (e.g. clarify instructions); faulty judges (e.g. train or recalibrate responses); or a mismatch between judges and tasks (e.g. decompose problem).

9.3.4 Understanding Perceptions of Risks

As previously suggested, the wide range of risks faced on large and PEN-BOT projects will be viewed differently by stakeholders and participants. This dichotomy can be the source of some of the least-understood and most frustrating conflicts related to these projects. This section discussed how perspective-specific dimensions of risk become important and can potentially effect how the risk is perceived and judged on large and PEN-BOT projects. For example, Kuyper & Vlek (1984) commented that motivational factors (e.g. degree of interest and involvement with the project) strongly affect the content and structure of risk judgments.

The thirteen tables included as Appendix F provide additional background to the discussion in this and following Sections. Examples from Appendix F have also been included in the following Sections.

Vlek & Stallen (1981) suggested individuals judge activities in accordance with perceived 'riskiness' (conceptualized depending upon the 'size of potential accident' and 'degree of

organized safety'); 'beneficially'; and 'acceptability'. They noted individuals differ in their judgments of risk, benefit and acceptability, so it is difficult to utilize group averages.

Wium (1988) summarized some of the ways in which the public (for example, as a project stakeholder) may perceive project risk differently from project participants, making risk comparisons difficult. Stakeholders generally may perceive risk in an intuitive and impressionistic manner largely influenced by personal experiences, by media accounts, cultural values or other aspects, which may be very different from the perspective of other project participants.

Spangler (1982) highlighted that the gap between public (e.g. project stakeholders) perceptions of risks and the manner in which they are treated by technical experts (e.g. project participants) is appreciable, and widening. Technical experts commonly feel the public 'misperceives' the risks of a project, perhaps due to a lack of information. Krimsky & Plough (1988) notes there are many areas where public risk perceptions are inconsistent with 'objective' information.

A frequent source of this dichotomy is the lack of an explicit recognition of the fundamental difference between value-based and non value-based dimensions of risks. Value-based dimensions may include questions of desirability, tradeoffs of public good, and other judgments respecting the acceptability of the risk. Non value-based dimensions are those related to the technical or quantifiable aspects of the risk. Experts should be able to reach an approximate consensus on the non-value dimensions of risks. An example of value-based risks, on the English Channel tunnel project, were those related to the

environmental and social impact (e.g. loss of employment in other sectors and community impacts) of the project.

Stakeholders commonly blend the two risk dimensions unless explicit attempts are made to differentiate them respecting, for example, discussion agendas. Addressing value-based dimensions is complicated by their temporal and cultural nature; as well, Covello (1984a) noted people may not understand how their preferences translate into policies and they may prefer alternatives which are not realistically obtainable.

Similarly, Krimsky & Plough (1988) considered two competing models respecting the interpretation of risk—'technical' and 'cultural'—and noted the differences in perceptions between the public (e.g. stakeholders) and the experts (e.g. project participants) are based on the alternate definitions and their relative importance.

Regardless of terminology adopted, the blending of value and non-value, or technical and cultural issues can lead to a wide gap between 'actual' versus 'perceived' risks. Perceived risks of the project are those which participants and stakeholders utilize when judging acceptability, and thus can be substantially influenced by value-based dimensions.

Thus, the recognition of the non-value/technical and value/cultural dimensions of risk is particularly important when dealing with issues of risk communication. Krimsky & Plough (1988) summarized factors relevant to the technical and cultural dimensions of risk (as presented in Table F.1 in Appendix F).

There has been considerable attention in the literature to issues of perceived risks, dimensions and acceptability of risks, primarily from the perspective of health and safety risks from technology (e.g. Cole & Withey, 1981; Fischhoff, Slovic & Lichtenstein, 1981; Slovic, Fischhoff & Lichtenstein, 1981, 1982, 1985, 1986; Vlek & Stallen, 1981; Stallen & Tomas, 1984; Johnson & Tversky, 1984; Cvetkovich & Earle, 1985; Hohenemser et al, 1986; Brehmer, 1987). Large and PEN-BOT projects are not immune to these phenomena, so it is important to consider some of these aspects of risk dimensions, perceptions and acceptability.

Debates regarding the risks of a project are often acrimonious and lead to the hardening of positions rather than understandings and compromise. Covello (1984b) summarized six sources of conflict and debate between project participants and stakeholders, respecting risk issues:

1. *Disagreements about data and statistics;*
2. *Disagreements about risk estimates and probabilities;*
3. *Disagreements about assumptions and definitions;*
4. *Disagreements about risk-cost-benefit tradeoffs;*
5. *Disagreements about the distribution of risks, costs, and benefits;*
6. *Disagreements about basic values and ideologies.*

The potential for resolving such conflicts is increased if discussions can be focused, in turn, on each specific type of issue. Covello (1984b) noted that often opponents in the risk debate 'talk past one another', with each focusing on a different issue or aspect of the problem.

Freudenburg (1988) noted it is tempting to assume risk controversies can be diminished simply if experts identify what are the 'real' risks and dismiss public concerns as due to misinformation or irrationality. It may be possible to resolve risk controversies in this fashion if the stakes are low, consensus is high, experience is vast and decisions do not impose burdens on one group for the benefit of others. However, he pointed out the real-versus-perceived risk dichotomy will be greatest for controversies which involve high stakes, low consensus, new technologies, and unequal distribution of burdens and benefits. He suggested that although often overlooked, human and social factors play vital roles in technological systems and risks Rather than being free of inconvenient 'people factors', such systems and risks are often dominated by them. This will very likely be the case on large and PEN-BOT projects.

The judgment of some risks are fairly straightforward. For example, respecting dimensions of financial risk (as measured by return distributions), Cooley (1977) suggested variance was a reasonable risk surrogate, as well as increasing risk associated with negative skewness and higher-order moments.

Fischhoff, Slovic & Lichtenstein (1981) note judging both risks and values (for example, by stakeholders) about technology is difficult and often inconsistent. The judgment of

many risks, by both the public and experts, may be subject to bias (expanded in Slovic, Fischhoff & Lichtenstein, (1981) and in a following section). They recommend the public must be better informed, more open to new evidence and rely less on unsupported judgments. Experts must recognize their own cognitive limitations and be sensitive to the qualitative aspects of risks which may influence the perception of the public.

Hohenemser, Kates & Slovic (1983) proposed a number of variables to act as hazard descriptors and to aid with risk comparisons (presented in Table F.2, Appendix F). Although not all variables would be applicable to large and PEN-BOT projects, when considered as risk dimensions, they can offer some insights into how stakeholders may react to project risks.

Covello (1984b) summarized a number of the most significant factors contributing to the public's perception of risk (presented in Table F.3, Appendix F, which is also included as Table 9.2), and noted there is likely considerable interaction amongst the factors.

Renn & Swaton (1984) summarized three levels of influence on risk perception: (1) perceived expected losses (i.e. estimates of average loss rates per unit time); (2) perceived disaster potential (i.e. estimates of maximum conceivable accident); and (3) qualitative risks characteristics (i.e. circumstances accompanying the risk situation such as voluntariness or possibility of personal control). Another important underlying risk dimension is cited by Krimsky & Plough (1988) as natural events (e.g. a weather disaster, suggesting greater acceptability) versus man-made events (e.g. a bridge failure, suggesting lesser acceptability).

Factor:	**Conditions Associated with Increased Public Concern:**	**Conditions Associated with Decreased Public Concern:**
Severity	• Large number of fatalities or injuries per event.	• Small number of fatalities or injuries per event.
Catastrophic Potential	• Fatalities and injuries grouped in time and space.	• Fatalities and injuries scattered or random in time and space.
Familiarity	• Unfamiliar.	• Familiar.
Understanding	• Mechanisms not understood.	• Mechanisms understood.
Uncertainty	• Risks scientifically unknown or uncertain.	• Risks known to science.
Controllability	• Personally uncontrollable.	• Personally controllable.
Voluntariness of exposure	• Involuntary.	• Voluntary.
Effects on children	• Children specifically at risk.	• Children not specifically at risk.
Effects on future generations	• Risk to future generations.	• No risk to future generations.
Victim identity	• Identifiable victims.	• Statistical victims.
Dread	• Effects dreaded.	• Effects not dreaded.
Trust in institutions	• Lack of trust in institutions responsible.	• Trust in institutions responsible.
Media attention	• Much media attention.	• Little media attention.
Accident history	• Major and minor accidents.	• No major or minor accidents.
Equity	• Inequitable distribution of risks and benefits.	• Equitable distribution of risks and benefits.
Benefits	• Unclear benefits.	• Clear benefits.
Reversibility	• Effects irreversible.	• Effects reversible.
Personal involvement	• Individual personally at risk.	• Individual not personally at risk.
Origin	• Caused by human actions/failures.	• Caused by acts of nature or God.

Table 9.2 Factors involved in the public's perception of risk, (Covello, 1984b); an example from Appendix F.

Benefit-related perspectives exert the greatest influence on a stakeholder's risk perception, e.g. whether they can personally profit, whether benefits will accrue to a majority or only a minority, or whether they are convinced other alternatives are available which may provide the same benefit with less risk (Renn & Swaton, 1984). When considering these benefit-based perspectives, stakeholders may give little consideration to the costs of, for example, providing such other alternatives.

Slovic, Fischhoff & Lichtenstein (1986) noted that 'dread' is the strongest determinant of perceived risk, followed by the degree of 'unknown' and possibly 'number of people at risk'. They observed measures of risk based upon number of fatalities (and variations) are not adequate models, citing the strong societal response to the Three Mile Island nuclear reactor accident, which caused no immediate deaths. They commented attempts to characterize, compare and regulate risks must be sensitive to the broader dimensions of risk which underlies public concerns and, for example, goes beyond 'risk of death' statistics which are commonly cited by experts as risk comparisons.

Hale (1987) defined dimensions of risk to include (1) types of harm (e.g. to persons or property; to physical, mental , social well-being; acute or chronic); (2) range of causal links considered; (3) victims of harm (e.g. named vs. anonymous); (3) control (e.g. chance vs. skill); (4) choice to enter danger (e.g. voluntary vs. involuntary); (5) time remoteness of harm (e.g. immediacy vs. delayed effects); (6) uncertainty versus obviousness (e.g. commonplace vs. unknown); (7) complexity and credibility; and (8) vividness, dreadfulness and severity (e.g. consequences of an incident). He further suggested risk

may be conceptualized into two elements: consequences (i.e. types of harm; dreadfulness and vividness; range of potential future states considered) and probability (i.e. remoteness in time; lack of knowledge and predictability; choice and controllability; combinatorial remoteness (rare events occurring together)).

Clarke (1988a) noted the public may assess (and be most concerned with) the risks of technology in terms of the catastrophic potential, as opposed to experts which may assess risk in other ways. He also suggested that organizations are powerful actors with interests of their own in controversies over risks, and it is important to go beyond individual decision making respecting risk and consider the bounding social and organizational structures.

Stakeholders will also view projects involving 'familiar' technology very differently from projects involving 'unfamiliar' technologies; the classic example being acceptance of coal-fired power generation plants versus nuclear power plants. Some novel aspects of large or PEN-BOT projects may therefore be perceived in a different light by some stakeholders compared with participants. Additionally, Douglas (1985) noted people accept the threat from natural disasters more calmly, with less sense of injustice and less desire for retribution than they do from man-made disasters. Thus, the threat from a large project may be expected to be perceived differently than from 'natural' threats even if of similar magnitude.

A further interesting perspective which affects both stakeholders and participants is that project-related risks to an identifiable person or group of stakeholders are viewed very

differently than project-related 'statistical' risks. The amounts which are judged appropriate (by both stakeholders and participants) to spend on safety–related or accident prevention aspects of a project are very different (i.e. often much lower) than the amount which would be spent, for example, once an accident has happened (e.g. rescue and relief expenditures) and there is risk to identifiable parties.

9.3.5 Possible Stakeholder Reactions to Risks

The question of how stakeholders will react to project risks is an important one to project participants, and is closely linked to risk dimensions and risk perceptions. As previously noted, projects embodying familiar technology are reacted to much more sanguinely than projects involving unfamiliar technology.

Renn & Swaton (1984) noted the significance of credible information sources, and confidence in the decisionmaking process (induced by the transparency of the organizing institution and the political and public participation process) on influencing risk perceptions. Starr (1987) suggested that public (or stakeholder) acceptance of any risk is more dependent upon public confidence in risk management rather than on the quantitative assessment of the risk, and that public perception of benefits always precedes the public's concerns with or the awareness of the risks.

MacCrimmon & Wehrung (1985) noted risk-taking has two dimensions: the riskiness of the situation (risk perception) and the willingness of a person to take the risks (risk propensity). They suggested risk propensity is influenced by the 'degree of threat' of the

situation, i.e. the chance of loss, the amount at stake, the predominance of losses versus gains, and the variation in returns.

Bowman (1982) suggested people put in loss situations or below aspiration levels may choose higher risks coupled with lower returns; similarly, troubled firms may accept more risk. It may not be unexpected, therefore, if some firms seek higher-risk PEN-BOT projects in the face of diminished returns or losses in more traditional areas. If such risk-seeking behaviour is encouraged then risk planning becomes even more important, for the firms which may be most ill-advised to accept higher risks may be actually pursuing them.

Lopes (1987) suggested that motivational and emotional factors play an important role in risk-taking, which, it is suggested, is a three-way interplay between motivation, probability and incentive. Some stakeholders and participants may be motivated by a desire for security, described as risk-adverse people; others may be motivated by a desire for potential, described as risk-seeking (Lopes, 1987). These motives and aspirations are related to safety and opportunity, respectively.

Langer (1977) suggested people strive to control their environment, fostering an 'illusion of control' over chance events. They prefer controllability over chance in situations, although it was also noted it may be strategically efficacious to treat all events as controllable; the illusion can potentially help us emotionally more than it can harm us practically. Nevertheless, this preference for control over chance should be recognized, for it can manifest itself in the project environment. Participants may allocate risks and responsibilities to the parties which are perceived, or perceive themselves, as best able to

control such risks. If the degree of this control is in part illusionary, potential problems may emerge. Stallen & Tomas (1984) discussed how individuals seek to reduce uncertainty and increase perceived control in risk situations.

How organizations react to risks is also an important question within the context of large and PEN-BOT projects. Rapoport (1989) noted there are some aspects of group decision-making which differ significantly from decision-making by individuals. Some of these differences may relate to reactions to risks. For example, organizational routines may increase risks, for they sometimes focus attention away from areas which may develop into common–cause failures or lead to a false sense of security (Heimer, 1988).

In a cohesive group, the 'groupthink' phenomenon may manifest itself, whereby pressure for consensus may compel the thought and evaluation processes of individuals to gravitate towards conformity, sometimes impairing the quality of decision–making (Rapoport, 1989).

Individuals within groups or organizations may sometimes be subject to the 'risky shift' phenomenon, whereby collectively, the group may display a greater propensity for taking risks than the propensity of the constituent individuals in the same situations. This behaviour may be induced by the perceived diffusion of responsibility in a group setting, thereby leading individuals to accept more risk in the group context; the sharing of persuasive arguments allowing more assertive members to influence or dominate more passive individuals; or through subtle cultural values whereby risk taking is seen to be a

positive virtue whereby the group reflects a loyalty to dominant values (Bass, 1983; Rapoport, 1989).

Project participants should note decision–making in strongly cohesive groups may also be subject to impairment from 'groupthink' phenomenon. Illusions of invulnerability may be induced in groups; warnings of impending danger may be disregarded and rationalized through group reinforcement of optimism or skepticism about danger; self-censorship may be practiced amongst group participants, who value unanimity, censor dissent and exclude dissenting opinions, and pressure for conformity; and the group fosters the illusion of unanimity through the suppression of dissent and through the emergence of self–appointed 'mindguards' who tend to isolate the group from discordant opinions and pressure dissenters (Janis & Mann, 1977; Rapoport, 1989).

9.4 DESIGN OF STAKEHOLDER INVOLVEMENT PROCESS, ISSUE MANAGEMENT PROCESS, AND OUTLINE RISK COMMUNICATION STRATEGIES

Inevitably, significant aspects of the stakeholder dialogue respecting large and PEN-BOT projects involve issues of risk, and issues of risk inevitably evoke controversies. Project participants often find stakeholders and the public do not understand highly technical information about risks and that perceptions of risk may be distorted by bias and other interpretive filters. Conversely, stakeholders often become frustrated as they see project participants unwilling or unable to address their concerns about project related risk issues; the media is commonly seen as sensationalizing risks and ignoring technical facts.

Project participants may question the need to bother about risk communication, which is an important facet of issue management. Covello, McCallum & Pavlova (1989) suggested twelve advantages which can flow from effective risk communication (as presented in Table F.4, Appendix F). Project participants may not be concerned with some of the cited societal advantages and government agency perspective. However, many of the noted advantages can be important and influential at the project level, particularly those related to reducing levels of public outrage, conflicts and community tensions which will facilitate the acceptance of the project. This table also follows as Table 9.3.

- Reduce the likelihood that societal attention and resources will be diverted from important problems to less important problems.
- Reduce the likelihood that individual and public attention will be diverted from significant risks to insignificant risks.
- Reduce unnecessary human suffering due to high levels of anxiety, fear, outrage and worry about risks.
- Reduce levels of public outrage.
- Reduce the likelihood of bitter and protracted debates and conflicts about risks.
- Reduce unwarranted tension between communities and agencies.
- Better understand public perceptions, needs and concerns.
- Better anticipate public responses to agency actions.
- Better inform individuals and communities about important risks.
- Better engage in dialogue with communities about risk issues.
- Better inform individuals and communities about agency procedures, processes and decisions.
- Make more informed risk management decisions.

Table 9.3 Advantages flowing from effective risk communication, (Covello, McCallum, & Pavlova, 1987); an example from Appendix F.

Some may be wary of risk communication, fearing such activities may have unexpected (and potentially) negative impacts, for example if the initiators have only limited knowledge of possible reactions by the information recipients (Eijndhoven, 1991).

Risk communication can be thought of as conveying information between stakeholders about risks or issues managing or controlling risks. Within the context of large and PEN-BOT projects, important risk communication activities will often be between project participants, such as proponents, and public stakeholder groups and regulatory stakeholders. Risk communication activities can form the basis of negotiating compromises respecting risk issues, amongst stakeholders (Renn, 1991b), and is an integral part of all phases of risk analysis, assessment and management (Grima, 1989).

The goals of risk communication, which distinguish the process from 'public relations', should be to involve stakeholders in decisions which affect them; to produce an informed public that is involved, solution–oriented and collaborative; and to ensure the process is an open, two-way exchange based upon respect and trust (Covello, McCallum & Pavlova, 1989). It may also provide opportunities to enlighten stakeholders, change attitudes and bolster support; and discharge regulatory requirements respecting the disclosure of information or a public involvement process (Renn & Levine, 1991).

Nevertheless, Otway & Thomas (1982) suggested risk perceptions can be only be slowly changed and not in an entirely predictable manner. Renn (1991a,b) noted the major difficulties associated with the communication of risk–based information (as summarized in Table F.5, Appendix F).

Keeney & Winterfeldt (1986) suggested effective risk communication strategies can better educate the public about risks, risk analysis and risk management actions, and help them realize there are no zero–risk solutions, tradeoffs will be necessary, and uncertainty cannot be avoided. Good communication approaches can improve the understanding of public values and concerns, increase mutual trust and credibility, and help resolve conflicts and controversies (Keeney & Winterfeldt, 1986; Kasperson, 1986; and Renn & Levine, 1991). Effective risk communication can facilitate the informed exchange between stakeholders and help ensure the nature of the problems and the basis for a resolution are adequately identified (Gregory, 1989).

Risk communication should openly present to the public information on the evaluation of risks and the decision processes about the acceptance of such risks. This is a difficult task, for public discussions about risk often involve many stakeholders, each with different values and goals. It must be recognized that the different groups may each require targeted forms of communication (Gregory, 1989). Additionally, 'risk-risk' situations are much easier to manage, for they are self-limiting and require a balance of risks, than 'how safe' situations, which are subject to 'zero-risk' rhetoric and a lack of regard for the sacrifices to lower risks further (Lave, 1987).

Information about the risk issues communicated to stakeholders is inevitably in summary form; it should allow stakeholders to apply their values and make as much of an informed choice respecting acceptance of the risk as would be possible if they had fully analyzed all risk information possible (Hattis, 1989). Project participants should consider how

information is likely to be interpreted by stakeholders and present information in such a form as to ensure such interpretations will be consistent with the 'facts' respecting the risks and uncertainties under consideration. Hattis (1989) noted facts about risks can be arranged in helpful or unhelpful ways, and there are relevant facts, irrelevant facts and facts stated in ways which can be misleading.

Covello, Winterfeldt & Slovic (1987) noted risk communication issues are the subject of great controversy and represent some of the most difficult and greatest challenges to risk management today. They suggested risk communication problems fall into four basic categories: message problems, source problems, channel problems and receiver problems (summarized in Table F.6, Appendix F). The media, as a channel, often plays a significant, and controversial, role in risk communication (Lichtenberg & MacLean, 1991). When faced with communicating to stakeholders general information about risk, and involving stakeholders in a consultative or decision process, a number of challenges are presented to project participants. These are summarized, along with suggested responses in Table F.7 and Table F.8 in Appendix F.

Slovic (1987); Covello, McCallum & Pavlova (1989); Covello, Sandman & Slovic (1989); Covello (1989, 1991); Hance, Chess & Sandman (1989, 1990); and Renn (1991b) offered comprehensive guidelines, principles and processes which would be beneficial, for example, to project participants communicating about risk to project stakeholders or other participants (e.g. government agencies and financial partners). Table F.9, Appendix F presents a summary of risk communication principles useful to project participants.

Renn (1991b) suggested a set of guidelines (provided in Table F.10, Appendix F) for risk communication as well as three essential conditions for successful risk communication programs (summarized in Table F.11, Appendix F). Roberts (1989) noted a crucial component of risk communication is credibility; and credibility is related to the validity of the risk analysis, communication, and decision-making processes; and suggested key components, when constructing a risk communication program, which will build such credibility (Table F.12, Appendix F).

Sandman (1986) presented a number of suppositions respecting risk communication aspects of waste facility siting processes. It is suggested the following six are equally applicable to many facets of large and PEN-BOT projects, as they often provoke similar opposition and controversies about siting and other project issues.

First, he suggested that project proponents acknowledge the community's substantial power to slow or stop the siting process, or in the case of a PEN-BOT project, the project itself. This explicit acknowledgment of the community's influence will help reduce the community's possible resentment over a perceived power imbalance and improve the dialogue between acknowledged equals.

Second, proponents are advised to avoid implying community opposition is irrational or selfish; community opposition may be rooted in distrust of government or other institutions. As noted in Section 8.5.1, stakeholders often mobilize in response to such perceptions.

Third, adapt a communications strategy to the known dynamics of risk perception, which is far more complex than the probability and magnitude of some undesirable event (as discussed in a previous section).

Fourth, do not ignore issues other than health and safety risk. Within the context of large and PEN-BOT projects, these other issues, such as potential declines in property values, construction disruptions, demands on community infrastructure and others may well dominate the community's concerns. Other non-impact issues may also become important, such as issues of control and fairness.

Fifth, make all planning provisional so that consultation with the community is required. If the community feels the important decisions are a fait accompli, opposition will only solidify.

Sixth, establish an open information policy, but accept community needs of independent information. Communicating technical information about the project and its risks will, admittedly, be difficult, and the failure to disclose relevant information can scuttle the entire process once the information becomes known.

Konheim (1988) summarized recurrent questions that the public expects to have answered by risk assessment processes. Project participants should be aware of what these concerns may encompass, so they may be addressed in the risk communication process. Some of the potential questions include:

- *"What are the specific risks compared to the benefits of the project?";*

- *"Are the risks to various groups worth the benefits gained?";*
- *"Does the design of the facility make the risk as low as it possibly can be?";*
- *"What is the chance of a serious accident, and what would be the worst possible impact?";*
- *"What provisions have been made to handle accidents?";*

and other pragmatic concerns, which are commonly overlooked (Konheim, 1988).

Mumpower (1988) looked to advertising strategies commonly employed about lotteries, which are quite successful in motivating people to partake in very low probability, high consequence events. Drawing upon this experience, Table F.13, Appendix F presents a number of "negative" communication strategies project participants should be very aware of and will likely be confronted with. They serve as preeminent examples of how opponents to a project or technology may be very effective in fermenting opposition through the emphasis of negative strategies about the project.

9.5 SUBSEQUENT FRAMEWORK ACTIVITIES

Subsequent Framework activities, which include the assessment of the project's feasibility in each of the previously-noted dimensions (technical, environmental, financial, economic, socio-political, organizational), and the Implementation phases of the project, are not the focus of this thesis and therefore have not been discussed in detail herein. There are a wide variety of feasibility assessment tools available; for example, Ranasinghe (1990)

developes a technique for use during the economic feasibility assessment stage for large projects.

However, it is important to note the linkages between these activities and those of the previous Stages. This relationship is illustrated on Figure 9.1 by means of cyclical and iterative processes, shown with dotted lines. Iterations to previous Stages would be expected as more detail respecting the project becomes known. Additionally, if any or all dimensions of the project prove infeasible, adjustments to the project are recommended. As illustrated on Figure 9.1, this adjustment process could include the following activities:

- *Adjust project approach;*
- *Identify other or additional participants;*
- *Adjust objectives;*
- *Adjust failure and success criteria;*
- *Adjust participant roles;*
- *Adjust execution plans.*

In this manner, the Framework suggests the risk planning process continues to be an iterative, dynamic process, as the previously outlined Stages of the risk planning Framework continue to be undertaken with increasing levels of detail.

CHAPTER 10.
OPERATIONALIZING THE FRAMEWORK: THE RISK PLANNING BRIEF

10.1 AN OUTLINE OF THE PROJECT RISK PLANNING BRIEF

As described in Section 6.1.2, the Framework provides a *'map'* of the risk planning process, to assist project participants *'navigate'* through the vagaries of large and PEN-BOT projects. To provide further assistance, and as one means to operationalize a Framework for use as a strategic planning tool, the use of a *Project Risk Planning Brief* is proposed.

The objective of the project's Risk Planning Brief would be to provide all participants with a unified, explicit statement of the project's risk planning information. While the Brief would represent one important expression of the use of a Framework, the process of risk planning itself is also invaluable. This process of pondering and defining these key characteristics will assist participants by providing what should be the foundations of a consistent and comprehensive a vision of the driving motivations and objectives of the project.

The key features of the Brief would be its currency and comprehensiveness, both essential so as to avoid the potential for surprise scenarios and other unacknowledged risks to emerge. The use of a tool such as the Brief could address some of the problems which originate from the noted lack of a unified approach to risk planning, such as those cited by

Ward & Chapman (1991) and Laufer (1990a), and would offer an extension to many of the existing approaches described in Section 1.7.2.

10.2 THE ORGANIZATION OF THE RISK PLANNING BRIEF

It is recommended the Risk Brief be organized in parallel with the components of the Framework, and describe the same dimensions by which the project's feasibility may be assessed. For example, risk planning activities should be considered in each of the key dimensions which include:

- *Technical*
- *Economic*
- *Financial*
- *Socio-Political*
- *Legal/Regulatory*
- *Environmental*
- *Organizational*

The organization of the Risk Brief in a format consistent with the Framework will also aid participants in the later stages of the Risk Planning process by helping to ensure potential risks are not overlooked. The following sections describe how information related to the Framework components may be usefully organized and presented.

10.3 THE SUGGESTED CONTENTS OF THE BRIEF

As guidance to project participants, the following presents a suggested outline of the of the contents of what may be a typical Brief.

10.3.1 Project Mission Statement

This should include a succinct statement of the project's purpose with reference to the identified need for the project.

10.3.2 Project Objectives

This would include operationalized expressions of how the project will accomplish its mission. These objectives would likely encompass many dimensions.

For example, the objective which may be viewed as overriding (because of familiarity or other influences) by many participants on a PEN-BOT project is the planning, design and construction of the new facility (i.e. a focus on the "build" phase). However, often the greater challenge is the planning, development from an embryonic stage, and the long term operation of a very substantial and unique commercial enterprise (i.e. a focus on the "operate" phase). Achieving this objective requires very different approaches and skills, and presents very different risks to participants.

As an example of a project with well understood mission and objectives, the US$2.2 billion Milwaukee Water Pollution Abatement project clearly defined at the outset the project's comprehensive, multiple objectives, which included 'Physical', 'Community' and

'Funding' objectives. They remained as the guiding criteria over the twenty year life of the project (Padgham, 1991).The Risk Planning Brief can also serve as the repository for an organized and comprehensive approach to risk communication and issue management. Issues and responses are summarized and updated as required, which can therefore provide participants with the basis so as to develop, and then implement, a strategy in response to each and every potential issue. Once again, the key features of the Brief are its currency and comprehensiveness, both essential so as to avoid the potential for surprise scenarios and other unacknowledged risks to emerge.

10.3.3 Project Failure and Success Criteria

This would present quantifiable statements of criteria, and targets, by which the feasibility of the project and the attainment of success will be judged. These statements should comprehensively respond to each and every objective. By way of guidance, Table 8.2 presents example Objectives and Failure and Success Criteria.

10.3.4 External Influences

This would include a description of the external forces which will influence the project and the project planning process; e.g. market forces, windows of opportunities, election schedules, etc.

10.3.5 Participant Profiles

This would present a description of participant missions, objectives, expertise, failure and success criteria; organized to be congruent with the similar project characteristics. Areas of inconsistencies should be noted and highlighted for action.

10.3.6 Participant versus Project Matrices

This would include a concise summary and comparison, in matrix form, of the objectives of participants versus the project; and the failure and success criteria, participants versus the project. Example motivational process related to stakeholders were presented in Table 8.3 and 8.4 and example stakeholder groups discussed in Section 8.5.2.

10.3.7 Participant Roles and Responsibilities

This would include a concise presentation, in matrix form, of participant roles and responsibilities, screened to ensure weaknesses, ambiguities, overlaps and other potential problem areas are identified. Participant contributions to the project would be summarized through definitions of participant objectives; failure and success criteria; and a clear denotation of roles, which will permit the assessment of participant contributions towards the project's objectives.

Organizing and presenting information through the Risk Planning Brief can serve as a valuable tool in assisting participants with an identification and analysis of the potential for conflict associated with the previously noted characteristics. For example, current information on the project's, and each participants' objectives; roles; failure and success

criteria could be summarized in the Brief through a series of matrices. The matrices may be summarized by project phase to better reflect the evolution of project characteristics. An example of a participants' "roles" matrix is presented as Table 10.1. Example participants are drawn from some of those which may be involved in the Prince Edward Island PEN-BOT project.

Activities: **Example Participants:**	**Activity #1 Description** *Start Date;* *Completion Date;* *Deliverables*	**Activity #2 Description** *Start Date;* *Completion Date;* *Deliverables*	**Activity #3 Description** *Start Date;* *Completion Date;* *Deliverables*	**Activity #4 Description** *Start Date;* *Completion Date;* *Deliverables*
Governments: *Federal* Public Works: Environment: Fisheries: Transport: Others: *New Brunswick* Various depts: *PEI:* Various depts:	In each cell, roles and responsibilities will be summarized. For example, roles can be defined as: *Primary Overall;* *Primary Component;* *Input Component;* *Review;* *Advise* *Approve;* etc.			
Project Manager				
Specialist Advisor Consultants				
Design Consultant: *Component*				
Construction Manager: *Component*				
Contractor #1: *Component*				
Contractor #2: *Component*				

Table 10.1 Example Risk Planning Brief Participant Roles and Responsibility Matrix.

Providing the Brief is a repository of the most current information on the project, it can then become a very valuable tool to identify incompatibilities, ambiguities; gaps; overlaps; strengths and weaknesses in any of the characteristics of interest. For illustration, the

example provided in Table 10.1 could be used to identify and address these key characteristics related to participant roles (such as ambiguities or gaps). Even the formalized process itself, though identification and structuring of the information, will force participants to consider a broader range of scenarios and potential risks than they otherwise may have.

In response to identified conflicts, it may be necessary to consider adjusting participants' roles; failure and success criteria; objectives; project approaches or execution plans. It may be necessary to undertake the iterative process of definition–assessment–adjustment many times, as the project planning proceeds in greater detail, more information becomes available, or circumstances change.

10.3.8 Potential Stakeholder Issues

A description of potential stakeholder coalescing issues, presented in matrix form. For consistency and completeness, issues can be correlated against identified external influences; project and participant objectives; and failure and success criteria. In this manner, the objectives which may provoke stakeholder response and reactions can be identified for action. Similarly, areas of greatest vulnerability related to participant criteria can be identified.

Information respecting issues and stakeholders would be summarized through a concise description of potential issues and stakeholder missions, objectives and possible behaviours. Such an organization would permit the Brief to serve as a basis, in support of

the following components of the Framework, to assess conflicts and reveal risks. Information respecting issues would be organized in accordance with the six major project dimensions so as to readily summarize which stakeholders may react to each issue, including highlights of stakeholder motivations, concerns, objectives, degree of influence and possible behaviour. For example, Ashley (1981) noted the potential value of this approach and specifically enumerating participant objectives to reveal conflicts and overlap. Further recommendations respecting stakeholder issues are presented in Section 9.4.

10.3.9 Potential Stakeholder Profiles

To the greatest extent possible, a description of possible stakeholder's postulated missions, concerns and objectives in response to the summary of issues. Statements of predicted actions and reactions to the project are included.

10.3.10 Project Organization and Structure

Building upon participant roles and responsibilities, a portrayal of the project's organization and structure, in descriptive and graphical formats. Particular attention should be paid to the flow of information and lines of communication; lines of responsibilities; decision-making responsibilities; and the inherent accommodation of flexibility and adaptability to change and evolution.

10.3.11 Risk Events

This important section would include a concise description of the risk events and scenarios which must be accommodated by the project. To ensure completeness and comprehensiveness, risks can be organized by means of the major dimensions of the project. A summary of risks, in matrix form, by participant responsibility is valuable to ensure risks are comprehensively identified and appropriately allocated for action and management to the suitable participant. Table 1.1 is an example of a checklist approach to identifying sources of project risk, while Section 9.2 discusses a number of tools and techniques which may be useful.

10.3.12 Execution Plans

A summary of the project's approaches and execution plans in each of the appropriate areas, including organizational; technical (pre-design, design, construction); operational; financial, etc. would be presented. This would include an identification of risk scenarios with appropriate contingency plans. Participant roles and timelines should be clearly identified.

10.3.13 Stakeholder Involvement Strategy

Drawing upon the Execution Plans, key decision points are identified and the stakeholder involvement process is described, with timelines, responsibilities and interactions related to the flow of information and expectations related to stakeholder and participant objectives.

Each potential stakeholder group should be addressed with a proactive strategy to respond to concerns and projected actions.

10.3.14 Issue Management Strategy

Closely related to the Stakeholder Involvement Strategy, the strategy describes the response to potential project issues; some of which may be addressed through stakeholder processes and others through execution plans. A summary of issues serving as the input of the Risk Communication Strategy should be provided.

10.3.15 Risk Communication Strategy

For each identified issue, concisely enumerate the stakeholder group affected; degree of concern; project's response to the issue; how the response will be communicated; information requirements and response strategy. Considerable guidance is available as presented in Section 9.3 and 9.4, and evidenced by the tables of Appendix F.

10.3.16 Feasibility Assessment Summaries

For each of the major dimensions (technical, environmental, financial, economic, socio-political and organizational), summarize the criteria, assumptions, information requirements; uncertainties associated with inputs and the project's behaviour; sensitivities to changes; and contingency strategies. An understanding of the assumptions is particularly important, for they may form the underlying basis for the rationale of the project's proceeding. Impacts of shifting assumptions should be described and key

indicators identified (i.e. parameters which should be closely watched as they will provide "early warning" of possible adverse impacts on the project's feasibility).

CHAPTER 11.
CONCLUSIONS

As PEN-BOT projects become more common, engineers and project planners find themselves increasingly bewildered by the breadth and complexity of such projects and the range of issues they must grapple with to move the project through the long approval processes and maneuver through the minefields of ill understood stakeholder concerns and opposition.

Traditionally, those involved in engineering projects have focused more attention on the technical and other quantifiable aspects of project risks. A particular focus of this thesis has been characterizing the special features of large and PEN-BOT projects and identifying the special challenges of these projects, many relating to the more difficult to identify and respond to "softer" issues.

The objectives of this thesis, as stated in Section 1.3, are to provide project participants some useful advice and insights into how to approach, in an organized manner, the process of risk planning with particular reference to large and PEN-BOT projects.

To this end, the unique aspects of large engineering projects were defined, with a view to provide guidance to participants. The 'BOT' project delivery process was examined, and through an examination of the approach, the six phases of 'PEN-BOT' were proposed as a better description of the phases and the process. It is suggested this nomenclature places a more realistic emphasis on the front end efforts and considerable expenditures necessary before a project may proceed to the "build", "operate" or "transfer" phases.

A survey illustrating the increasing popularity of the PEN-BOT approach was presented, including a detailed case study of the Channel Crossing project, outlining both the prevalence and the unique challenges of the such projects. The risks of the Channel Crossing project, both as a large project and as a very complex PEN-BOT project, were described and lessons drawn from the problems encountered.

The attitudes and perceptions of project participants respecting risk planning issues were surveyed in a working environment through a "Project Planning Issues Questionnaire". The significant differences, amongst project participants, in risk and project planning attitudes and perceptions was revealed with a number of recommendations addressing these problems developed.

In the course of this work, a particularly diverse body of literature was examined. Both in the preceding Chapters and in the Appendices, a wide variety of advice has been extracted from such sources for use by participants on large and PEN-BOT projects. This included a distillation of precursors of project success and failure (presented Section 8.3 and in Appendix E); and guidance for addressing stakeholders (Section 8.4 and 8.5); identification of risks (Section 9.2) and the challenges in addressing risks and risk communication strategies (Section 9.3 and Appendix F).

A Holistic Risk Planning Framework (as illustrated in Figure 6.2) was developed and presented as a map of a process to address many issues which in themselves, are difficult to structure, particularly within the environment of large and PEN-BOT projects.

The tool of a *Risk Planning Brief* was suggested as one tool to aid with the operationalization of such a Framework and thereby facilitate the structuring and presentation of risk planning information. More specific elements related to the Brief were presented in the previous Chapter.

No planning process or checklist can completely identify all possible risk events and no framework can offer perfect guidance. However, it is felt this developed Framework can offer considerable value to participants by virtue of its definition of the *process*. Each project is unique, and participants must adopt the specifics of the Framework to meet their needs as they are related to the project at hand. The Framework offers an approach which would enable participants to address their risk planning challenges with new insights.

It is difficult, of course, to apply hindsight objectively to the problems past large projects have faced. Nevertheless, a number of sections, including Chapter 4, presented a discussion of the problems and challenges encountered by PEN-BOT projects. Many of these challenges could have been lessened through the more rigorous approach proposed by the Framework; for example, the hurdles posed by stakeholders in the case of the Prince Edward Island Crossing Project; or the conflicts arising from ill-defined or poorly thought out roles amongst the early participants on the Channel Project.

The Framework lays out a "way of thinking" for participants, to allow them a process whereby they can better build on their past knowledge and experience, and attempts to be exhaustive in illustrating iterative loops and interrelationships so as to better equip participants to deal with the unknowns presented by large and BOT projects. The lesson

should be that if during the process of risk planning, components of a Framework are overlooked or inadequately considered, the risk of project failure or lack of success will unquestionably be increased.

11.1 RECOMMENDATIONS FOR FUTURE WORK

There are a number of areas which are suggested as logical extensions to the work presented in this thesis, as well as some components of the thesis which could be examined in further depth.

Future researchers may wish to approach a rigorous validation of this Framework in a number of ways. First, projects could be "planned in hindsight" following the precepts of the Framework. Building upon the discussions in Chapter 3 and Chapter 4 of the Prince Edward Island PEN-BOT and the Channel Crossing projects, these projects could be explicitly traced through the Framework to examine their behaviour and characteristics in greater detail, with a view to determine when, how and why the projects followed or deviated from the Framework, and to what effect.

However, by their very characteristics of uniqueness, concurrence with, or deviation from the Framework may not in itself be considered by some as irrefutable evidence of validation. Thus, a second strategy which could be employed may include the "forward planning" of one or more projects. This could involve the use of the Framework by project participants in 'real time' on an actual project, supplemented with the tracking of

its usefulness, participant response, and other characteristics which could be assessed to allow the Framework to be adjusted to enhance its practicality, ease of use and robustness.

Third, further reflection by project participants upon individual Framework components, linkages and iterations may reinforce the logic and robustness of the components, and therefore by extension, the logic and robustness of the Framework as a whole.

As well as the issues noted previously, there are a number of logical extensions to the work described in Chapters 3 and 4 related to the case studies of the Prince Edward Island and Channel Crossing PEN-BOT projects. It would be useful to continue to monitor and analyse these projects. In the case of the Channel project, the project could continue to be tracked through its longer than anticipated 'build' phase, followed by the early stages of the 'operate' phase. In the instance of the PEI project, it could be monitored through the recently-commenced 'build', and 'operate' phases.

In addition to the lessons which may be evident from such follow-up examinations, it may be useful to occasionally scrutinize, in retrospect, the analysis presented in this thesis should more information become available respecting earlier events and project phases. It may also be insightful to consider, once more operational experience is gained with these and other PEN-BOT projects, as to ultimately how objectives and failure and success criteria were achieved and judged.

It may also be enlightening to follow a project from a very early stage, such as the Lions Gate Crossing in Vancouver, vis-à-vis the Framework and a risk planning perspective. The Lion's Gate project, in early 1994 in a fuzzy 'pre-Propose' phase, could be described

as a project searching for a process, and thus could be examined in the context of being a candidate for the PEN-BOT approach. Insights into participant motivations could also be drawn from an exploration of their activities and behaviours as the project proceeds.

This may lead to useful extensions of this thesis in a number of areas associated with PEN-BOT projects and the efficiencies of the PEN-BOT approach itself. This may include insights in identifying the appropriate 'pre-Propose' processes, as well as exploring further participant motivations, and consideration of specifically what 'projects' and 'participants' are best suited for the approach.

Such an examination could also consider how participants may readily identify the key characteristics of a project which may suggest it would be a good candidate for implementation using the PEN-BOT approach. Similarly, it would be valuable to identify the key characteristics of participants which would suggest their involvement may be appropriate. For example, it is clear financial fortitude and a willingness to provide a long-term, flexible commitment to the project would be important participant characteristics. An understanding of the appropriate characteristics would potentially enable project approaches to be better tailored to participants and vice-versa.

In a related area, an examination of the motivations of PEN-BOT participants would reveal relevant insights into their behaviour and perceptions of the project and risk planning process. Do they act as 'rational' decision makers at all times, and how are their judgments and perceptions altered by their involvement in the project? How do they react when, for example, failure and success criteria cannot be achieved and must be adjusted.

Additionally, an extension of this Framework could be developed to allow an equitable comparison of the PEN-BOT approach to other, more conventional, project delivery methodologies. This would undoubtedly lead to a reflection upon issues of the equity (or inequities) of public-private risk allocations and rewards associated with the PEN-BOT approach.

An important aspect of the PEN-BOT approach are the characteristics of the final 'transfer' phase, including those determined by the concession period. As more PEN-BOT projects are proposed and implemented, an examination of the characteristics of the concession period and terms offered to the project proponents could lead to important insights. Drawing upon such extensions, and risk allocation and equity models could allow guidelines to be developed respecting the appropriateness of characteristics associated with the concession period.

There are other elements respecting phases of PEN-BOT process from which further guidance is available in the associated literature. This could include an examination of the underpinnings of some of the processes in the 'evaluate' phase, as suggested by the body of literature and theory associated with multi-objective decision making. Similarly, additional insights are available in the body of literature associated with negotiation strategies and processes.

The individual components of Framework could be further explored and elaborated upon, including an examination of the decision tools and processes within each component. This could lead to advances related to approaches to structuring and managing the information

requirements of the Framework components. Computer-aided approaches and expert systems technology may be of considerable assistance with these tasks.

PEN-BOT projects will become increasingly common. Even recently such projects were a novelty, while now the approach is commonly cited by governments and private sector participants as an effective response to meeting our growing infrastructure demands in an era of severe fiscal constraints. As the demands for infrastructure will continue to accelerate, and our fiscal constraints are unlikely to ease in the foreseeable future, engineers must adapt to what may be a fundamental shift in the manner in which projects are conceived, planned, financed and delivered. In this environment, it is hoped the presented Framework can provide valuable assistance.

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APPENDIX A.
CHANNEL TUNNEL PROJECT TIMELINE (1802-1990)

The following timeline is presented so as to cover the period of greatest interest with respect to the PEN-BOT issues associated with the project. After 1990, many issues can be more considered construction issues and thus are not of the same degree of interest and have not been included in the same detail.

Notes and references are listed following Appendix B.

1802:	French Engineer, Albert Mathieu, proposes to Napoleon Boneparte, that a tunnel be driven under the English Channel.
1870:	"We are of the opinion that it is not an unreasonable proposition to drive a tunnel under the Channel, but that in some measure it must be a venture" - Nature magazine, 20 January 1870 (33).
1872:	Channel Tunnel Company formed and applied to UK government for permission to construction a rail-road tunnel.
1874:	The cost for a proposed twin-track railway tunnel cited as £10 million (138).
1875:	France and England sign an agreement for research and study related to a Channel tunnel.
02/1875:	French company, *'The Association for a Submarine Railway'* formed to promote a rail tunnel crossing (77)(78).
08/1875:	The French government grants a concession to a French promoter of a tunnel scheme; terms are ninety-nine years from opening of the tunnel, the government will not grant permission for any other railway crossings for a period of thirty years, construction will be completed within twenty years, the government can buy the line after fifteen years of operation, and limits to fares are specified (77). Some similarities to the terms granted in 1987!

1882: First Channel Tunnel Group formed in Britain. Colonel Beaumont, of the Corps of Royal Engineers, designs and constructs a machine which bores a tunnel of 1800 m under the Channel; War Office stops efforts on grounds of defense considerations. The unlined tunnel remains today (80).

09/1883: Although the tunnel "scheme is shelved for the present"(78), discussions continue. The Association for a Submarine Railway estimates the costs of the tunnel railway at £3 million or 75 million francs. It was stated "the cutting of it through the grey chalk presented no difficulty, and nothing could be more easy than the ventilation."(78) Potential benefits were spoke in glowing terms; "From the standpoint of politics and political economy, no work more useful to humanity had ever been attempted; it was one of peace and civilisation, of international fraternity; it would save transhipment and insurance, and gain an hour for passengers, and two hours for merchandise."(78) Traffic capacity was estimated at 250 trains per day (78).

05/1884: Channel Tunnel bill rejected in the House of Commons; "that the Channel Tunnel would have been a big thing from the promoter's standpoint is not to be denied; that it would have paid anything like an adequate interest upon the capital sunk is a matter we regard as altogether doubtful....judged in the light simply of an investment, we are quite content to see it rejected by a majority so great that it is not likely to be revived."(79). For a hundred years, anyway!

1957: Two groups, the Anglo-French Channel Tunnel Study Group and the Channel Bridge Study Group formed to examine options for a fixed link (1).

1958-59: Channel Tunnel Study Group undertakes geotechnical and marine borings.

1960: Channel Study Group puts forward its proposals to the government for a link, in terms of a rail tunnel accommodating shuttle traffic (57).

09/1963: Government white paper (*'Proposals for a Fixed Channel Link'*, HMSO Cmnd 2137) presented, reporting a tunnel was feasible and the economically preferred option (1).

1964: Britain and France agree a rail tunnel is feasible and a good economic investment (1), and agree in principle to build the tunnel; cost estimated at about $300 million US. (11)

1964-65: Subsurface investigations continue, hundreds of kilometers of geophysical and seismic lines, and 73 channel boreholes (at 500 metre intervals) with

6000 metres of cores collected (33). This work will remain the primary source of geotechnical information.

1966: Governments "decide the Tunnel should be built" (1); financing is to be private.

03/1971: After one false start and three unacceptable proposals, a new group (British Channel Tunnel Company and Societe Francaise du Tunnel sous la Manche) is formed and its proposal accepted; a further round of studies is to be submitted in one year (1) It is intended to "divide the project thereafter into a number of phases of increasing financial importance....having natural break points...it would be possible for decisions to be made according to changing economic and political circumstances" (1).

10/20/72: Agreement No. 1 signed, between Governments and companies, and "marked beginning of Phase I" (1). During Phase I, seven onshore and fifteen marine boreholes are drilled (80).

09/15/73: Government White Paper (*'The Channel Tunnel'*, HMSO Cmnd 5430) issued supporting project; House votes in favour of proceeding to next phase (1).

10/11/73: Conservative government announces a cutback in public sector building as part of the UK counter-inflation program, but "it will not affect the tunnel, according to a UK government spokesman" (33). However, it set the stage for a nervous regard of cost estimates and their potential for escalations.

11/01/73: House of Commons rejects call for a new study of a rail-only link as an alternative, rather than the proposed RO-RO shuttle tunnel; Labour (in opposition) opposes the shuttle scheme, citing environmental considerations, lack of regional and transport planning, and inappropriate financial arrangements. *New Scientist* (33) questions economic analyses and suggests rail-only link more acceptable and appropriate. A "secret report" claims that a rail-only tunnel would cost 30% less to build, and 85% less to operate than the shuttle tunnel, and make a profit, but "the problem is that it would not make enough profit to satisfy the private investors" (32).

11/17/73: Agreement No.2 signed, between the Governments and the companies, and treaty between France and UK signed (HMSO Cmnd 5486). Treaty not in effect until ratified by UK with legislation passed in the House; Phase II begins: construction of access works and driving 2 km of service tunnel. Also, updated forecasts and studies to be undertaken.

??/1974: General election—change of government from Conservative, which initiated the project, to Labour, which is going ahead but reviewing the studies.

04/1974: Labour Government announces a committee will be set up to review the project "with some urgency" (9), to report by the end of the year. Final cost of £970 million "mentioned" (13).

08/1974: Head of Committee, which is to urgently review the tunnel project, finally appointed—Sir Alec Carincross (9).

11/01/74: Cost estimates of the rail link from London to the tunnel climb - last year, estimates given as £120 million, earlier in the summer, £350 million, now up to £500 million (9). Still little action from committee to report on project; Channel Tunnel Bill must be passed by Parliament by the end of the year to comply with agreements with the French and the two tunnel companies (9).

11/21/74: Critics argue that many of the original assumptions on which the tunnel analysis was based are no longer valid; ".....that inflation will be only 5% per year and construction costs will rise only 7% per year now seem ludicrous....sharply increased petrol costs seem likely to reduce holiday driving.....on which the project's success depends". It is also felt that the new French president, Valery Giscard d'Estaing, wants to postpone or shelve the project (31).

11/30/74: New £500 million rail link from London to the tunnel is scrapped by the British Government, and ask the French for a one year delay before committing to Phase III of the tunnel itself (10).

01/23/75: UK fails to ratify the Treaty, therefore unilaterally withdraws from project on the basis of cost overruns at a time when the country is in deep recession. "An immediate outcry in Parliament,...indicating a future government might revive the project" (11). Contractors and investors will be compensated.

10/1978: British Railways and SNCF advocate a $1.2 billion US single-track tunnel; UK Transport Minister reportedly enthusiastic (15). The tunnel is cited as costing £650 million, and is a "cut-down" version of the tunnel scrapped in 1975 (19).

10/1978: Draft green paper prepared by EEC transport commission proposes 10 projects to improve EEC transportation infrastructure; project with the first priority is Channel tunnel. The proposal is for a pilot study on the tunnel

economics, by the end of the year, and up to 20% of the capital costs paid by the EEC (16).

02/1979: The EEC commissions a study, by Coopers & Lybrand to ascertain the benefits of a Channel fixed crossing. It will look at proposed options. The "front runner" is the single-tracked bored tunnel, but other options are suggested, including a much wider bored tunnel and a steel bridge (17). Study due in November (19).

08/1979: Six schemes mentioned as proposed to the EEC, and the favoured scheme is the British Rail single-track concept, which would carry rail traffic only, leaving trucks and cars remaining on the ferries (19). French noted as reluctant to move in light of previous British withdrawal.

11/1979: EEC commission approves the EEC plan to improve transportation infrastructure, with the top priority being the Channel crossing. The Channel project could attract interest rebates worth 14.5% of its £650 million cost (20).

01/1980: "Renewed interest" in a tunnel cited, as BR has its feasibility study underway, noting the rate of return is "interesting enough to attract private financing". The joint BR-SNCF decision "may come" in 1980, with two years then required to launch the project. EEC aid may be forthcoming because of "the fight between Britain and its Common Market partners over the size of its contribution to the community budget gives a strong political push to providing some special assistance for the UK" (21). Promised EEC aid stated as £130 million, but cannot be given to private companies (22).

??/1980: Change in government in UK, from Labour to Conservative; Margaret Thatcher now Prime Minister.

03/1980: Coopers & Lybrand report submitted to EEC; looks at four main choices: single-track tunnel; double-track tunnel; road bridge and road bridge plus rail tunnel. Economic rates of return 16%-18%; with all four choices would yield a positive rate of return, even under pessimistic economic growth and oil price assumptions. No independent assessment of costs made, however. EEC member governments "reacted coolly" to infrastructure spending plans. (23).

22/03/80: Britain's Transport Minister announces in House no government funds for Channel crossing; "keen" to see the link built, but privately (24). Several private consortia announce many proposals, including the European Channel Tunnel Group (five schemes including single rail-only tunnel) (24).

Transport Ministry asks for further study of the two proposals by its economic advisor (25).

08/80: Other consortia formed and proposals advocated; Linkintoeurope Ltd. make submission to Transport Committee proposing an eight, 2 km span bridge (road only, £2,000 million; road/rail, £3,000 million), forecasting private financing and a 14% return (26).

10/1980: Proposal for a "brunnel" submitted to Transport Committee, advocated by steel interests (Redpath Dorman Long). Supporters claim 60,000 to 80,000 jobs created during construction, in areas of high unemployment; costs estimated at £4,600 to £5,900 depending on two or three lanes in each direction. Economic rate of return (5%-8%) is low compared to the rail-only tunnel; "But the prospect of being able to drive all the way to and from France—and job creation in the regions—may have more political appeal" (27).

01/1981: Tarmac Ltd., in conjunction with merchant bankers Robert Fleming & Co., submits a proposal for a pair of larger rail tunnels, which could accommodate roll-on, roll-off traffic (28). Tarmac's proposal, in three phases, is based on the previously-scrapped 1975 design, and is estimated to cost $1,730 million. First would be a single tunnel, then terminal facilities, then a second tunnel (29). It is described as the "best match yet for government preferences.....the first to offer totally private financing, include twin bored holes and provide sufficient detail for serious consideration"(30). It is based on the project suspended in 1975, and was prepared in response to the government announcement of no public funding. (35).

02/1981: French officials are waiting for a decision by the British, expected in mid-June, on crossing proposals. Six detailed schemes submitted with two or three more expected. The BR/SNCF single rail tunnel is considered the front runner (28).

03/1981: House of Common's select committee on transport recommends in favour of a RO-RO scheme with a single tunnel, which coincides somewhat with the Tarmac phased scheme. The committee "dismissed proposals of a string of suspension bridges and a sunken tube tunnel because of their technical difficulties.....(and) is critical of the currently most developed plan, one put forward jointly by the British and French national railways." (34).

10/09/81: Joint announcement by President Mitterrand and Margaret Thatcher that more studies will be carried out on the proposals. It is reported the tunnel was on the agenda of this, their first summit, "....only because of the need

to produce something positive from the summit—and there were remarkably few subjects a British Tory and a French Socialist could agree on."(65) Lobbying and public pronouncements by the proponents of the schemes continue, however, with each consortium advocating the advantages of its scheme. EuroRoute (British Steel subsidiary Redpath Dorman Long, Trafalgar House and Sir Robert McAlpine & Sons) claims their bridge and tunnel is the most cost effective and will create 250,000 man-years of work and high steel demand. Channel Tunnel Developments is advocating the scheme originated by Tarmac, now joined by Wimpey, Robert Fleming and Kleinwort Benson. (36).

10/1981: British and French officials meet to discuss an agenda for legal and technical issues, but "the French are reluctant to become deeply involved without a firm guarantee that the program will go forward" (37), remembering the British withdrawal from the 1975 project. The British government is now pushing hard for a decision by year-end to ensure the project is not derailed by the next general election in 1984 (37).

11/1981: The process grinds on with civil servant meetings, but "there is no chance for a decision before next March" (38). However, if the link is not chosen before April, 1982, the necessary bill cannot be enacted by November, 1982, and "the project may be frozen until after the next British general election in 1984" (38). Even if started now, the project may not generate sufficient numbers of jobs before the election, which is seen as Thatcher's goal. As well, there appears to be a difference in financing objectives—French wish to pay from public funds, the British from private. Investors are noted as getting cold feet, and wanting government assurances that the tunnel would be strike-free (38).

12/81: EEC, "despite having voted initial development costs a few weeks ago, has made it clear that there will be no community funding for a cross-Channel link." (39). British Steel steps up public relations campaign in favour of EuroRoute bridge, claiming "it could be built faster than any other route" (39). The schemes expect to present detailed proposals to the government in the spring.

01/30/82: "If ministers do not give their blessing to a channel tunnel scheme by April, construction start-up will be delayed until after Britain's next general election—that delay could shelve the chunnel indefinitely" (41).

02/1982: Various proponents mudsling. Channel Tunnel Developments claim none of the other six proposed links are ready to go ahead, and claims the British Rail rail-only tunnel as "obsolete before it's started". British Rail hits back, "....I would seriously question whether if theirs is ready to go ahead....they only started to consider seriously the question of heat generation in the

tunnel as recently as last December", and regarding the EuroRoute proposal, "...there are a grat number of technical problems to be solved" (42).

04/1982: Report by government economic advisor, Sir Alan Cairncross, states "My conclusion is that there is no overwhelming case for a fixed link....it is not yet clear that the return would be adequate in financial terms...." (43). Overall, the objections are based on firstly, in 1975 it was assumed ferry service would not improve whereas it has; secondly, he is sceptical about the traffic forecasts; and thirdly, money would be very expensive to borrow with the present high interest rates. Nevertheless, if a link is desired, he favours the twin bored tunnel, such as was abandoned in 1975; it is felt there is too much uncertainty with bridge options (43). As well, the Channel Study Working Party publishes its report (financed by opponents to the link—the Dover Harbour Board, European Ferries, Hoverspeed and Sealink), concluding "at best, the channel tunnel was a high-risk, low-return investment, while at worst it was a waste of money.....the cross-channel price war had wrecked the Channel Tunnel's finances." (43).

04/1982: Falklands war; relations cool between Britain and France in light of French arms sales to Argentina.

05/1982: In the midst of a Falklands war, and shortly after the British HMS Sheffield is sunk with a French Exocet missile, Mitterrand and Thatcher meet. Their discussions were dominated by EEC and Falklands issues; "Thatcher was in no mood to come to any accommodation with Mitterrand over the tunnel." She "effectively vetoed the tunnel project." It was noted "the change in British attitudes stems as much from a general coolness between Britain and France and the weakness of ....the British transport secretary, as from doubts about the tunnel itself." (44) Other differences cited include views of public (French) versus private (British) financing; as well, the French seek guarantees against another British cancellation (44). Private investors are cited as wishing guarantees against cancellation and in case traffic falls below expectations (44). No date was set to resume Anglo-French project discussions.

06/03/82: Government silent on the fate of the project, however, "the fact that studies are continuing is seen by some observers as a face saver for the French. And it is almost certain that there will be no tangible progress on the Channel Tunnel during the lifetime of the present government." (45).

06/16/82: Report of Franco-British working group published, "broadly favours a tunnel....makes it clear that if the Channel Tunnel were to go ahead, it would be a political decision to proceed....(it) effectively rejects plans to link....(with)..a bridge or a combined bridge and tunnel.....work on a tunnel

could begin in 1984 and be finished by 1991....it would be difficult to find private finance for a twin tunnel."(48). In response, Britain's transport secretary and French counterpart announce more studies on the fixed link are required; now an inquiry into finance. The transport secretary "refused to deny that Thatcher had cancelled the project" (48). It is reported, "originally, President Mitterand had no such qualms at pledging public money. Experience of government has changed his mind—the French now take the British line: money must come from the international money markets not from the voters."(46). The French Minister of Transport says "...the hour of truth for the tunnel will come in the autumn.....it would only go ahead if the two partners showed firm political will."(48). The Economist comments "what everyone...really wants is a straightforward road link, impeded only by customs officials and duty-free shops. All proposals which promise this are still, sadly, unconvincing on two points—their ability to raise the necessary money and adapt engineering techniques (some still unproven) to the special circumstances of the world's busiest shipping lanes." (46).

06/24/82: The government inquiry on legal and financial aspects of the project is to be undertaken by Midland Bank Ltd., National Westminster Bank Ltd. and Credit Lyonnais, to report in the fall (49). Banque Nationale de Paris and Banque Indo-Suez brought into study (50). British government "refuses to bear any commercial risk.....would only consider getting involved if the project was cancelled for political reasons."(50). Banks reportedly undertook the study to gain the inside track in the project financing (52).

03/1983: EEC reportedly considering whether it could provide private financing guarantees or otherwise be involved in the project; they request the banks extend the study terms to include the EEC. The financial review of the project now scheduled for completion in early summer (51)(52).

05/24/83: On an electioneering visit to Dover, Thatcher promises the construction of the tunnel "is not a live issue."(190)

08/1983: Chairman of British Steel discloses "two large French construction groups, one with engineering interests, are preparing to form a joint venture with his (so far) all-British consortium", i.e. EuroRoute bridge-tunnel (52). Also continues to point to the advantages of EuroRoute. The "long-overdue" bank study is now expected in late September. The report is expect to conclude private financing is possible with "...certain conditions, which include some form of risk-sharing by the public sector....construction of a rail-only link, which is faster and cheaper to build than the brunnel, would be easier to finance privately" (52).

02/1984: Rival tunnel proponents pool their resources and form the Channel Tunnel Group, now consisting of five British Construction Companies (Balfour Beatty, Costain, George Wimpey, Tarmac and Taylor Woodrow) (60). National Westminster Bank, (one author of financing report) joins the CTG (61). CTG appoints Sir Nicholas Henderson, former ambassador to France and "who was close to Thatcher during the South Atlantic war"(65).

05/24/84: Long-awaited report on financing finally submitted. The report concludes financing is possible "....only if the government would carry at least a limited and circumscribed part of the financial risk" (54). The government does not agree, however; the British transport secretary says "any link.....(will) have to be financed entirely from private capital"(55). Report favours a twin rail shuttle link, concluding it is "the only scheme that is both technically acceptable and financially viable" (56), but the report is labelled "outdated" and a "serious misjudgment" by EuroRoute, who want an independent engineering assessment of the rival schemes (53). The study estimates the twin tunnel would cost around £2,000 million to build, £7,500 million with escalation and interest; the EuroRoute would require £54,000 million with escalation and interest. EuroRoute claims that is too high - £25,000 million is more realistic (55).

10/1984: EuroRoute announces "French engineers (from GTM Entrepose)....outlined proposals to cut significantly the cost of a proposed bridge and tunnel link" (58), which are thought to involve "financial separation of the road and rail parts and a new design for the bridge section suspension cable elements." (58). It is noted "EuroRoute will come up against the British Government opposition to a Channel link based on a bridge which could be a danger to shipping or technically doubtful." (58) EuroRoute cost quoted at £4,060 to £4,400 million (58).

11/1984: Thatcher and Mitterrand meet, and agree "....to draw up the technical and financial specifications for a link, in political horse-trading which involved the EEC budget."(65) Anglo-French officials set to work, and agree upon a process for evaluating all proposals, and that guidelines for a method to select a project will be prepared in the upcoming months, covering safety, environmental and operation guidelines (59). As well, the proponents of the bored tunnel alternative announce they can cut the construction time for the tunnel project from six to four and a half years, thereby enhancing the amenability of the project to private financing (59).

12/1984: A EuroRoute poll claims 53% of Britons, and 59% of Frenchmen favour the 'brunnel' concept, in contrast to 28% and 18% favouring the 'chunnel' scheme (60).

04/01/85: In anticipation of the issuance of a 'Request to Promoters', French contractors and bankers negotiate their participation with The Channel Tunnel Group Ltd. consortium (Costain, Tarmac, Balfour Beatty, Wimpey, Taylor Woodrow, National Westminster Bank, two merchant banks) advocating the twin-tunnel scheme. The French partners will set up France Marche, as 50% owner, and consists of Societe Generale d'Enterprises, Societe Auxiliare d'Enterprises, DUMEZ, Bouygues, SPIE-Batignolles and three French banks. "...construction contracts would be negotiated with founder contractors, under arduous terms to win the confidence of investors."(61)

04/02/85: 'Invitation to Promoters' jointly issued by Britain and France; competing consortia must submit proposals by October 31, at which time the governments anticipate a three month evaluation period. Guidelines state the design must have a 100-year (62) or 120-year (64) life, and bridges must be able to withstand collision with a 250,000-tonne supertanker travelling at 17 knots (65); offers political guarantees against cancellation; pricing freedom but no government financing guarantees. Proposals "....will not need to include detailed engineering test results"(62), but the governments "...want to be satisfied that any project we choose is not going to give rise to any deleterious effects."(62). The proposals must include "....detailed financial forecasts from the start of the project until at least ten years after loans are repaid, and estimates of the number of jobs created."(63) As well, the government "...expects equity financing to form a substantial part of the funding.....(and) also want to see how much of their own money the consortium members are chipping in."(63) An Anglo-French treaty, and the passage in the House of Commons of a hybrid private and public bill will be necessary; "....the two governments will promise not to halt the project for the length of the concession save on grounds of a national security."(63) Sponsors are "...confident they can raise the necessary funds through a combination of City project financing and public flotation" (63). It is reported that "...the betting is on EuroRoute. Mrs. Thatcher would like a scheme which allows people to drive across, even if the return is lower."(63)

07/1985: EuroRoute brings in, as an equity partner, British merchant banker Kleinwort Benson, and opens negotiations with the railways, who have up until now, favoured the CTG scheme.(66) It is reported "It is still anybody's guess who will win."(66)

07/1985: Channel Tunnel Group announces formation of a new Anglo-French consortium, consisting of three French banks (Banque Nationale de Paris, Credit Lyonnais and Banque Indo-Suez); five French contractors (Bougues, Dumez, Spie Batignolles, Societe Auxiliaire d'Enterprise and

Societe General d'Enterprise); five British contractors (Balfour Beatty, Wimpey, Costain, Tarmac and Taylor Woodrow), and one British bank (National Westminster Bank). The CTG ".....now has the support of four out of the five banks that conducted an independent review for the French and British governments.....only Midland Bank, out of the five, has yet to commit itself to supporting a scheme.....most of the major construction companies in the two countries also support the scheme..."(67)

08/1985: Speculation mounts; it is reported "The race to build the Channel tunnel, or possibly bridge, is hotting up. Establishing itself as the clear favourite, because of the strength of its political and commercial backing, is the Channel Tunnel Group.....Senior Whitehall officials say that the Prime Minister personally favours the tunnel, rather than the bridge."(67) It is reported the Prime Minister wishes to launch a scheme before the next general election, to help her image on unemployment, hence the lowest technical risk scheme is the tunnel. However, "Thatcher's well-know antipathy for the railway" (67) was pointed out. EuroRoute is reportedly cooling on their plans to incorporate a rail tunnel, citing construction costs and the difficulty in generating sufficient traffic because of the attractor of the road link.(67)

09/1985: Japanese bankers, including the Bank of Tokyo and Industrial Bank of Japan, meet with CTG, who request £1,000 in financing from the Japanese. Japanese participation in the engineering and construction was "largely dismissed.....(British engineers)...claiming that the Japanese got the technology from the British in the first place."(70)

09/1985: Flexilink launches a £400,000 advertising opposition campaign, "..harnessing the widespread English distrust of anything foreign in support of its triple aims of persuading the Government to reject all the schemes submitted, blocking the successful project in Parliament and through the courts, and sabotaging fund-raising in London financial markets...."(190).

10/19/85: Merchant bankers in Britain and France work on financing arrangements for the schemes; EuroRoute reported has spent £12 million to date on their proposal (68). Barclay's Bank now part of the EuroRoute scheme (68).

10/24/85: EuroRoute announces their scheme would invest £280 million in offshore vessels, thus "....open a large market for similar tunnels longer than 40 km.....we see an opportunity for further major immersed tube work."(69) The consortia vying for the crossing are estimated to have invested a total of £20 million on proposals (69).

10/31/85: Ten groups submit proposals to the governments regarding a fixed link; four were accompanied by the required £175,000 deposit. The

governments promise a decision in mid-January; the two front-runners are cited as the CTG/France Manche twin-tunnel and the EuroRoute UK/EuroRoute France brunnel proposal.(72)

11/1985: The Nature Conservancy Council, "the government's watchdog on conservation"(73) warns it will oppose EuroRoute on the grounds of adverse environmental impact on a wildlife refuge on the Kent coast. EuroRoute's submission admits that it "....is the most sensitive environmental impact of its proposal."(73) The EuroRoute scheme is "....said to be favoured by the Prime Minister."(73)

11/14/85: Agreement reached between the railways of Britain, France and Belgium regarding the details of trains to run through the tunnel(74).

12/12/85: House of Commons transport committee narrowly votes in favour of the CTG twin tunnel scheme, preferring it "....because of proven technology, because it was more likely to be built within time and budget that the other contenders and because it minimized the environmental effects."(75) Additionally, the committee felt "....only if the governments consider a fixed road link to be indispensable should the choice fall on EuroRoute."(75) EuroBridge and Channel Expressway were "largely dismissed."(75)

12/15/85: Department of Transport and Treasury submit engineering and finance evaluation to cabinet; "it is generally accepted that only the tunnel options are still in serious contention"(76), i.e. the CTG and the "dark horse" Channel Expressway road and rail tunnel proposals. All other schemes "...ran into serious technical objections"(82) when assessed under 21 different headings (82). Treasury is uneasy regarding high uncertainty in traffic (hence revenue) forecasts, cost estimates are optimistic, and "There is a suspicion that the promoters know quite well they will come crying to some future government for help, either when the money runs out half way across, or when profitable traffic fails to materialise."(76) The emergence of the Channel Tunnel Group as the clear winner of the technical review "....has been largely accepted by the French government, but British ministers still hanker after a scheme which will allow motorists to drive all the way to France."(82)

01/1986: Newspaper and media blitz. Channel Expressway (i.e. Sealink British Ferries) claim it's scheme is "The tunnel people want from the cross-channel professionals."(82) Polls report 51% of the British public, and 73% of the French public, favour a fixed crossing; 28% of British public and 38% of the French public favour Channel Expressway versus 16% and 10% of British favouring the EuroRoute or CTG scheme; and 15% and 10% of French favouring the EuroRoute of CTG scheme (83).

01/18/86: With a joint announcement by Thatcher and Mitterand on the winning project scheduled for January 20, "The politicians are having a fearful time trying to agree on one scheme."(83) British transport secretary asks the three consortia (CTG, EuroRoute and Channel Expressway) to "look for common ground"(83). EuroRoute (perceived as last in the race) seeks a linkage with CTG, who refuse, feeling they can win alone, and the French firmly favour the scheme; the British regard Channel Expressway favourably. Mitterand would like to give the project a go-ahead prior to French parliamentary elections upcoming in March (83). Morgan Grenfell, banking advisor to the CTG scheme, advises the British government "...that international financing obtained for the CTG-France Manche project could not be transferred to any other scheme."(95)

01/20/86: Thatcher and Mitterand announce the Channel Tunnel Group scheme receives official approval to proceed (84); the loosing Channel Expressway proponents claim a change in government in France will scuttle the CTG proposal (85). CTG will be required to submit, by year 2000, a plan for a road link (85). The British Government must prepare a White Paper (expected within two weeks); followed by a Anglo-French treaty (signature expected in February); and debate, committee hearings and passage of a hybrid bill in the House of Commons (which could take over a year) (85). Construction cannot commence until passage of the bill (ratifying the treaty). CTG has spent an estimated £5 million on its submission, with a further £10 million estimated expenditures prior to receiving the final approval for construction in eighteen months (85). "Speaking in parliament, Nicholas Ridley, the Secretary of State for Transport said the CTG's scheme was well-developed, used proven technology and was less risky and less expensive."(86)

02/1986: Department of Transport publishes its technical assessment of the proposals, stating the CTG scheme "..beat the three other contenders in every major category....(and it)..involved the fewest engineering risks."(91)

02/12/86: Treaty signed between France and Britain covering the project (Cmnd #9745); to be followed by the introduction of a hybrid bill (in March) which "should achieve Royal Assent in the summer of 1987"(91) to allow work to commence.

03/16/86: French elections; new right-wing government and Prime Minister. Although "doubts arose whether France would remain committed after the right-wing electoral victory....these doubts have been stilled..."(97)

03/1986: British Rail and SNCF officials "are at loggerheads over whether the high-speed trains that will run through the tunnel should be based on British or French technology."(93)

04/14/86: Channel Tunnel Bill introduced into Parliament, intended on giving "..planning permission to the tunnel, and a wide range of associated works...rail terminals at Cheriton near Folkestone, and Waterloo in London; improvements to the railway line between the tunnel and London...(and) the dumping of spoil. ...The extent of the Channel Tunnel Bill removes any possibility of a public inquiry into any aspect of building the tunnel. .....However, a public inquiry will be held in France."(96)

07/01/86: EuroTunnel p.l.c. and EuroTunnel S.A. registered as a public company in France and Britain, "an Anglo-French group which has been granted a concession to develop, finance, construct and operate the Channel Tunnel between the UK and France."(98)

07/1986: British public opinion indicates "...46% of Britons against the tunnel, only 31% for. ....(and) the deep hostility of the green lobby and those whose lives or livelihood in Kent might be disrupted."(97) The Channel Tunnel Bill is about "..a month behind its promoters' hopes..."(97)

07/1986: Planned institutional equity issue of £206 million postponed to September; "....the delay resulted from haggling with 38 banks over terms covering.....loans and standby credits....Analysts agree that the largely technical delay does not damage the overall financing program....investment managers in London...point out that investment at this stage involves considerable risk and a very long-term approach....Critics, who have mounted a vociferous assault on the project.....have now moved into the financing battle. ...Sealink British ferries sent potential investors a document claiming the project would lose more that $500 million in the first years of operation. Eurotunnel's financial advisors are predicting a profit of almost $600 million in the same year."(99) As well, Sealink "...attempted to scare MP's into voting against the project by sending them a....specially produced video, painting a doomwatch picture of what would happen if fire broke out the in the 22-mile tunnel."(103)

08/1986: Main construction contract signed (119) between Eurotunnel and TML, who are to hand "over a completely operational system, including terminals and rolling stock, to Eurotunnel on May 15, 1993 within a budget of £4,6000 million."(138) The contract was signed prior to the issuance of the institutional equity, because, "Eurotunnel's board of directors, which was by this injection of capital made independent of the company's founder shareholders."(119) Contract has a commencement date of May 15, 1986 and a contract period of seven years (120).

10/27/86: Eurotunnel "organisers were cheered....when Sir Nigel Broackes, the chairman of Trafalgar House....which had backed an unsuccessful

alternative proposal for a road link announced...he was joining the Eurotunnel board."(102) "Sir Nigel rode smiling to the rescue. He joined the board as a non-executive director, reassured reluctant institutional investors with he considerable presence and spared the British government the embarrassment of having to confess that the City of London would not finance the project."(108)

10/30/86: Eurotunnel barely manages to raise the £206 million institutional equity offering, extending the deadline by one week and "the Bank of England resorted to arm-twisting to find backers for the £10 million or so that the offer lacked...."(101) "The failure...to meet its British target is being ascribed to two factors. The first is the reluctance of British Rail's pension fund to invest in a project which would clearly benefit many of the present contributors to this fund. The second is that the recent sales of state assets....have soaked up capital funds and left little over for investment in new industrial projects."(101) The British Rail pension fund reportedly refused three requests to buy £10 million of equity (130).

02/1987: Eurotunnel reportedly "...struggling to change itself from a consortium of tunnel-building experts into one with the broader range of talents needed to plan a complicated cross-channel service....it has been slow to order the novel shuttle-wagons...."(108)

02/14/87: As Eurotunnel "scrambles to find a new British co-chairman.....the impending resignation of the current British co-chairman of Eurotunnel, Lord Pennock, follows months of muttered misgivings about the organization....The future of the project now hinges on Eurotunnel's ability to find a powerful and committed new chairman who can win the British investing institution's support for the coming issue of equity."(110) Meanwhile, Mrs. Thatcher and her ministers are "....bracing itself for the possibility that the link may not now be built.....the transport secretary (advises)..the financing problems were probably more serious than recent press reports had suggested."(110)

02/14/87: Lord Pennock resigns as chairman; "Several senior industrialists have declined invitations to succeed him."(111) It is reported "Amid resulting criticism of the British management, Sir Nigel Broackes was appointed a director of the board, and tapped as a likely successor to Pennock."(111) {Comment he was previously a non-executive director}. It is expected that the offering date of the public equity issue will slip from early July to September.(111)

02/21/87: Broackes resigns from Eurotunnel; a new British co-chairman is expected to be confirmed shortly (112).

02/1987: Alastair Morton, chief executive of Guiness Peat since 1982, appointed British co-chairman. Lord Pennock continues as Eurotunnel director (119).

03/1987: A confidential independent audit of the project, commissioned by the consortium of lending banks, focusing on "the financial risk that investors would face if the tunnel took longer to construct than planned, or if traffic failed to live up to the forecasts"(113), reportedly concludes "the financial returns claimed by Eurotunnel were correct, and that there was little chance of construction problems reducing the returns or of the forecasts being wrong."(113)

03/06/87: Herald of Free Enterprise ferry sinks with the loss of almost 200 lives (190).

04/1987: Design contract for the British half of the tunnel works awarded to Mott, Hay and Anderson, who were the principal designers on the pre-1975 project (114).

04/1987: "However, safety is likely to become rather less contentious. The ferry operators, who have been most vocal about safety, have not been helped by the tragedy of the Herald of Free Enterprise."(115)

04/1987: Mr. Alastair Morton, joint-chairman of Eurotunnel, postpones the public equity offering, "....and set about stripping away every uncertainty before making a pitch to investors some time in the autumn."(117)

04/22/87: Ratification of the Treaty by the French National Assembly (190).

04/30/87: House of Lords Select Committee on the Channel Tunnel Bill finishes hearing petitions; a record total of 4854 petitions in the Commons and 1459 in the Lords were lodged (190).

05/1987: Flexilink and Hoverspeed commence a retaliatory advertising campaign against the tunnel, with the theme "Tunnel Vision" (190).

05/12/87: European Investment Bank approves a loan of £1,000 million to Eurotunnel, based upon "...the EIB's own independent assessment of the technical, economic and financial viability of the project."(119)

06/11/87: U.K. general election; Thatcher's government re-elected.

06/1987: French start work excavating a 35m diameter access shaft. In the U.K., commencement of the works awaits Royal Assent for the Channel Tunnel Bill, expected, although a plant has began casting the concrete lining segments (118).

07/23/87: Channel Tunnel Act received Royal Assent.

08/1987: Approximately 50 international banks agree to underwrite loans for the project, involving an eighteen year payback, and an interest rate of 1.25% above the London Inter-bank Agreement rate. Approximately 30% of the loan is from Japanese banks and 25% each from British and French (122).

09/1987: Eurotunnel's co-chairmen are "...touring the world financial capitals to broaden participation in ....(the) loan package.....sponsors want to spread participation over at least 150 more banks worldwide."(122) Visits are paid to 531 banks (130) in Europe, Bahrain, Tokyo, New York and Toronto.

10/31/87: Stock market crash, followed by heavy losses by institutions underwriting the large British Petroleum privatization issue (133), resulting in nervous investors and underwriters.

11/1987: The final loan credit is signed with a worldwide syndicate of 198 banks, only two of which were American (130).

11/05/87: Eurotunnel claims the stockmarket crash "...hasn't affected our plans in any way."(126); "Eurotunnel must press on regardless..."(126), and releases a pathfinder prospectus for the issue of Equity III shares to public. Underwriters will be studying the prospectus closely and are nervous; "....decisions will be taken when the underwriting terms have been settled and hinge on the state of the stockmarket on the eve of the issue."(126) If the issue fails to float, the project is unlikely to proceed (136).

11/13/87: The prospectus reveals the project is already three months behind schedule because of financing delays; the revised schedule indicates a delay of five months, using up most of the allowed-for six months slack (127). Other reports indicate the delay was due to the "...liquidation of one of the tunnel boring machine suppliers"(139); this report is later confirmed (141).

11/16/87: Financial institutions agree to underwrite the Equity III issue, "...with no escape clause ....which means that the share issue will raise £750 million."(128) Share units are priced at £3.50 each.

11/27/87: Interest in the offering is cited as "mildly surprising"(131). Application lists for Equity III closes, with a reported 20% undersubscription in both Britain and France (136).

11/28/87: The first of eleven tunnel boring machines commences work (132).

12/10/87: Stock exchange dealings in the Eurotunnel shares commence (129); share prices drop almost 30% (136). The price weakness is attributed to dumping by underwriters (139).

12/20/87: John Anderson, loaned from Bechtel is appointed deputy managing director of Eurotunnel. Although Bechtel will not receive a construction management contract from Eurotunnel, it is expected they may provide up to 25% of the 400 to 500 personnel on the Eurotunnel management team (134).

12/30/87: Shares hit a low of 233p. The project had expended £444 million, including £156 million in construction contracts and £220 million in corporate and financial costs. A total of £1,020 million raised as equity (139). Bank draws are projected to be required before the end of 1988 (141).

04/1988: Disagreements between British Rail and SNCF regarding the construction of a high speed rail line from the tunnel to London and traffic forecasts. SNCF plans on spending up to £1,800 million on its' high speed TGV line, while British Rail is reluctant to spend more than £550 million, which will allow only limited upgrading. The French, and Eurotunnel would like to see a new British high speed line, which is costed at an additional £1,000 million (140).

05/1988: The "ferry operator P&O's attempts to shave operating costs and the recent bout of price cutting on short haul air routes are a foretaste of things to come when Eurotunnel brings its massive dose of additional cross-channel capacity into play."(141) Investment analysts are still not impressed with Eurotunnel, recommending "The shares are only for those who can afford to lose their entire investment."(141)

05/14/88: Eurotunnel co-chairman, Alastair Morton, calls "..for a partnership between private capital and British Rail to build a new designated track"(142) between the tunnel and London, arguing without it, the rail route will be too slow. British Rail will build a new line only if it is proven profitable.

06/30/88: Tunnelling progress is slow; although scheduled at 52 feet per day, the French seaward service tunnel has progressed less than 150 feet in the past two months, plagued by breakdowns; these startup problems are "taking longer to resolve than ...hoped" (143).

07/1988: A British Rail report estimates, on the basis of its own (lower) traffic forecasts that the capacity of the tunnel to London rail route will be exceeded at peak summer times immediately upon tunnel opening, and

year-round 13 years after opening. Since no new link is proposed until at least 1998, "...the 280 km/hr French trains will slow to a stately average of 80 km/hr for the journey through southeast England."(144)

08/25/88: Eurotunnel serves notice on TML "that the rate of tunnelling is not sufficient to meet the project schedule."(145) TML has met Milestone One (start up, U.K. seaward service tunnel; but missed Milestone Two (start up, French service tunnel) and Milestone Three (1 km on French tunnel by July 1). With progress to date at 1.8 km on the UK side, 200 m on the French side, TML is likely to miss Milestone Four (UK service tunnel 5 km by November 1). TML is to respond with a detailed plan; targetted tunnelling rates are 200m/week (UK) and 50m/week (France) (145). It is anticipated that Eurotunnel will commence drawing the bank loans in October (145).

10/02/88: Tunnelling has reached 3,080 m and 301 m (UK & France) (149) which is "between three and four weeks behind schedule"(147), and has picked up "slightly" since Eurotunnel's notice to TML. Average rates of tunnelling are 107m/week (UK) and 18 m/week (France); targeted rates are 200m and 70 m/week (147); both tunnels should have reached at least 1 km further (149). Completion is still anticipated on time in May 1993, and Eurotunnel expects to draw bank loans in early November; the 22 lead banks have granted permission, confirming Eurotunnel had satisfied the "conditions precedent" for the loan (149); approval from the remaining banks are expected to follow (148). "The crucial indicator is the cover ratio....(Eurotunnel) said ...it was still 20% above critical levels"(149). Eurotunnel updates cost and revenue estimates; revenues are 6% higher (better economic conditions) while costs are 7% higher, (construction costs now at £5,227 million) "in large part because of the expenses associated with closer supervision of TML"(147). British co-chairman Morton feels "....the contractor has been inefficient....(and) has an equipment and management problem, not a tunnelling one."(148) "TML is set to incur penalty fines of up to £10 million in November"(148). "TML is putting up a stout defense, submitting around 80 claims for extensions of time for delays beyond its control"(150).

10/13/88: Banks release the first $350 million of the loan facility (150).

11/02/88: Progress on the English tunnel reached 3.6 km versus 5 km planned. Four TBMs are at work with three more planned by next month. (152)

12/1988: While the French seaward service TBM, which was 500 feet ahead of schedule suffers a serious breakdown, progress of the other TBMs is improving but remains behind schedule (153). "The best weekly advance so far is 500 feet, well short of the 650 foot average that must be consistently achieved every week for the next two years."(153)

12/18/88: The chief executives of the French contractors in TML hold a press conference, '"who emphasized that they were speaking for themselves, and not for TML. TML's contract with Eurotunnel prohibits it from speaking with the press."(154) They claim "TML's relationship with Eurotunnel and TML's boring machines both were undergoing longer than expected running in periods."(154) Critical sections of the work are reportedly five to six months behind schedule; TML cites three causes for delays: "First, Eurotunnel was late in raising financing, so TML had corresponding delays in ordering equipment. Second, Eurotunnel did not release land fast enough. And third, TBM producers took longer than expected to design and manufacture the tunneling machines"(154) and is claiming a five-to-six month extension (154).

02/1989: Spurred on by the report the British tunnel has reached the 5 km milestone (three months late) and tunnelling is averaging 200 m per week, the stock price surges to 835p (155), up 28% in three days and up 163% since last September (156).

02/08/89: A report that the completion date of May 1993 may not be met sends share prices down 9% (156).

04/1989: Eurotunnel announces a revised completion date of June 15, 1993 (164), contract extensions of up to three months to TML, and additional incentive payments to TML of £106 million if the completion milestone is met (163). Estimated construction costs grow to £5,500 million because of increased interest charges due to the delay (163). The banks are reportedly "looking for quantifiable improvements if the utilisation of the project loan facility is to continue"(163). The service tunnel boring progressed towards each other at 1,400 feet per week, "25% faster than necessary"(164). Target boring approach rates are raised from 984 feet/week to 1,105.6 feet/week, although the lower target rate was only met three of four times in the past year.(164). Although the accord ended "nine months of arduous confrontation"(164), "...there is still discord over personalities....lending banks insisted on top-level changes....Eurotunnel replaced its previous managing director.....Morton says it is essential that the joint venture find a new chief executive as soon as possible."(164)

05/1989: TML appoints an American engineer, J. K. Lemley as chief executive officer. Eurotunnel "believes the project climate has improved significantly (and)...are communicating a lot better...(and in a) more cooperative manner than a year ago."(165)

06/1989: TML announces a driving record for the service tunnel was set, with 2,097 feet bored in 30 days (167).

10/2/89: Eurotunnel announces construction costs have risen "more than $3.2 billion above the 1987 estimate of $7.8 billion....it is short $1.6 billion to complete the work....but is prevented from raising extra cash by a contractual impasse with TML..."(168). This funding gap leaves Eurotunnel "technically in default of its credit agreement with the bank syndicate"(168). Eurotunnel says "talks between Eurotunnel, TML and its shareholders, and the banks are continuing and we believe we can achieve a common view of costs and contingencies as a basis for putting additional finance finally in place early in 1990.....Eurotunnel will ask its shareholders to put up 25% of the shortfall as equity, next year or in 1991, and it will borrow the rest from its banks."(168) TML and Eurotunnel disagree over the lump sum contract work for construction of the terminals; "the massive disparity has arisen because designs for the works were at an early stage when the original contract was signed."(169) TML's claims for design changes and costs "allowing for inflation up to project completion in 1993....is equivalent to $1.2 billion"(168). The Maitre d'Oeuvre is to referee the dispute and assess "...whether extra spending on these items projected by TML is due to Eurotunnel's specifications."(171) TML continues with a management restructuring which "has obviously improved the relations"(168) between TML and Eurotunnel. "The ....(tunnelling incentive and penalty) arrangement for preventing cost overruns had collapsed because TML had incurred all possible penalties."(174) Shares are down to £5.28, compared with a 1989 peak of £11.64 (169).

10/10/89: Eurotunnel reports that the French main tunnels are eight and thirteen weeks ahead of schedule, while the British main tunnels are eight and twelve weeks behind schedule. Opening date is still projected for mid-1993 (170).

12/1989: The Maitre d'Oeuvre "ruled broadly in Eurotunnel's favour" with respect to a disputed £380 million over-run on equipment and terminals; TML claimed Eurotunnel had "...made more demanding specifications than in the original contract."(174) Although TML could go to international arbitration, the banks "have accepted Eurotunnel's view that ....TML...is likely to lose."(174)

01/09/90: "After 99 days on the brink of bankruptcy" (174), the bank syndicate reportedly agrees to release a further £400 million in funds (176), and gives Eurotunnel until May to arrange financing (at least 25% in equity (176)) for the estimated additional £1,500 million required (174). "Eurotunnel is to undertake another estimated-cost-to-completion exercise in conjunction with the bank's technical adviser and the Maitre d'Oeuvre."(176) The banks required Eurotunnel to "settle on a firm revised costing for the project, and produce new agreements with TML to minimize the risk of

any further rise in costs."(174) Eurotunnel estimates the figure of £7 to £7.2 billion plus some contingency; a revised tunnelling incentive formula is agreed to (TML will pay 30% of overruns, without limit) with new bonuses and penalties to encourage completion by June 1993 (174). Tunnelling costs now estimated at £1.58 billion; TML will be paid £87 million more, the equivalent of the previous penalty payable (178). Eurotunnel agrees to trim, by 25%, its project supervision overheads and adjusts TML's incentives and procurement fees (176). Eurotunnel and TML have found £100 million in savings, "largely by reducing the 100-mph design train speeds to 80 mph."(177); "Eurotunnel maintains that the Chunnel system's capacity and revenue will be unaffected by the speed limit."(179). Still, "Despite months of negotiations, the tunnel protagonists are still unable to agree on a fixed price for the contract covering the railroad terminals and operating equipment in the tunnels. The two parties remain several hundred million dollars apart....TML say Eurotunnel design changes are inflating costs, and it aims to resolve this dispute through arbitration."(177)

01/12/90: The construction death toll rises to five; four have died in accidents on the British side, one in accidents on the French side (175).

02/08/90: A leaked letter reveals TML is very critical of Morton, Eurotunnel's co-chairman. TML believes "...Morton has downplayed the major administrative changes TML exacted from Eurotunnel. ...(TML) would not have signed the agreement were it not clear that far-reaching senior management changes in Eurotunnel were irrevocably committed. If the project is to survive, a dramatic improvement in the way that Eurotunnel exercises its management of the contract is essential."(181). Further, TML claims Eurotunnel "...implied TML's acceptance of a maximum speed of 80 mph: This is incorrect. We believe that 80 mph is still too high."(181)

02/1990: Eurotunnel reports a record month of tunnelling; the service tunnel is scheduled to breakthrough in December. Nevertheless, with French main tunnels 12 and 16 weeks ahead of schedule, British main tunnels are 21 and 17 weeks behind (182).

02/14/90: TML, "...under pressure to reduce costs and improve productivity in the U.K." (183), undertakes more middle-management streamlining, "...appointing another American manager as results of a complete organization review.....Eurotunnel, too is expecting major shake-ups in its management...."(183). TML reportedly "can't stick Morton day to day"(184) and want him replaced; as a concession, a new deputy chief executive will be announced (184).

02/19/90: Eurotunnel admits that the previous announcement by Morton that a "partial" agreement to release £390 million in interim financing was

premature; the banks have only now agreed (185). TML refuses to sign an agreement unless Morton is removed; the banks refuse to release funds unless TML signs. Eurotunnel withholds a $105 million payment to TML, which goes to a French court, for the second time in 1990, and receives a favourable ruling (187).

02/21/90: "...the very public row was worrying Bank of England officials, who brought the warring parties together. ....TML threatened to stop work unless Morton relinquished some control."(187). Eurotunnel accedes to TML demands; Morton is moved sideways to deputy chairman and chief executive, and "removed from the day to day management of the project"(185); an American Bechtel executive, John Neerhout, is to take his place (187). TML and Eurotunnel still remain "far apart on the estimated cost of the terminals and the tunnels' fixed equipment.....they will have to reach agreement before Morton can ask the banks and shareholders to pump in more cash."(187)

03/01/90: Boring starts on the last of 12 tunnel faces; landward service tunnels in France and the UK are completed. The service tunnels expect to meet in November (188). Work continues on redesigning the terminals for cost savings or deferral of some of the work until after revenue is generated (189).

04/23/90: Eurotunnel announces an additional £2,500 million in financing will have to be raised, through a mix of shareholder equity and additional bank loans. The skeptics remain critical regarding Eurotunnel's ability to pay back the debt, which may exceed £7,000 million; on June 14, Hoverspeed will launch its new fleet of high-speed catamaran ferries which will cut the travel time in half, competing closely with times the tunnel will offer (with shorter times on some routes). (191)

12/10/1993: TML formally turns the completed project over to Eurotunnel for testing and commissioning. Phased-in operations are expected to commence March, 1994, with the official opening scheduled for May 6, 1994. (192)

The notes and references follow Appendix B.

APPENDIX B.
THE GROWTH OF THE CHANNEL TUNNEL PROJECT BUDGET (1874 - 1993)

1874:	**£10 million**.
1930:	**£30 million** (107).
07/1947:	**£65.5 million** (107).
1960:	**£112 million**; £160 million including escalation and interest costs (107).
1963:	**£143 million**; government estimate (107).
03/1973:	**£366 million**; 1972 costs, no inflation or financing charges. Government Green Paper (5).
06/1973:	**£846 million**; includes 10% contingencies. Forecast completion date, 1980. 10% to be raised by private risk capital; balance, including all escalations, to be raised by sponsors as Government guaranteed loans; full interest and debt repayment guaranteed. Coopers & Lybrand report (5). Includes: £468 million, construction costs, January 1973 costs and includes 10% contingencies; £192 million, interest during construction; £186 million, escalation to January 1980 (33).
09/1973:	**£464 million**; January, 1973 costs, no escalation, 10% contingencies. Government White Paper (1).
10/1973:	**£1,020 million**; "out-turn" (escalated to 1980) costs, which includes £192 million interest during construction (33).
04/1974:	**£970 million**; "final cost" (13).
03/1980:	**£1,171 million**; January, 1979 costs, Coopers & Lybrand report, March 12, 1980. Seven year completion. (23).
1981:	**£1,730 million**; 'Tarmac' scheme, private financing, three phases (I, single tunnel, £830 million, 1990; II, terminals and RO-RO, £420 million, 1996; III, 2nd tunnel, £480 million, 2004); (35).

1982: **£1,800 million**; Anglo-French study group reports costs "are likely to be reasonably correct"(65).

1985: **£2,600 million**, 1985 costs; £3,500 million, escalated, 1993 completion (71).

1985: **£2,700 million**, 1985 costs, Spring, 1993 completion. (Source: Tunnelling & Underground Space Technology, Vol. 1, 1986).

1985: **£5,736 million**, includes escalation and interest and £1,000 million contingencies; spring, 1993 completion. (Source: Tunnelling & Underground Space Technology, Vol. 1, 1986).

1986: **£6,200 million**, January, 1986 costs, includes escalation and interest and £1,350 million contingencies, (97).

Comparison between 1985 and 1986 cost estimates:

	1985	**1986**
Construction costs:	£2,725	£2,525
Optional extras:		101
Owner's costs:	368	296
Inflation:	586	660
Interest during construction:	1,057	1,152
Financing fees & costs:		114
Contingencies:	*1,000*	*1,350*
TOTAL:	**£5,736**	**£6,200**

10/1988: **£5,227 million** construction costs, 7.2% higher than the November 1987 estimate (149). "Costs...are expected to be 7% higher, in large part because of the expenses associated with closer supervision of TML" (147). "£80 million of the new costs are put down to Eurotunnel's new project information system to monitor progress and cost."(148) "...higher costs reflect recruitment of American consultants Bechtel to strengthen Eurotunnel's project management, tunnelling delays, rising construction costs, and extra facilities now deemed necessary."(149)

04/1989: **£5,500 million** construction costs, with a delay in opening to June 15, 1993, which increases interest costs (163).

10/1989: **£7,000 million** construction costs (Eurotunnel); **£7,500 million** construction costs (TML); Eurotunnel and TML disagree (169); or $10.2 billion (Eurotunnel) (168). Capital costs rise 48% (171); "...by Eurotunnel's own calculation, the project cost has risen by nearly 50% over the November 1987 estimate....costs of tunnel construction and surface works have both risen 30%, while rolling stock procurement....nearly 200%.'(168)

01/1990: **£7,200** million construction costs (Eurotunnel) plus contingencies (176); additional financing in addition to the £6,000 already arranged will be required. Tunnelling costs revised to £1.58 billion, which includes an increase to TML of £87 million, the penalty previously payable (178).

04/1990: **£7,600** million constuction costs; total financing of £8,500 million, including contingencies, required (191).

06/1990: **£7,660** million construction costs; additional rights issue of £530 million plus additional bank loans of £1,800 negotiated.

12/1993: Over **£10,000** million "final" cost; with over £1,000 million of TML's unresolved construction claims remaining outstanding. Claims against the British and French government are settled but claims against the British and French Railways remain unresolved.

APPENDIX B (CONTINUED).
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APPENDIX C

PROJECT RISK AND PLANNING ISSUES QUESTIONNAIRE

Questionnaire

Project

Planning

Issues

Ph.D. Thesis Research

August 1990

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The following questions (which should take about fifteen to twenty minutes to answer) explore some issues relating to projects, in the context of those upon which you are involved or responsible for in the Department, for the purpose of undertaking confidential research towards a Ph.D. thesis in civil engineering.

It is important to note that there are definitely no "right" or "wrong" answers; the only "correct" answers are what you honestly think and feel.

1. I would consider the departmental projects which I am involved with to be, on a scale of 1 to 5, where 1 *is not at all risky* to 5 which is *extremely risky* (circle):

Extremely risky (5).....(4).....(3).....(2).....(1) Not at all risky

2. If you think of or describe a project as *risky*, what do you mean? (Please be as specific as possible).

3. When you describe projects as *risky*, what do you feel are the *important sources* of risk on projects? (Please be as specific as possible).

4. What do you feel are some of the *specific risks* on the projects you are involved with? Please mark the risk you feel is most important.

5. What do you feel are the *best indicators* or *most appropriate measures* of project risks or a project's riskiness?

6. When you are faced with project risks, what are some of the *specific actions* you would take to reduce the risks?

7. How would you rate your own willingness to accept project risks or a risky project, as compared with: (circle)

(a) Those you report to?

Much more willing...more willing...about the same...less willing...much less willing

(b) Those who report to you?

Much more willing...more willing...about the same...less willing...much less willing

(c) Others in your position?

Much more willing...more willing...about the same...less willing...much less willing

8. To what extent do you feel you can exercise control over the risks of a project? (circle)

To a great degree.....to a moderate degree.....to a small degree.....not at all

9. What do you feel are the *most indicative* or *best measures* of **project success**?

For the questions relating to'"% chance' of an event, it may be useful to think in terms of 'number of projects out of every hundred projects'. For example, a "5% chance" of an event would mean that, on average, the event occurred on 5 projects out of every 100 projects.

10. Regarding the projects you are associated with, in general, what overall chance do you feel they have of *being successful*?

_____% chance of success

11. Clearly, completing projects *on schedule* is desirable. Nevertheless, late completions may sometimes occur. In general, for each of the following, what would you feel would be an *acceptable chance* of:

(a) **Not** completing a project on schedule? _____% chance would be acceptable.

(b) Completing a project *one month late?* _____% chance would be acceptable.

(c) Completing a project *two months late?* _____% chance would be acceptable.

(e) Completing a project *one season late?* _____% chance would be acceptable.

(f) Completing a project *two seasons late?* _____% chance would be acceptable.

12. Completing projects *on budget* is most desirable. Nevertheless, the reality is sometimes projects are not completed within the budget. In general, what would you feel would be an *acceptable chance* of:

(a) *Not* completing a project within budget? _____% chance would be acceptable.

(b) Completing a project *25% over budget?* _____% chance would be acceptable.

(c) Completing a project *50% over budget?* _____% chance would be acceptable.

(d) Completing a project *100% over budget?* _____% chance would be acceptable.

13. What do you feel are the *most indicative* or *most appropriate measures* of **project failure?**

14. What do you feel are the *characteristics* of a project or *events* which may lead to, or contribute to, **project failure**?

15. Overall, what do you feel would be an acceptable chance of a **project failing**?

_____% chance would be acceptable.

16. How would you rate the following characteristics pertaining to completion cost, as **indicators of project failure**, with 1 being *not important* as an indicator of project failure and 5 being an *extremely important* indicator of project failure? (circle)

(a) Completion cost **10% over** budget:

Not important (1).....(2).....(3).....(4).....(5) Very important

(b) Completion cost **25% over** budget:

Not important (1).....(2).....(3).....(4).....(5) Very important

(c) Completion cost **33% over** budget:

Not important (1).....(2).....(3).....(4).....(5) Very important

(d) Completion cost **50% over** budget:

Not important (1).....(2).....(3).....(4).....(5) Very important

(e) Completion cost **100% over** budget:

Not important (1).....(2).....(3).....(4).....(5) Very important

17. How would you rate the following characteristics pertaining to scheduled completion as **indicators of project failure**, with 1 being *not important* as an indicator of project failure and 5 being an *extremely important* indicator of project failure? (circle)

(a) Project is completed **one month** late:

Not important (1).....(2).....(3).....(4).....(5) Very important

(b) Project is completed **two months** late:

Not important (1).....(2).....(3).....(4).....(5) Very important

(e) Project is completed **one season** late:

Not important (1).....(2).....(3).....(4).....(5) Very important

(f) Project is completed **two seasons** late:

Not important (1).....(2).....(3).....(4).....(5) Very important

(g) Project is completed **three seasons** late:

Not important (1).....(2).....(3).....(4).....(5) Very important

18. How would you rate the following characteristics pertaining to O & M costs, as **indicators of project failure**, with 1 being *not important* as an indicator of project failure and 5 being an *extremely important* indicator of project failure? (circle)

(a) Once completed, O & M costs run **10% more** than originally estimated:

Not important (1).....(2).....(3).....(4).....(5) Very important

(b) Once completed, O & M costs run **25% more** than originally estimated:

Not important (1).....(2).....(3).....(4).....(5) Very important

(c) Once completed, O & M costs run **50% more** than originally estimated:

Not important (1).....(2).....(3).....(4).....(5) Very important

(d) Once completed, O & M costs run **100% more** than originally estimated:

Not important (1).....(2).....(3).....(4).....(5) Very important

19. How would you rate the following characteristics pertaining to the project's capacity, as **indicators of project failure**, with 1 being *not important* as an indicator of project failure and 5 being an *extremely important* indicator of project failure (circle)

(a) Once completed, the project accommodates or can function at only **90%** of the originally planned capacity:

Not important (1).....(2).....(3).....(4).....(5) Very important

(b) Once completed, the project accommodates or can function at only **75%** of the originally planned capacity:

Not important (1).....(2).....(3).....(4).....(5) Very important

(c) Once completed, the project accommodates or can function at only **50%** of the originally planned capacity:

Not important (1).....(2).....(3).....(4).....(5) Very important

(d) Once completed, the project accommodates or can function only **25%** of the originally planned capacity:

Not important (1).....(2).....(3).....(4).....(5) Very important

20. How would you rate the following characteristics pertaining to public scrutiny as **indicators of project failure**, with 1 being *not important* as an indicator of project failure and 5 being an *extremely important* indicator of project failure? (circle)

(a) The project is subject to numerous casework requests:

Not important (1).....(2).....(3).....(4).....(5) Very important

(b) The project is subject to intense scrutiny and criticism in the Legislature:

Not important (1).....(2).....(3).....(4).....(5) Very important

(c) The project is subject to intense criticism from the media and the public:

Not important (1).....(2).....(3).....(4).....(5) Very important

Consider the capital budget cycle, wherein a project is proposed and its budget estimated for inclusion in the Capital Five Year Plan. For example, in the fall of the year, project estimates would be prepared for those projects proposed to start in the upcoming fiscal year. At the same time, estimates would be prepared for projects starting in future years—in two, three, four or even five years hence. The following questions will solicit your views regarding the inherent certainty associated with each of those estimates.

21. Most recently, when preparing (or reviewing/approving) the budget for a project commencing in **Year 1** (i.e.. the current year) of the plan, in general, what do you feel the anticipated chances are of:

The project budget *should not be exceeded*, for the contingency amount will accommodate any uncertainty?

Anticipated chances are _____%

22. Now consider future projects—those which are planned to commence in **Year 3 (1992/93)** of the plan. Most recently, when preparing (or reviewing/approving) a **Year 3 project** budget, in general, what would you feel the anticipated chances are of:

The budget *should not be exceeded*, for the contingency amount will accommodate any uncertainty?

Anticipated chances are _____%

23. Finally, consider the far future projects - those which are planned to commence in **Year 5** (1994/95) of the plan. Most recently, when preparing (or reviewing/approving) **a Year 5 project** budget, in general, what would you feel the anticipated chances are of:

The budget *should not be exceeded*, for the contingency amount will accommodate any uncertainty?

Anticipated chances are _____%

24. Please consider the following statements, and circle how, in general, you feel: if you strongly agree; agree; are indifferent; disagree or strongly disagree.

(a) Budget overruns on a project can usually be justified.

Strongly agree.....agree.....indifferent.....disagree.....strongly disagree

(b) The reasons for a project's late completion are usually out of my hands.

Strongly agree.....agree.....indifferent.....disagree.....strongly disagree

(c) End-user acceptance of a project should be the most important goal of a project.

Strongly agree.....agree.....indifferent.....disagree.....strongly disagree

(d) Late completion of a project can usually be justified.

Strongly agree.....agree.....indifferent.....disagree.....strongly disagree

(e) Spread of bid prices is a good indication of the project's riskiness - the greater the spread between the lowest bidder and all others, the greater are the risks.

Strongly agree.....agree.....indifferent.....disagree.....strongly disagree

(f) Most causes of project budget overruns are usually out of my control.

Strongly agree.....agree.....indifferent.....disagree.....strongly disagree

(g) Problems on projects can be expected when the contractor bids too low.

Strongly agree.....agree.....indifferent.....disagree.....strongly disagree

(h) Maintaining a project on budget is generally more important than maintaining a project on schedule.

Strongly agree.....agree.....indifferent.....disagree.....strongly disagree

(i) Most projects, when completed, exceed their originally estimated budget for one reason or another.

Strongly agree.....agree.....indifferent.....disagree.....strongly disagree

25. Overall, I would regard:

_____% of my projects as *satisfactory*;

_____% of my projects as *marginally satisfactory*;

_____% of my projects as *not satisfactory*.

26. Problems on projects may arise for a number of reasons. Consider the following two scenarios and indicate, in your experience, the approximate percentage of project problems which may be attributed to each:

_____% of problems on projects arose from *events or scenarios* which **could not have** been anticipated;

_____% of problems on projects arose from *events or scenarios* which **could have** been anticipated.

27. Consider the following five areas as generally responsible for project problems, and indicate, in your experience, the approximate percentage of project problems which may be attributed to each:

_____% of problems on projects could generally be attributed to (i.e. could have/should have been controlled by) the contractor;

_____% of problems on projects could generally be attributed to (i.e. could have/should have been controlled by) the consultant;

_____% of problems on projects could generally be attributed to (i.e. could have/should have been controlled by) the C & TS project management team;

_____% of problems on projects could generally be attributed to (i.e. could have/should have been controlled by) other parties;

_____% of problems on projects could generally be attributed to reasons outside the control of any of the above parties.

Thank you for your cooperation. Comments on the Questionnaire?

Please return to the address on the questionnaire cover.

APPENDIX D. QUESTIONNAIRE DETAILED RESULTS

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
1. I would consider the departmental projects which I am involved with to be, on a scale of 1 to 5, where 1 is "not at all risky" to 5 which is "extremely risky":	(3)	(2)	(4) (3) (3) (2) (2)	(5) (3) (2)
2. If you think of or describe a project as "risky", what do you mean?	Whether or not the following will be achieved: • technical correctness and optimally functioning upon completion; • community and client acceptance of project; • budgetary expectations met (both capital and O&M); • done in time.	A measure of the chance of success that a project has of meeting its objective; the chances that a project will solve the problem.	• project is risky when there is a possibility that it may not meet one of the budget, schedule and scope. • risk in terms of failure; what are the chances of the project failing financially or physically; • usually the projects do not have a high chance of failure and hardly ever result in a catastrophic failure resulting in direct injury to the public or workmen; • failures usually result in inconvenience to the public, law suits and cost overruns. • the owner may not accept it (politically sensitive); • high chance of cost overrun;	• potential for some degree of failure; workmanship or material. • trench cave-ins; • danger to workforce from heavy machinery. • one risk may not be risky, but accumulated risks together can be; • multiple sources of risk combine; • consensus difficult to obtain.

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
2. If you think of or describe a project as "risky", what do you mean? ***(Continued)***			• possibility the project may not accomplish its intended goals. • outcome is uncertain, project may have a number of unknowns associated with it at the outset; • project has commenced without the benefit of adequate predesign work; • "politics" brings uncertainties especially with respect to the budget and senior level interference. Project that is susceptible to: • cost overrun; • not meeting intend of design; • not meeting intended needs; • public criticism; • late completion. • large dollar values; • concerns about contractors abilities.	

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
3. When you describe projects as "risky", what do you feel are the most important sources of risk on projects?	Haste: excessive push to deliver a project by an arbitrary/overly ambitious deadline; Technical skill: faulty design, construction; Improper public process/consultation, creating confusion, false/mixed expectations or/and mis/dis-information.	• can the problem be solved; • is the proposed solution correct or the best; • will the project be completed on budget; • can the work be completed within the allotted time; • are all factors known about the project	• unknowns associated with the project; • politics and senior level interference; • inadequate predesign work; • non-technical people trying to make technical decisions; • projects done in too much of a rush, without proper planning and project management steps occurring over the life of the project; • not following proper project management techniques. • making engineering assumptions during design instead of proving it with more $$$; • a "smart" contractor who would sooner open doors to claims than cooperate with the engineer; • awarding to lowest tender who may be only marginally qualified or may have bid too low; • poor engineering design and/or inspection; • substandard engineering.	• political source; political involvement with municipalities and bands, as these institutions have their own agendas, each pulling against rather than working with each other; • presupposing one supports the government view, this is not true. • trench collapse while work is in progress; • heavy equipment working in proximity to work force. • material failure; • poor workmanship.

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
3. When you describe projects as "risky", what do you feel are the most important sources of risk on projects? ***(Continued)***			• biggest source is contractor; this is always an unknown right up to the last stages; • many safeguards are built-in except contractor selection; • level of contractor expertise, experience, motivation; • contracting market is more variable and unpredictable than southern markets; cost control and estimating marginally more risky. • resources allocated to the project - people, $$$; • outside factors — weather, supply and cost of materials. • design error, wrong assumptions; • badly worded spec or drawing; • uncooperative contractor; • inexperienced contractor; • contractor bid too low; • inadequate policing of contract; • bad weather.	

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
4. What do you feel are some of the specific risks on the projects you are involved with?	• public fear; • public misinformation; • newness/novelty of approach; • land claims/aboriginal interests.	• soil conditions; • ability to get approval of review agencies; • ability to complete the work on budget and on schedule.	• inadequate budgets; • project management; • planning, design; • unknowns related to design and construction; • inter-governmental regulations; • contractor performance; • operating Authority's performance. • overdesign - reduces risk of cost overrun but inflates project cost; • unexpected soil conditions; • rainy weather during construction; • suppliers can't meet schedules; • poor estimating; • conflict between more than one contractor on site, or between subcontractors; • conflict between Engineer and Contractor; • bad contractor.	• poor assembly of components; • poor and uneven compaction of bedding or backfill. • trench collapse, heavy equipment conflicts with workforce; • worker safety risks. • personal risks - dealing with bands when government has not dealt in good faith; • being the "front man" in the field, dealing with uneducated or emotional "crap" at the street level; • being intimidated by bands.

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
4. What do you feel are some of the specific risks on the projects you are involved with? ***(Continued)***			Two broad categories, internal and external risks: Internal: • project budget; • person or persons scheduled to work on the project - their perception of the project; • public perception and schedule for the project; External: • contractor, and the suppliers of resources to him, i.e.. gas, oil, for equipment; materials and transporters of materials; • weather. • low bidder may be unskilled, inexperienced, unmotivated but still be an acceptable tender; • design flaw leading to failure, although not common. • poor, unqualified contractors, contractor performance; • not following proper project management techniques.	

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
4. What do you feel are some of the specific risks on the projects you are involved with? ***(Continued)***			• contractor succeeds in a large claim because of a "hole" in the contract; • project cost is too high because of "overdesign"; • project requires corrective measures after construction; • not enough $$ to cover overruns; • public complains of being inconvenienced (late completion, etc.).	
What is the most important risk?	?	• soil conditions; • ability to complete the work on budget and on schedule	• not following project management steps; • contractor performance; • budget. • unexpected field conditions; • bad contractor—unqualified, too low bid, poor attitude, overextended; • bad engineering—inadequate or inappropriate specs/design. • low bidder unskilled, inexperienced, unmotivated. • contractor succeeds in a large claim because of a "hole" in the contract. • not following proper project management techniques.	• personal risk and intimidation. • worker safety risks.

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
5. What do you feel are the best indicators or most appropriate measures of project risks or a project's riskiness?	• level or magnitude of public controversy or concern or confidence; • newness of technology; • severely limited budgets and or timeframes.	• closeness of bids received through tender process; • project estimate close to average of the tenders received; • number of bidders.	• scope of the project. • potential for physical failure; • engineers, consultants and contractor's amount of experience with a particular type of project; • amount of motivation in project team. • review of proposed contractor; • review of design and specifications; • senior engineer's personal attention to project details; • review history of previous similar projects; • review history of project engineer. • was the project completed on time and within budget; • did the final project meet its expectations; • does it perform as intended. • project complexity; • project size; • experience of engineering staff assigned to project; • contractor's experience; • contractor's history of past performance and past claims;	• evaluate the project team; knowing the people involved helps assess the riskiness of the project. • number of complaints or problems with a given system or project; • number of component failures.

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
5. What do you feel are the best indicators or most appropriate measures of project risks or a project's riskiness? ***(Continued)***			• comparison of low bid to engineer's estimate. • did the final project meet its expectations.	
6. When you are faced with project risks, what are some of the specific actions you would take to reduce the risks?	• consult with public, clients, et al; • provide back-up technical support and analysis; • make certain financial resources are secured; • make sure unrealistic deadlines are adjusted, negated or resolved.	• assign experienced personnel to management team; • monitor the work on the project closely.	• ensure adequate budgets are in place, start with well-founded cost estimates; • follow project management procedures; • good quality control program; • have good contracts and specifications in place; • ensure contractor compliance with contract. • removal of all risks in nearly always possible but will cost too much or not be cost effective; • do more geotech work; • more needs assessment; • more senior engineer reviews throughout project; • tighter control on contract awards; • tighter supervision and progress reporting; • proper commissioning; • detailed O&M manuals.	• use confidence to put people at ease; • projects will go ahead when there is a certain degree of trust, gained at a personal level and put to use at a working level. • increase testing and inspection; • keep morale high so as to prevent shoddy work resulting from disgruntled workforce. • closely follow standard safety work procedure; • keep in mind the potential impact of the project not properly functioning.

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
6. When you are faced with project risks, what are some of the specific actions you would take to reduce the risks? ***(Continued)***			• become in control of the project as much as possible. • unfortunately, there are some risks we just have to assume; • in many cases we would like to reject low tenders but realistically cannot; • some handle risk in estimating work by consistently overestimating but this is chicken sh**; • flexibility in hiring consultants and hiring the right person, and knowing when to hire/fire a consultant reduces risk. • use consultant with good past performance record; • ensure adequate soils info before design; • ensure that consultant and contractor have insurance policies: E&O, Liability, Bonding, etc.; • ensure that engineering team is qualified; • ensure that budget will be adequate; • ensure that design addresses the needs;	

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
6. When you are faced with project risks, what are some of the specific actions you would take to reduce the risks? ***(Continued)***			• ensure adequate budgets, with reasonable contingencies are in place at the outset, based upon well founded cost estimates.	
7. How would you rate your own willingness to accept project risks or a risky project, compared with:				
• **Those you report to?**	More willing.	About the same.	Much more willing. More willing. More willing. More willing. More willing. About the same.	Much more willing. About the same. About the same.
• **Those who report to you?**	More willing	More willing	More willing. About the same. Less willing. Less willing.	Much more willing. About the same. About the same.
• **Others in your position?**	More willing	About the same	More willing. More willing. More willing. About the same. About the same. Less willing.	Much more willing. About the same. About the same.
8. To what extent do you feel you can exercise control over the risks of a project?	To a great degree.	To a moderate degree.	To a great degree. To a great degree. To a moderate degree. To a moderate degree. To a moderate degree. To a small degree.	To a moderate degree. To a moderate degree. To a moderate degree.

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
9. What do you feel are the most indicative or best measures of project success?	• project functioning well upon completion • community and client acceptance • meets budgetary (O&M and capital) expectations • meets timeline	?	• project performs as it was intended; • project is completed on time and budget. • final cost of project; • completion date; • extent of warranty repairs; • O&M costs after commissioning; • engineering costs as a percentage of total project cost; • end user satisfaction; • overruns/ underruns; • final product meeting the intent of the project as designed. • on time; • under budget; • project meets or exceeds the needs and expectations of the user. • quality workmanship at a fair price; • the end product; • to a lesser degree, good timing; • presumably the project meets a need—i.e.. it should have been initiated in the first place;	• besides the job being technically carried out, on budget, on time, etc., what is remembered in the communities or the bands is how they were treated by the person in the field managing the project; • best measure is satisfied community. • elatively trouble-free operation of a system over time; • aesthetically pleasing. • progress and schedule was followed, and in unavoidable circumstances, an appropriate revised schedule was met; • the right decisions regarding financial implications were made.

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
9. What do you feel are the most indicative or best measures of project success? ***(Continued)***			• "on time and on budget" may not have anything to do with the project, just a reflection of the budget—it may be a success, but it is not the end product. • cost is less than other completed projects; • no contractor claims; • final product meets design standards; • public doesn't complain; • under budget; • minimal number of change orders; • low O&M costs; • on time.	
10. Regarding the projects you are associated with, in general, what overall chance do you feel they have of being successful? (___% chance of success)	100%	80%	98% 97% 95% 90% 80-95% 70%	99% 98% 98%

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
11. Clearly, completing a project on schedule is desirable. Nevertheless, late completions may sometimes occur. In general, for each of the following, what would you feel would be an acceptable chance of: (___% chance would be acceptable):				
a) Not completing a project on schedule?	10%	80%	90% 80% 80% 60% 15% 5%	25% 25% 20%
b) Completing a project one month late?	15%	25%	80% 75% 60% 60% 20% 15%	25% 25% 10%
c) Completing a project two months late?	10%	10%	60% 50% 50% 20% 10% 10%	25% 10% 5%

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
d) Completing a project one season late?	5%	5%	30% 20% 10% 10% 5% 0%	10% 5% 0%
e) Completing a project two seasons late?	1%	0%	5% 5% 3% 2% 0% 0%	0% 0% 0%
12. Completing projects on budget is most desirable. Nevertheless, the reality is sometimes projects are not completed within the budget. In general, what would you feel would be an acceptable chance of: (___% chance would be acceptable)				
a) Not completing a project within budget?	7%	90%	60% 50% 50% 50% 20% 10%	40% 25% 15%

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
a) Completing a project 25% over budget?	1%	15%	50% 30% 15% 10% 10% 5%	25% 5% 5%
a) Completing a project 50% over budget?	0%	10%	10% 5% 5% 1% 0% 0%	10% 2% 0%
a) Completing a project 100% over budget?	0%	0%	0% 0% 0% 0% 0% 0%	0% 0% 0%
13. What do you feel are the most indicative or most appropriate measures of project failure?	• nonfunctioning or improperly functioning project upon completion; • non-acceptance by the client or the public; • significantly over budget; • significantly behind schedule or well after the deadline.	When the percentage or amount of work accomplished is less than the amount spent on the project.	• does not meet original expectations or fails to work as intended; • cost overruns; • completed past original completion date. • high percentage of engineering costs; • dissatisfaction of end user; • dissatisfied contractor; • cost overruns; • large number of change orders; • late completion; • claims from contractor;	• poor design; • inadequate quality control; • poor work progress; • poor budget control. • disinterest by parties. • plagued by O&M problems, unreliability; • not on schedule; • over budget; • unsafe.

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
13. What do you feel are the most indicative or most appropriate measures of project failure? ***(Continued)***			• high O&M costs. • number of complaints; • % over budget; • % over on O&M cost estimates; • % over other similar projects; • engineering costs as a % of project costs; • disagreements over O&M responsibilities after project completion.	
14. What do you feel are the characteristics of a project or events which may lead to, or contribute to, project failure?	• mis/non-information • mixed expectations or unclear expectations; • poor design preplanning or monitoring; • hasty or unrealistic timelines or unrealistic time pressures; • major or unreasonable technical risks.	• poor scope of work; • unrealistic completion date; • definition of who is responsible for the project not clear; • need for the project not defined; • cost estimate not done prior to starting the project.	• not following project management procedures; • poor quality and cost control; • non-compliance to specifications by the contractor. • squabbling project team; • contractor bid too low; • contractor has insufficient resources, no bid bond; • inexperienced or underqualified engineer; • too many change orders; • contractor not cooperative, constantly writing letters. • inexperience (engineering or contractor); • bad management (engineering or contractor);	• inadequate co-ordination, inspection and supervision. • antagonistic views of all parties concerned; • power struggles between government, bands and municipalities; • poor management team; • weak directors (senior management). • unskilled or inexperienced engineers; • political interference resulting in technical decisions being made by non-technical people (e.g.. pressure from owner or municipality); • unrealistic bid pricing, contractor cutting corners to cover costs;

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
14. What do you feel are the characteristics of a project or events which may lead to, or contribute to, project failure? *(Continued)*			• lack of motivation (engineering or contractor). • ineffective communication of project budget, schedule and expectations to all parties involved; • ineffective control of project resources. • poor work quality, lack of quality control/inspection; • lack of cost control on project. • large number of redesigns after project commences; • letter war between engineer and contractor; • strained relations between engineer and inspector; • unexpected soil conditions; • bad weather.	• poor communication and assuming other parties did something or checked something; • poorly defined scope and different expectations between owner and contractor.
15. Overall, what do you feel would be an acceptable chance of a project failing? (__% chance would be acceptable)	• 0% (for projects completed) • higher for projects considered as not failing in absolute terms, but failing in some areas where remedial action can be taken.	5%	50% 25% 10% 5% 5%	2% 1% 0%

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
16. How would you rate the following characteristics pertaining to completion cost, as indicators of project failure, with 1 being not important as an indicator of project failure and 5 being an extremely important indicator of project failure?:				
a). Completion cost 10% over budget:	(3)	(3)	(1) (1) (1) (1) (2) (2) • dependent to a certain extent on project value (i.e. absolute dollars overrun). • possibility exists that a need facility is installed with quality for a good price but the budget is way off—project would be a success but the project would be a failure.	(1) (1) (1)
b). Completion cost 25% over budget:	(4)	(4)	(2) (3) (3) (3) (3) (4)	(2) (2) (4)

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
b). Completion cost 33% over budget:	(4)	(4)	(3) (3) (4) (4) (4) (5)	(3) (4) (4)
b). Completion cost 50% over budget:	(4)	(4)	(3) (4) (5) (5) (5) (5)	(4) (5) (5)
b). Completion cost 100% over budget:	(5)	(5)	(5) (5) (5) (5) (5) (5)	(5) (5) (5)

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
17. How would you rate the following characteristics pertaining to scheduled completion, as indicators of project failure, with 1 being not important as an indicator of project failure and 5 being an extremely important indicator of project failure?				
a). Project is completed one month late:	(1)	(2)	(1) (1) (1) (1) (2) (2)	(1) (2)
b). Project is completed two months late:	(1)	(3)	(2) (2) (2) (3) (3) (4)	(3) (3)
c). Project is completed one season late:	(2)	(4)	(3) (3) (3) (4) (4) (5)	(3) (5)

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
d). Project is completed two seasons late:	(2)	(5)	(5) (5) (5) (5) (5) (5)	(5) (5)
e). Project is completed three seasons late:	(2)	(5)	(5) (5) (5) (5) (5) (5)	(5) (5)
18. How would you rate the following characteristics pertaining to O&M costs, as indicators of project failure, with 1 being not important as an indicator of project failure and 5 being an extremely important indicator of project failure?				
a). Once completed, O&M costs run 10% more than originally intended:	(3)	(2)	(1) (1) (2) (2) (2) (3)	(1) (1) (2)
b). Once completed, O&M costs run 25% more than originally intended:	(4)	(3)	(2) (3) (3) (4) (4) (4)	(2) (3) (3)

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
c). Once completed, O&M costs run 50% more than originally intended:	(4)	(4)	(3) (5) (5) (5) (5) (5)	(2) (3) (3)
d). Once completed, O&M costs run 100% more than originally intended:	(4)	(4)	(5) (5) (5) (5) (5) (5) • this is very important, and too often this is neglected or never checked back on by designers.	(5) (5) (5)
19. How would you rate the following characteristics pertaining to the project's capacity, as indicators of project failure, with 1 being not important as an indicator of project failure and 5 being an extremely important indicator of project failure?				
a). Once completed, the project accommodates or can function at only 90% of the originally planned capacity:	(3)	(2)	(2) (2) (3) (3) (3) (4)	(3) (3) (4)

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
b). Once completed, the project accommodates or can function at only 75% of the originally planned capacity:	(5)	(3)	(3) (4) (4) (4) (5) (5)	(4) (4) (5)
c). Once completed, the project accommodates or can function at only 50% of the originally planned capacity:	(5)	(4)	(4) (5) (5) (5) (5) (5)	(5) (5) (5)
d). Once completed, the project accommodates or can function at only 50% of the originally planned capacity:	(5)	(5)	(5) (5) (5) (5) (5) (5)	(5) (5) (5)

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
20. How would you rate the following characteristics pertaining to public scrutiny, as indicators of project failure, with 1 being not important as an indicator of project failure and 5 being an extremely important indicator of project failure?				
a). The project is subject to numerous casework requests:	(3)	(3)	(1) (2) (2) (2) (3) (4) • how a project is scrutinized by the media or legislature should not be a measure of its success or failure; if one were to use it as such he would be in serious trouble.	(4) (5) (5)
b). The project is subject to intense scrutiny and criticism in the Legislature:	• scrutiny: (2) • criticism: (5)	(4)	(1) (3) (4) (5) (5) (5)	(5) (5) (5)

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
c). The project is subject to intense criticism from the media and the public:	(5)	(4)	(1) (3) (4) (4) (4) (5)	(5) (5) (5)
21. Most recently, when preparing (or reviewing/ approving) the budget for a project commencing in Year 1 (i.e.. the current year) of the plan, in general, what do you feel the anticipated chances are of the project budget *should not be exceeded*, for the contingency amount will accommodate any uncertainty? (Anticipated chances are ____%)	95%	10%	80% 60% 60% 50% 10-15% 5%	95% 75% 5%

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
22. Now consider future projects —those which are planned to commence in Year 3 (92/93) of the plan. Most recently, when preparing (or reviewing/ approving) a Year 3 project budget, in general, what do you feel the anticipated chances are of the project budget *should not be exceeded*, for the contingency amount will accommodate any uncertainty? (Anticipated chances are ____%)	50%	25%	70% 60% 50% 40% 30% 25%	85% 50% 15%

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
23. Finally consider far future projects —those which are planned to commence in Year 5 (94/95) of the plan. Most recently, when preparing (or reviewing/ approving) a Year 5 project budget, in general, what do you feel the anticipated chances are of the project budget *should not be exceeded*, for the contingency amount will accommodate any uncertainty? (Anticipated chances are ____%)	5%	50%	80% 60% 60% 40% 25% 20%	75% 25% 15%
24. Please consider the following statements, and indicate, in general, you feel: if you strongly agree; agree; are indifferent; disagree or strongly disagree:				
a). Budget overruns on a project can usually be justified:	• disagree	• disagree	• agree • agree • agree • agree • agree • indifferent	• agree • agree • strongly disagree

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
b). The reasons for a project's late completion are usually out of my hands:	• disagree	• indifferent	• indifferent • indifferent • agree • agree • agree • agree	• indifferent • agree • agree
c). End-user acceptance of a project should be the most important goal of a project.	• strongly disagree	• agree	• disagree • indifferent • indifferent • indifferent • agree • agree	• disagree • agree • agree
d). Late completion of a project can usually be justified.	• disagree	• disagree	• agree • agree • agree • indifferent • indifferent • disagree	• agree • agree • disagree
e). Spread of bid prices is a good indication of the project's riskiness—the greater the spread between the lowest bidder and all others, the greater are the risks.	• indifferent	• agree	• agree • agree/indifferent • indifferent • indifferent • disagree • disagree	• agree • agree • disagree
f). Most causes of project budget overruns are usually out of my control.	• disagree	• indifferent	• indifferent • indifferent • indifferent • disagree • disagree • disagree	• indifferent • agree • agree

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
g). Problems on projects can be expected when the contractor bids too low.	• agree	• agree	• agree • agree • agree • agree • indifferent/ disagree • disagree	• agree • strongly agree • strongly agree
h). Maintaining a project on budget is generally more important than maintaining a project on schedule.	• agree • but very situational depending on criticalness of time.	• agree	• strongly agree • agree • agree • agree • agree • agree • depends	• indifferent • agree • agree
i). Most projects, when completed, exceed their originally estimated budget for one reason or another.	• strongly disagree	• agree	• indifferent • indifferent • disagree • disagree	• strongly agree • disagree • strongly disagree
25. Overall, I would regard:				
a). **___% of my projects as satisfactory:**	90%	80%	92% 90% 90% 80% 80% 33%	99.9% 99% 97%
b). **___% of my projects as marginally satisfactory:**	10%	50%	33% 18% 10% 9% 8% 5%	2% 1% 0.5%

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
c). **___% of my projects as not satisfactory:**	0%	20%	33% 10% 3% 2% 2% 1%	1% 0% 0%
26. Problems on projects may arise for a number of reasons. Consider the following two scenarios and indicate, in your experience, the approximate percentage of project problems which may be attributed to each:				
___% of problems on projects arose from *events or scenarios* which could not have been anticipated:	30%	80%	75% 50% 50% 30% 20% 10%	90% 10% 5%
___% of problems on projects arose from *events or scenarios* which could have been anticipated:	70%	20%	80% 70% 50% 50% 20% 5%	90% 15% 3%

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
27. Consider the following five areas as generally responsible for project problems, and indicate, in your experience, the approximate percentage of project problems which may be attributed to each:				
a). ___% of problems on projects could generally be attributed to (i.e. could have/should have been controlled by) the contractor:	20%	40%	70% 50% 30% 20%	50% 50% 45%
b). ___% of problems on projects could generally be attributed to (i.e. could have/should have been controlled by) the consultant:	20%	40%	35% 20% 20% 20%	15% 15% 10%
c). ___% of problems on projects could generally be attributed to (i.e. could have/should have been controlled by) the government's project management team:	20%	40%	30% 20% 20% 3%	25% 10% 10%

Question	Senior Management	Director	Project Managers	Designers & Field Inspectors
d). ___% of problems on projects could generally be attributed to (i.e. could have/should have been controlled by) other parties:	20%	10%	20% 10% 10% 5%	10% 5% 2%
c). ___% of problems on projects could generally be attributed to reasons outside the control of the above parties:	20%	0%	20% 10% 10% 5%	25% 5% 1%

APPENDIX E.
PRECURSORS OF SUCCESS & FAILURE: CHECKLISTS FROM THE LITERATURE

The following 14 tables summarize checklists and lessons from the literature related to the success and failure of projects. They are further discussed in **Section 8.3.2.**

Project definition:

- Define comprehensively.
- Communicate clearly.
- Phase as appropriate.
- Identify, assess and develop sub-objectives clearly.
- Relate objectives to participants.
- Do not force clarity until appropriate.
- Beware of progressive change.
- Avoid too early a commitment.

Planning, design and technology management:

- Attend to broader, systems aspects of projects.
- Relate to phasing, logistics, geophysical uncertainties, and the design & production.
- Have back-up strategies for high-risk areas.
- Develop the accuracy of estimates to an extent consistent with the uncertainties present.
- Avoid concurrency (urgency and technical uncertainty together).
- Test design adequately before final project commitment is made.
- Recognize the extent to which R&D is completed will affect accuracy of estimate.
- Use flexible design philosophies.
- Recognize that good design management is essential, especially where there is technical uncertainty or complexity.
- Recognize that interface management is important where there are significant interdependencies.
- 'Freeze' design once agreed.
- Beware of switching design authority during different phases of project.
- Pay attention to detail since mistakes can prove costly.
- Encourage replication where appropriate.

Politics/Social factors:

- Ensure effective sponsorship.
- Recognize fiscal, safety, employment, etc. constraints.
- Ensure support for such management actions as may be necessary.
- Constrain nationalistic aspirations on international projects.
- Manage community factors effectively.

Schedule duration:

- Recognize the major impact that output, price, regulation, technical developments, government or corporate changes can have on definition of success.
- Phase projects where/as possible to avoid unnecessary over-commitment.

Schedule urgency:

- Avoid rushing.
- Note possible disruptive effect on work sequencing.
- Beware of impact on full discussion by all parties.
- Beware of when urgency and technical uncertainty go together (concurrency).

Legal agreements:

- Ensure break clauses are adequate.
- Beware of 50-50 partnerships.
- Beware of mixed public-private funding.
- Seek commitment to making contract work.

Table E.1 Factors contributing to the successful implementation of major projects (Morris & Hough, 1987)

.....Continued

Finance:

- Undertake full financial analysis of all project risks: budget validity, political support, owner's commitment, etc., including inflation and possible currency variations.
- Be cautious over availability of funds.
- Be prepared to stop funding where necessary.
- Seek sponsors interested in success of project per se, not just a good return.
- Beware of exchange rate movements.
- Check definition of project success if business base of project changes.

Contracting:

- Consider whether more innovative contractual arrangements may not be required.
- Consider incentive contracts where it is difficult to get competition, though beware of too high a level of technical uncertainty.
- Ensure contractors are sufficiently experienced to perform the work.
- Consider extent to which competitive bidding is appropriate.
- Beware of same organization acting as contractor and owner.
- Provide adequate bid preparation time.
- Beware of the cheapest bid.
- Beware of having to manage a large number of contracts.
- Define contractor's responsibilities clearly.
- Make contractors financially responsible for their performance as far as possible.
- Beware of contracts which unfairly penalize contractor for factors outside his control.
- Beware of mixing firm price and reimbursable forms.
- Question the threat of liquidated damages.
- Appraise carefully whether owner interference in the contract execution is justified.

Project implementation:

- Seek appropriate client, parent company & senior management attitudes and support.
- Control all those aspects of project which can affect the chances of success.
- Recognize the magnitude of task and organize appropriately.
- Obtain clear client guidance.
- Foster good client-contractor relations.
- Integrate the project teams' perspectives with the project aims during start-up.
- Assess risk adequately.
- Develop good planning, clear schedules, adequate back-up strategies.
- Exercise firm, effective management from the outset.
- Recognize the importance of effective, schedule-conscious decision making.
- Provide clear organization appropriate to project's size, urgency and complexity.
- There should be one person or group in overall charge having strong overall authority.
- Ensure effective leadership.
- Strive for a well motivated, experienced team.
- Develop appropriate controls, highly visible, simple and 'friendly'.
- Check definition of success, where changes are allowed.
- Ensure resources are adequate, properly planned and flexibly employed.
- Consider use of site labour agreements.
- Ensure labour practices are consistent amongst and between contractors.
- Give full recognition to quality assurance and auditing.
- Recognize that good communications are vital.

Human factors:

- Ensure top management support.
- Recognize and demonstrate the importance of effective leadership.
- Seek competent personnel.
- Ensure communications are effective & consider which power style is appropriate.
- Recognize that people are human and less than perfect.

Table E.1 (continued) Factors contributing to the successful implementation of major projects (Morris & Hough, 1987)

Task complexity:

- Divide the project into easily manageable parts with clear interfaces.
- Minimize number of contracts.
- Simplify design.
- Simplify organization.
- Simplify specifications.
- Simplify financial arrangements.
- Simplify legal arrangements.

Procedural uncertainty:

- Minimize technical uncertainty.
- Flexible design needed.
- Long projects should be phased.
- Avoid competitive bidding.
- Adequate risk assessment needed.
- Take strategic action if exchange rates change.
- Plans actions carefully.
- Avoid late design changes.
- Ensure adequate funding.
- Clarify schedules.

Psychological regret:

- Assess impact of project on environment and people.
- Ensure sponsors truly interested.
- Legal arrangements should be fair.
- Fair allocation of risk needed.
- One person or group should have overall authority.
- Motivated and experienced team needed.
- Participative decision making with socially oriented leadership needed.

Stress:

- Unrushed commitment needed.
- Avoid rushed bidding.
- Avoid rushed initial definition /design/ development.
- Good attitudes and relations needed.

Schema generality:

- Plan to allow for future phases, logistics, geographical uncertainties, interdependent design & production.
- Government to allow flexible management.
- Devise back-up strategies.
- Consider other than the lowest bid.

Schema veridicality:

- Project definition to be well investigated, communicated and agreed.
- Minimize conflict of participants' objectives.
- Government to give clear objectives.
- Terminate project if necessary.
- Legal arrangements should be clear.
- Clear advice from clients needed.
- Appropriate organization needed.
- Clear and comprehensive organization needed.
- Good communication needed.

Schema stability:

- Care needed in forecasting important events and risky situations.
- Establish government commitment.
- Government to monitor progress and ensure continuity.
- Consider appointing contractor earlier.

Table E.2 Morris' lessons bearing on the success of projects, organized by a typology of conditions enabling biases (Error! Bookmark not defined.**Skitmore, Stradling & Tuohy, 1989)**

Ensuring compatible participants:

- Minimize the number of direct and indirect participants.
- Seek maximum compatibility between participants.

Overall project organization:

- Allow for fluctuating participation.
- Ensure a highly competent and relevant organization.
- Decisiveness within the critical period.
- Need for a continuous, comprehensive project overview.

Provide the appropriate senior management:

- Recognize the potential unpopularity of project secondments and assignments.
- Address the need for greater multi-disciplinary skills.
- Senior management sufficiently experienced, most competent and objective.
- Establish an inner project-directing group.

Table E.3 Factors to reduce neglected risks on large projects (Sykes, 1982)

- Insufficient use of status/progress reports.
- Use of superficial status/progress reports.
- Inadequate project manager administrative skills.
- Inadequate project manager human skills.
- Inadequate project manager technical skills.
- Insufficient project manager influence.
- Insufficient project manager authority.
- Insufficient client influence.
- Poor coordination with client.
- Lack of rapport with client.
- Client disinterested in budget criteria.
- Lack of project team participation in decision making.
- Lack of project team participation in major problem solving.
- Excessive structuring within the project team.
- Job insecurity within the project team.
- Lack of team spirit and sense of mission within project team.
- Parent organization stable, non-dynamic, lacking strategic change.
- Poor coordination with parent organization.
- Project more complex than the parent has completed previously.
- New 'type' of project.
- Initial under-funding.
- Inability to freeze design early.
- Inability to close-out the effort.
- Unrealistic project schedules.
- Inadequate change procedures.
- Poor relations with public officials.
- Unfavorable public opinion.

Table E.4 Characteristics which strongly affect the perceived failure of projects (Baker, Murphy & Fisher, 1983)

- Frequent feedback from parent organization.
- Frequent feedback from client organization.
- Judicious use of networking techniques.
- Availability of back-up strategies.
- Organization structure suited to project team.
- Adequate control procedures, especially for dealing with changes.
- Project team participation in determining schedules and budgets.
- Parent commitment to established schedules.
- Flexible parent organization.
- Parent enthusiasm.
- Parent commitment to established budget.
- Parent commitment to technical performance goals.
- Parent desire to build-up internal capabilities.
- Project manager commitment to established budget.
- Project manager commitment to established schedule.
- Project manager commitment to established technical performance goals.
- Client commitment to established schedules.
- Client commitment to established budget.
- Client commitment to established technical performance goals.
- Enthusiastic public support.
- Lack of legal encumbrances.
- Lack of excessive government red tape.
- Minimized number of public/government agencies involved.

Table E.5 Characteristics associated with perceived success of projects (Baker, Murphy & Fisher, 1983)

The presence of these characteristics improves perceived success, while their absence contributes to perceived failure of projects:

- Goal commitment of project team.
- Adequate project team capability.
- Minimal start-up difficulties.
- Absence of bureaucracy.
- Clearly established success criteria.
- Accurate initial cost estimates.
- Adequate funding to completion.
- Task (vs. social) orientation.
- On-site project manager.
- Adequate planning and control techniques.

Table E.6 Characteristics related to both perceived success and perceived failure of projects (Baker, Murphy & Fisher, 1983)

- Cost underestimates.
- Lack of project team goal commitment.
- Lack of team spirit, sense of mission.
- Over-optimistic status reports.
- Decision delays.
- Overall lack of similar experience.
- Use of 'buy-in' strategies.
- Lack of alternative backup strategies.
- Inadequate control procedures.
- Insufficient use of progress/status reports.
- Inadequate change procedures.
- Lack of budget & schedule commitment.
- Insufficient project manager authority and influence.
- Lack of project team participation in setting schedules.
- Functional, rather than projectized, project organization.

Table E.7 Determinants of cost and schedule overruns (Baker, Fisher & Murphy, 1983)

- Encourage openness and honesty from the start from all project participants and specifically seek to avoid and reject 'buy-ins'.
- Develop realistic cost, schedule, and technical performance estimates and goals.
- Seek to enhance the public's image of the project.
- Make prompt decisions regarding project go-ahead or contract award.
- Seek to establish definitive goals for the project and seek to establish a clear understanding and consensus among the principal project participants regarding the importance of these goals.
- Establish project team of adequate size with a flexible & flat organizational structure.
- Create an atmosphere that encourages healthy, but not cutthroat competition.
- Delegate sufficient authority to the principal client contact and let them promptly approve or reject important project decisions.

Table E.8 Strategies for overcoming potential problems on large projects (Baker, Fisher & Murphy, 1983)

- Flat management organization with a capacity for constant change.
- Adequate personnel for entire project life, with special attention by participating organizations ensuring availability and reintegration.
- Adequate coupling of different decision circuits within the bureaucracy.
- Attention to generated social conflicts and demands for increased public accountability.
- An extensive and thorough study of the project in the pre-investment phase, of 5% of construction budget; assessment by an external, independent body; and special attention to methods of handling uncertainty.
- Balanced assessment of the restrictions of time, money and quality.
- Systematic and frequent external assessment of the project by external experts and auditing commissions.
- Agreements prior to commencement regarding escalation and the establishment of appropriate financial reserves.

Table E.9 Lessons related to effective execution and cost control of mega-projects (Goemans& Smits, 1986)

- Organizational growth thresholds must be carefully monitored and accommodated.
- Management style must be crafted to fit changing organizational needs.
- The role of a board of directors must mature as its organization grows.
- Organizational growth must be earned—not conferred.
- Public sector operating procedures must be adapted to the tasks of the enterprise.
- Politics & management: a difficult but necessary balancing act for public managers.
- Parent governments need to develop management strategies for overseeing the activities of subsidiary corporations.

Table E.10 Lessons from the WPPSS failure for managers of public enterprises (Leigland, 1987)

- Initial clarity of project mission, goals and general direction.
- Top management support & willingness to provide necessary resources and authorities.
- Detailed specification of project schedule and plans.
- Client consultation, communication and active listening to all active parties.
- Recruitment, selection and training of the necessary personnel for the project team.
- Availability of the required technology and expertise to accomplish the technical tasks.
- Client acceptance.
- Provision of an appropriate communication network to all key implementation factors.
- Ability to handle unexpected crises and deviations from plan.
- Competence (administrative, interpersonal and technical) of the project team leader and the amount of authority available.
- Degree of political activity within the organization and the perception of the project as furthering an organization members' self interests.
- Likelihood of external organizational or environmental events impacting the project.
- Perception of the importance or urgency of the project.

Table E.11 Critical success factors for projects (Pinto & Slevin, 1988b)

Technical causes:

- Complete and adequately detailed definition of the project and its interfaces.
- Proven design with thorough checking of any modification or innovation risks.
- Anticipation of applicable codes and regulations.
- Cognizance of differing local engineering and construction doctrines.
- Appropriate use of specifications to reduce complexity & enhance flexibility.
- Adequate and stringent inspection and quality assurance.

Non-technical causes:

- High project management visibility; current performance reviews flagging exceptions.
- Flexible organization, eliminating ambiguous responsibilities, attention to recruiting personnel and a replacement plan for key positions.
- Appropriate use of project management tools and use of audits.
- Attention to information handling processes.
- Adequate risks management, avoiding partial identification and analysis.
- Fostering of team spirit and attention to cross-cultural problems.
- Appreciation of the importance of planning in the early phase of a project.

Table E.12 'Technical' and 'non-technical' causes of project success or failure (Hayfield, 1986)

- Be prepared to participate on a whole or partial basis as the project requires.
- Be willing to consider creative options when selecting partners.
- Be alert to and organize specifically for the transition points in development phases.
- Be careful to select only feasible projects to work on.
- Monitor power balance amongst partners to ensure appropriate organizational changes.
- The project concept needs to be communicated to all participants to ensure all share the same goals and concept of progress.
- Feedback systems need to be installed.
- Accountability to stakeholders to ensure all know the status of the project.

Table E.13 Groundrules for participants to promote success on Third World macroprojects (Murphy, 1983)

- It is virtually impossible to have good projects in a bad national-level policy environment.
- There is a widespread tendency to underestimate the cost of implementing specific projects and the time required.
- Consider at the outset as wide a range as possible of alternative project approaches.
- Explicit attention should be paid to defining a project's objectives at the earliest stage and to ensuring that all participants agree on those objectives and on the strategy for achieving them.
- The most important reason for the success of a project is a strong commitment by the government to its objectives.
- Good project preparation reduces the likelihood of difficulties during implementation by anticipating problems which may arise.
- A common cause of delayed or poor implementation is inadequate or incomplete project preparation.
- Include physical and price contingencies as an integral part of cost estimates.
- Projects with few, well-defined objectives, based upon proven technologies or approaches have a better chance of successful implementation than projects with many objectives or unproven methods.
- Projects can also suffer from being too restrictive in scope or fail to recognize the need for complementary investments and activities.
- As projects are seldom implemented exactly as designed, they should embody sufficient flexibility to allow management to change course if necessary.
- Ensuring effective coordination with agencies or organizations is inherently difficult, and unless well planned, can be very time-consuming and unproductive; a clear definition of the responsibilities of each participating agency and adequate incentives for them to cooperate in achieving the project's objectives are required.
- A coalition among the interested agencies and principle actors needs to be formed early in the planning stage and continued throughout implementation.
- Appropriate design and adequate preparation are essential.
- There is a close correlation between good managers and good projects.
- Weak management of the project are often at the root of delays and cost overruns, manifested in inadequate planning, delays in land acquisition, protracted bidding and contracting procedures, insufficient project supervision, slow responses to changes in the policy environment, and low staff morale and productivity.
- Technical problems arise continually but are usually resolved eventually and tend to be less intractable than financial or managerial problems.

Table E.14 Lessons from the implementation of World Bank projects (Baum & Tolbert, 1985)

APPENDIX F

The following thirteen tables are provided as additional background to the discussion in Section 9.3 and Section 9.4.

Technical rationality:	*Cultural rationality:*
• Trust in scientific methods, explanations, evidence.	• Trust in political culture and democratic process.
• Appeal to authority and expertise.	• Appeal to folk wisdom, peer groups and tradition.
• Boundaries of analysis are narrow and reductionist.	• Boundaries of analysis are broad and include the liberal use of analogy and historical precedent.
• Risks are depersonalized with emphasis on statistical probability.	• Risks are personalized with the emphasis on the family and the community.
• Appeal to consistency and universality.	• Focus on particularity with less concern for consistency.
• Where there is controversy, in science, resolution follows status.	• Popular culture does not follow the prestige principle.
• Those impacts that cannot be specified are irrelevant.	• Unanticipated or unarticulated risks are relevant.

Table F.1 Factors relevant to the technical and cultural rationality of risk (Krimsky & Plough, 1988).

Technology descriptor:
- Intentionality.

Release descriptors:
- Spatial extent.
- Concentration.
- Persistence.
- Recurrence.

Exposure descriptors:
- Population at risk.
- Delay.

Consequence descriptors:
- Human mortality (annual).
- Human mortality (maximum).
- Nonhuman mortality (experienced).
- Nonhuman mortality (potential).
- Transgenerational.

Table F.2 Hazard Descriptors–Dimensions of Technological Risks (Hohenemser, Kates & Slovic, 1983)

Factor:	**Conditions Associated with Increased Public Concern:**	**Conditions Associated with Decreased Public Concern:**
Severity	• Large number of fatalities or injuries per event.	• Small number of fatalities or injuries per event.
Catastrophic Potential	• Fatalities and injuries grouped in time and space.	• Fatalities and injuries scattered or random in time and space.
Familiarity	• Unfamiliar.	• Familiar.
Understanding	• Mechanisms not understood.	• Mechanisms understood.
Uncertainty	• Risks scientifically unknown or uncertain.	• Risks known to science.
Controllability	• Personally uncontrollable.	• Personally controllable.
Voluntariness of exposure	• Involuntary.	• Voluntary.
Effects on children	• Children specifically at risk.	• Children not specifically at risk.
Effects on future generations	• Risk to future generations.	• No risk to future generations.
Victim identity	• Identifiable victims.	• Statistical victims.
Dread	• Effects dreaded.	• Effects not dreaded.
Trust in institutions	• Lack of trust in institutions responsible.	• Trust in institutions responsible.
Media attention	• Much media attention.	• Little media attention.
Accident history	• Major and minor accidents.	• No major or minor accidents.
Equity	• Inequitable distribution of risks and benefits.	• Equitable distribution of risks and benefits.
Benefits	• Unclear benefits.	• Clear benefits.
Reversibility	• Effects irreversible.	• Effects reversible.
Personal involvement	• Individual personally at risk.	• Individual not personally at risk.
Origin	• Caused by human actions/failures.	• Caused by acts of nature or God.

Table F.3 Factors involved in the public's perception of risk. (Covello, 1984b).

- Reduce the likelihood that individual and public attention will be diverted from significant risks to insignificant risks.
- Reduce the likelihood that societal attention and resources will be diverted from important problems to less important problems.
- Reduce unnecessary human suffering due to high levels of anxiety, fear, outrage and worry about risks.
- Reduce levels of public outrage.
- Reduce the likelihood of bitter and protracted debates and conflicts about risks.
- Reduce unwarranted tension between communities and agencies.
- Better understand public perceptions, needs and concerns.
- Better anticipate public responses to agency actions.
- Better inform individuals and communities about important risks.
- Better engage in dialogue with communities about risk issues.
- Better inform individuals and communities about agency procedures, processes and decisions.
- Make more informed risk management decisions.

Table F.4 Advantages flowing from effective risk communication. (Covello, McCallum, & Pavlova, 1987).

- Inaccurate perception of the meaning of probabilities.
- Overconfidence in one's own ability to manage and control risky situations.
- Thirst and desire for scientific certainty and unanimity among experts.
- Tendency to underestimate natural and to overestimate technological (human made) risks.
- Reluctance to make trade-offs between different types of risks or risk sources.
- Fear of unfamiliar, low-probability high-consequence risk sources.
- Strong preoccupation with risk-related factors such as equity, voluntariness, and societal ability to manage and control risk source.

Table F.5 Problems encountered when communicating risk-based information. (Renn, 1991b).

Origin of the Problem:	***Example:***	***Nature of the Problem:***
Message Problems	Government or industry data on health risks.	• High level of scientific complexity with technical analyses unintelligible to laypersons. • Large model and data uncertainties.
Source Problems	Government or industry officials.	• Lack of institutional trust and credibility. • Disagreements amongst experts. • Lack of data addressing specific fears and concerns of stakeholders. • Limited understanding of interests, values, fears and priorities of stakeholders. • Use of legalistic, technical, and bureaucratic language.
Channel Problems	Media.	• Selective and biased reporting emphasizing wrongdoing, disagreements and conflicts. • Focus on drama or sensational aspects. • Premature disclosure of scientific information. • Oversimplifications, distortions and inaccuracies in interpreting technical risk information.
Receiver Problems	Individual citizens.	• Inaccurate perceptions of levels of risk. • Lack of interest in risk problems and technical complexities. • Overconfidence in ability to avoid harm. • Strong beliefs and opinions resistant to change. • Unrealistic demands for scientific certainty. • Reluctance to make trade-offs. • Difficulties in understanding probabilistic information related to unknown technologies.

Table F.6 Problems in risk communication. (Covello, Winterfeldt, & Slovic, 1987).

Challenges:

- Risk information is often complex, highly technical and uncertain.
- Experts often disagree on assumptions underlying a risk assessment and provide widely different risk estimates, leading to public confusion about their validity.
- Stakeholders (e.g. regulatory agencies) sometimes lack public trust and credibility, which can be fostered by public perceptions of lack of technical competence, over-influence of special-interest groups or stakeholder bias in favour of a technology or political strategy.
- Experts and laypersons often define risk differently; laypersons almost always include a number of other dimensions (such as catastrophic potential, equity, controllability and involuntariness). Thus, laypersons tend to assign relatively little weight to technical risk analyses.
- Experts often use technical, legalistic or bureaucratic language when discussing risk, which is difficult to understand and sometimes leads to the impression of unresponsiveness and evasiveness; contributing to confusion and suspicion.
- While average citizens may not pay attention to most risk information, individuals that do may be highly selective and focus on the unusual and dramatic aspects.
- Individuals holding strong beliefs are exceedingly resistant to change, even in the face of opposing information. Conversely, those holding weak beliefs are often subject to manipulation by subtle differences in the presentation of risk information.
- Most people have difficulty in interpreting probabilistic information, and particular difficulty in comprehending extremely small probabilities.

Approaches:

- Use simple, graphic and concrete material, avoiding technical language if possible.
- Compare risks within a carefully defined context relevant to the target audience.
- Avoid risk comparisons which may appear noncomparative due to qualitative characteristics.
- Understand and recognize qualitative concerns about other risk dimensions.
- Identify and explain the strengths and limitations of different measures of risk.
- Identify, acknowledge and explain uncertainties in risk estimates.
- Recognize the power of subtle changes in the way risk information is presented.
- Recognize that often risk debates involve much broader considerations, such as political values and ideologies.

Table F.7 Challenges and approaches to providing information about risk. (Covello, Winterfeldt, & Slovic, 1987).

Challenges:

- Actions by project participants or regulatory agencies in soliciting stakeholder input and participation are often viewed with skepticism and as a form of 'rubber-stamping', particularly as stakeholders are often invited to participate only after many of the important decisions have been made.
- Stakeholders each bring their own strongly-held values and concerns to the arena; frequently the initial atmosphere is of distrust and confrontation. Public meetings are difficult to hold in a highly charged, emotional atmosphere.
- Participants sometimes do not understand the nature or sources of a particular conflict, which can range from disagreements about levels of risk to fundamental disagreements over values.
- Many communication strategies are inappropriate for specific types of conflict. For example, if conflicts are about facts or statistics, providing information and education may help. However, if conflicts are about risk equity issues or values, information strategies are of little use; specific underlying concerns must be addressed.
- Stakeholders are often unwilling to compromise or accept trade-offs. Some stakeholders may exhibit a 'not-in-my-backyard' attitude respecting new risks and may demand complete elimination of the risk irrespective of costs or other constraints.
- The media may aggravate risk communication problems by highlighting personal fears and anxieties, focusing on dramatic or sensational aspects of risk and emphasizing conflict over agreement.

Approaches:

- Involve stakeholders early in the decision making process, before key decisions have been made and participants are committed to a particular course of action.
- Make public involvement objectives clear from the beginning.
- Leave room for option invention by those directly affected by the decisions.
- Respect stakeholder interests, emotions, values, priorities, preferences and concerns.
- In public meetings, avoid violations of community norms.
- Establish procedural safeguards to ensure all voices and stakeholders can be heard.
- Carefully analyze the nature of conflicts and distinguish between different types; for example, between factual and ideological disagreements.
- Adopt different communication strategies for different types of conflicts and disagreements.

Table F.8 Challenges and approaches to involving stakeholders in consultative or decision processes about risk. (Covello, Winterfeldt, & Slovic, 1987).

Risk Communication Planning:

- Risk communication will be successful only if carefully planned & evaluated.
- Planning and evaluation activities should be part of a continuous process aimed at assessing objectives and improving performance.
- Rigorous evaluation is needed to measure success, identify program weaknesses, and improve current and future efforts.
- Planning and evaluation require a substantial commitment of time, attention and resources by top management.
- Public involvement & direct exchanges of information are an important yet underutilized source of knowledge for identifying risk communication problems, understanding issues, & setting objectives.
- Different risk communication goals & audiences require different strategies.

Message sources:

- In communicating risk information, trust and credibility are the most precious assets.
- The single most important problem undermining risk communication efforts is the lack of trust and credibility.
- Trust and credibility are difficult to build; once lost, are almost impossible to regain.
- Attention to details is often critical to effective risk communication.
- Effective risk communication is often undermined by the failure to coordinate amongst participants, often resulting in conflicting messages and public confusion.
- Collaborating with credible agencies & organizations can provide special access to target audiences, enhanced credibility & additional resources.
- Few things make risk communication more difficult than conflicts or public disagreements with other credible sources.

Message Design:

- The design of effective risk messages is often complicated by multiple, conflicting objectives, including the community's 'right to know', the costs of unnecessarily alarming people, and the possible consequences of premature or delayed action.
- The most effective risk messages clarify, not simplify, complex risk information.
- Graphs and other visual materials represent an important but underutilized means for communicating risk information.
- Risk comparisons are a useful tool for informing and educating people about risks; however, the simplicity and intuitive appeal of risk comparisons may be deceptive.

Delivery channels:

- All message delivery channels for communicating risk information have counter-balancing strengths and weaknesses.
- Some channels are more appropriate for specific issues and targets; some more likely to reach specific target audiences and some more feasible given program resources.
- The media are generally more interested in politics and conflict than in risk; in simplicity than in complexity; and more interested in danger than in safety.

Table F.9 Guiding principles for the risk communication process. (Covello, McCallum, & Pavlova, 1989).

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Target audiences:

- If you do not listen to people, you cannot expect them to listen to you.
- The public is not a single, monolithic entity; there are many publics, each with its own interests, information needs, concerns and priorities.
- People consider many factors in evaluating and judging the acceptability of risks.
- Public concerns about risks are a function of:
- the perceived level of risk;
- the level of outrage (a combination of several factors including fairness, benefits, alternatives, control and voluntariness);
- the perceived effects of the issue on individual and social welfare (e.g. adverse effects of negative publicity on community property values and tourism).
- People in the community are often more concerned about issues such as trust, credibility, competence, control, voluntariness, fairness, caring and compassion than on statistics and the details of quantitative risk assessment.
- Regardless of how well you communicate risk information, some members of the audience will never be satisfied.

Table F.9 (continued) Guiding principles for the risk communication process. (Covello, McCallum, & Pavlova, 1989).

- Specify your intentions and goals at the beginning of each presentation.
- Try to convey the basic rationale of risk analysis to your audience by referring to everyday experiences of probabilistic judgments. Good illustrations are consumer choices, the stock market, sweepstakes, or the weather forecast.
- Start always with the list of facts and models that all experts agree on in principle, then develop your own arguments and interpretations.
- Try to escape from role expectations by using a personal approach, and relate the risk to the experience of each participant.
- Be cautious in quoting risk numbers or showing risk diagrams. Probabilities do not mean anything to most people unless the numbers are compared with the expected values of other risk sources. Comparisons of risk should be used to illustrate probabilities and not to document or justify acceptability.
- Share the anxieties and inner conflicts of the audience and reveal your personal value conflicts when arguing for one or the other scenario.
- Emphasize that some of the crucial risk properties (such as voluntariness and personal control) refer to individual decision making, whereas risk sources relying on collective decision making usually do not encompass these possibilities. Functional equivalents, however, such as institutional control and open information policies, are available to compensate for the lack of personal control.

Table F.10 Guidelines for risk communication (Renn, 1991b).

- Communication strategies should be carefully structured and prepared. Factual information, interpretation of facts, opinions about expected outcomes, and evaluations of these outcomes should all be communicated in a different format.
- Communication strategies should be organized in a dialogue forum. The audience must have the opportunity to voice its concerns to the communicators, to participate in setting the agenda, and to convey its perspective to the policy maker.
- Comprehending risk assessment and risk management provides an appreciation of the tasks and problems of regulators and risk managers. Such appreciation is the first step in creating and sustaining trust.

Table F.11 Three essential conditions for successful risk communication programs. (Renn, 1991b).

- An analysis of the decision-making process to ascertain what lends credibility to the results from the assessor's point of view.
- An analysis of uncertainties in the risk analyses and the basis by which conservative judgments are made in light of these uncertainties.
- An analysis of the decision processes to determine what checks are in place to test whether conceivable eventualities are not excluded without proper analysis.
- An analysis of the checks built into the decision-making process to confirm that objectivity is central, and that hidden agendas are not driving the process.
- An analysis of the checks to provide external, neutral and objective peer review.

Table F.12 Key credibility-building processes of a risk communication program. (Roberts, 1989).

- Emphasize consequences over probabilities (e.g. dollar winnings for lotteries; lives lost for technological risks).
- Express consequences as aggregated non-discounted rather than net present value (e.g. a $1,000,000 jackpot rather than 20 annual payments of $50,000; 1,000 fatalities rather than 20 additional deaths over 50 years).
- Ignore probabilities; stress the notion of 'possibilities'.
- Emphasize absolute frequencies rather than base rates (e.g. 12,000 winners per day rather than a 1-in-100 chance of winning; 200 total fatalities rather than a 10^{-6} lifetime risk for exposed individuals.).
- Present detailed, vivid information about specific instances of extreme outcomes (e.g. winners for lotteries; deaths or accidents for technologies).
- Frequently repeat the presentation of detailed case information.
- Focus on the most extreme consequences of the probability distribution
  (e.g. big winners in lotteries; catastrophic accidents for technologies).
- Look for situational factors that can influence individuals' behaviour (e.g. very high jackpot levels for lotteries; close proximity for risky technologies).

Table F.13 Negative communication strategies for low-probability, high-consequence events (Mumpower, 1988).