



**AgEcon** SEARCH  
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

*The World's Largest Open Access Agricultural & Applied Economics Digital Library*

**This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.**

**Help ensure our sustainability.**

Give to AgEcon Search

AgEcon Search  
<http://ageconsearch.umn.edu>  
[aesearch@umn.edu](mailto:aesearch@umn.edu)

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

Australian Agricultural Economics Society  
38th Annual Conference  
Victoria University  
Wellington, New Zealand

7-11 February, 1994

---

## Scenario Analysis - An Alternative Approach to Assessing the Future

Michael Blyth and Ralph Young  
CSIRO Corporate Planning Office

### ABSTRACT

Assessment of the future is an important input for strategic planning. The long lead times which businesses and public sector organisations endure in situations such as the research, transfer and commercialisation of a new technology or decisions on large scale investment projects, make important the need for an informed view of the future.

Building scenarios is a way forward in developing plausible and internally consistent views of the future. The use of scenarios in strategic planning was pioneered by Royal Dutch Shell and is most often used by organisations and business which are extremely sensitive to external factors beyond their control. The present paper reviews scenario approaches and applications, and describes an application of the Shell approach to assessing research prospects.

---

## Introduction

Planning for the future is important to the long term survival of private and public sector organisations alike. The future is not predictable. Tomorrow will not be the same as today. Over the past ten years many political, social, economic and technological changes reshaped the world. Most of these changes were not foreseen ten years ago. Those that were foreseen were not considered plausible and were not acted upon. The next ten years is unlikely to be any less surprising. Furthermore, the pace of change is increasing.

There are many tools available to planners and decision makers to assist them in making their assessments of the future. These range from sophisticated quantitative models to simple exercises of judgment. Are these tools adequate for assessing the future, especially the long term? The demand for forecast information is increasing. This paper presents a review of scenario analysis as a tool for addressing the future. It is argued that the use of scenarios leads to better decisions for the future, because they improve the decision maker's understanding of the business environment.

The objective of the paper is to review scenario analysis especially in relation to strategic decision making and strategic planning. The paper draws on the experience of one of the authors who spent some time in 1993 working with Group Planning, at Shell International Petroleum Company, in London. Following a review of forecasting techniques, scenario analysis methods are discussed. To illustrate the development and use of the scenarios method, reference is made to previous scenarios exercises, including Shell's global scenarios 1992-2020 and applications to Australia's long-term future. An application of Shell's scenario planning approach to an assessment of the organisation of research and development over the next 30 years is presented. Finally, some lessons are noted for introducing scenario analysis to strategic planning for research.

## Tools for assessing the future

There are a diversity of techniques used for assessing the future. Most of these represent forecasting techniques which make use of information currently available to make estimates of future values for the variables of interest. The extent to which economic theory is used to underpin the processes of generating forecasts varies greatly between the different techniques.

The following list draws on Jones and Twiss (1978) and Freebairn (1975)<sup>1</sup>. It is not complete and is intended to provide examples of approaches used in each major category.

### *Quantitative Methods*

There are a variety of *formal* quantitative models which provide a basis for generating and updating forecasts. The main examples include:

- Econometric models
- Input-Output models
- Programming models

---

<sup>1</sup> Other useful reviews include Australian R&D Organisation (1980), Bails (1993), Tan Guat Cheng (1989) and Toft and McCarthy (1983)

- Simulation models

The specification of these models seeks to incorporate the main causal factors influencing the forecast variables in one or more mathematical functions which make up the model and represents an abstraction from the more complex real world. The activities of specification, estimation and validation generally form an iterative process before the final version of the model is arrived at. Validation typically involves explaining historical levels of the forecast variables to an acceptable degree of accuracy.

Potential advantages cited by Freebairn (1975, p. 158) for formal over other forecasting techniques include a greater capacity to allow for complex relationships and feedback effects; a convenient device for gaining an understanding of these relationships, and for organising the necessary information input; the capacity to enforce consistency constraints on the forecasts relating for example to observed supply and demand relationships and with accounting identities; the opportunity to replicate forecasts, evaluate sources of forecast error and take action to improve subsequent forecasts in a systematic way because all the assumptions are explicitly stated.

Disadvantages (Freebairn, 1975 p. 158) relate to the model being a simplified abstraction of the real world and the imposition of assumptions which may be intolerable; the basis of such models in historical behaviour which may be inappropriate if the future is likely to be characterised by changing institutional and behavioural patterns; and the requirements for data and resources which the development of such models require.

*Informal* models or judgmental forecasting may also be included in the category of quantitative models because, although the process of generating the forecasts may be qualitative, the differences between formal model and informal model forecasting procedures are largely one of degree (Freebairn (1975, p. 159). Economic theory and experience are typically combined to generate subjective assessments of future values of the forecast variables. The commodity forecasts presented by ABARE at the National Agricultural and Resource Outlook Conference are examples of this type of forecast. The advantages of greater flexibility and avoidance of the need to make restrictive assumptions are contrasted by Freebairn with the disadvantages of the increased chance of personal bias and failure to impose consistency constraints on the informal model forecasts.

Frequently, expert judgement is used in combination with formal quantitative models to generate forecasts. The need to avoid merely extrapolating from past experience and to incorporate likely structural changes in the future, particularly technological change is identified by Cline (1985 p.125). In similar vein, Jain (1993 p.124) observes that "no forecasting model accounts for everything", and indicates that "judgmental override" is widely viewed as improving forecasts over a purely mechanical system.

### *Qualitative Methods*

Two broad categories of qualitative methods are identified by Jones and Twiss (1978)

The first relates to "creativity spurring techniques" which aim to overcome the "subconscious constraints", based on prior conditioning and past experience, which limit the vision of forecasters to seeing the future as an extension of the past. Examples of such techniques

include brainstorming, Delphi techniques, nominal group techniques, contextual or mind mapping<sup>2</sup>, and lateral thinking.

The second category concerns the systematic analysis of patterns to reveal gaps which are likely to be filled by future developments. Included amongst these are morphology<sup>3</sup>, gap analysis<sup>4</sup> and environmental surveillance and monitoring.

Like informal models and judgmental forecasts, these qualitative methods of forecasting have the advantages of flexibility and are not necessarily bound by historical information. However their lack of rigour and degree of subjectivity seem likely to limit their adoption by professional economists, other than perhaps as one of the steps in a more formal process of forecasting.

#### *Time Series Models*<sup>5</sup>

Forecasts generated by time series models are based on past values of the forecast variable. Because the link with economic theory is usually tenuous at best, such forecasts are frequently termed "naive" forecasts. Time series models vary from the very simple, eg. no change, or same change, to technically complex eg. autoregressive integrated moving average (ARIMA) models. Other models impose or fit pre-determined functional forms to historical data as a way of generating forecasts eg. logistic curves or envelope curves.

Advantages and disadvantages noted by Freebairn include simplicity and ease of application; the degree of accuracy achieved relative to more complex formal models; and the lack of a basis for improving forecasts since causal relationships are ignored

#### *Indicator Analysis*<sup>6</sup>

The use of leading indicators is a relatively common approach at the macroeconomic level for forecasting cyclical change. The indicator may represent one or a combination of variables related to the forecast variable by statistical correlation or theoretic causation. Indicators may also be used as "explanatory" variables in commodity forecasting models and other formal models.

#### *Balance Sheet Methods*<sup>7</sup>

This forecasting method determines the balance of demand over supply or vice versa from independent forecasts of supply and demand as a means of inferring forecasts of prices and

---

<sup>2</sup> Contextual or mind mapping is a procedure of "systematic doodling" by which different developments or factors are linked in a logical fashion (see Jones and Twiss, 1978 pp 106-111)

<sup>3</sup> Morphology is a method of systematically forecasting new products or processes by examining in a matrix analysis all the possible combinations of the alternatives for attaining each stage of a technology (see Jones and Twiss, 1978 pp 119-127)

<sup>4</sup> An example of gap analysis is the identification of market gaps from an analysis of the product/market mix to identify segments which are unsatisfied in terms of price, quality, design or volume

<sup>5</sup> See Freebairn, 1975 p. 160-161

<sup>6</sup> *ibid* p 161-62

<sup>7</sup> *ibid* p 162

quantities. The method is commonly used in commodity analysis of world markets such as grains and sugar, and for long term forecasts by FAO. The main advantage is the compact and objective format provided for generating forecasts of future market demand and supply. The main disadvantage concerns the simplifying assumptions and subjective procedures used to determine the final supply and demand balance.

### Surveys<sup>8</sup>

Surveys constitute a commonly used method for generating information on decision maker's intentions which in turn provide a basis for generating forecasts. Surveys of consumers and producers are regularly undertaken to obtain information for producing macroeconomic forecasts, whilst ABARE and other agencies conduct regular farmer surveys to get information on intentions as well as historical information. Such information may provide more accurate forecasts than those based on historical data, but an offsetting disadvantage is the cost of conducting surveys.

### Scenarios

Scenario analysis is a disciplined way to think about the future which "demands above all an understanding of the forces that drive the system, rather than reliance on forecasts" (Wack 1985). Thus not all exponents of scenario analysis regard the approach as a forecasting tool *per se* so much as a means for taking account of uncertainty. In some instances, scenarios are used to generate alternative sets of forecasts for the future, with one of these alternatives being selected as the best bet. Such an approach is viewed as outmoded and even dangerous by the foremost practitioners. The two main approaches are probability-based methods and intuitive logics. These are discussed in more detail below.

In concluding this section, it may be observed that the large number of approaches which have been developed testifies to the lack of success of any single one. In evaluating the various methods, Freebairn (*op.cit.* p.172) for example notes that for long term forecasts, selected informal model and formal model forecasts were not significantly more or less accurate than naive forecasts. For short term forecasts, informal model forecasts achieved a "significant gain in accuracy relative to the naive forecasts." Similarly, in an evaluation of a range of forecasting methods applied to the New South Wales prime lamb market, Vere and Griffith (1990) find that "no single method is clearly superior in all situations" and recommend the use of combined econometric and naive approaches.

### Forecasting for what?

Forecasts are produced to assist decision makers to make informed choices or decisions for the future. Forecasts are needed because of the time lag between when the decisions are taken and when the products of the decision begin to flow. Often, the source of forecast information is outside the decision maker's environment. However, in some situations the forecaster and the decision maker are in direct contact. They be part of the same organisation, or they may even be the same person.

---

<sup>8</sup> *ibid* p 163

Specialist forecasters are skilled in the use of forecasting tools. Most are also familiar with the nature of the forecast variable(s). However, a forecaster's interest in the forecast often ends when the forecasts are generated and delivered to the decision makers.

Economic forecasters have not enjoyed a good reputation. There is increasing scepticism about the value of economic forecasts, fuelled by such events as their failure to foresee the economic recession of the early 1990s in the US and the UK. Forecasts often fail because they miss critical turning points, discontinuities or structural changes that occur in the environment. Much traditional forecasting is based on extrapolation of past conditions and experiences into the future. Therefore, previously unencountered events are not anticipated or factored into the future assessments. Long-term forecasting, for example, often underestimates the contribution and impact of technological and political change in the future. For example, some of the most important events of the last 5 years, such as political upheavals in Eastern Europe and the former Soviet Union, the Iraqi invasion of Kuwait, the dismantling of apartheid in South Africa, and even the successful completion of the GATT round were not foreseen by even some of the most knowledgeable observers. There are many instances of events occurring which were considered to be improbable and implausible. Similarly, prognostications of global doom and gloom, such as those of Malthus, the Club of Rome and the *Global 2000 Report to the President*, underestimated the role of technology in economic activity. according to Schwartz (1991 p.173) 'the single most frequent failure in the history of forecasting has been grossly underestimating the impact of technologies'.

Another feature of economic forecast information for decision makers is that forecasts are often self correcting. Forecast information, such as a projected shortage or surplus of a commodity, if widely held will be incorporated into the current decisions of producers with result that the forecast shortage is corrected. A forecast wool shortage provides a hypothetical example of this market behaviour (Stoekel 1985, p. 176). The projected shortage would lead to increased prices as buyers and sellers take positions in the market acting in their own self-interest. The higher prices would encourage wool producers to build up their flocks and produce more wool. Wool supplies would rise as a result of the increased investment in wool production. The higher wool prices would be an incentive for increased R&D and innovation, leading to higher yields. R&D will also be encouraged for substitute fibres. Suppliers to the wool industry will have an incentive to expand their operations. At the same time, at the retail level, consumers will respond to higher wool prices and purchase less woollen products, choosing cheaper substitutes. These factors act to correct the original forecast shortage. In the event of overcorrection, the outcome could be the opposite of the forecast, with surplus production and lower prices than forecast. Stoekel (1985, p176) offered a warning to the users of forecast information: 'be wary about any projected deficits and surpluses of commodities'. Cline (1985) and Miller and Harris (1972) also refer to the phenomenon of *post* validation being reduced as market responses are generated to *ex ante* forecasts, which suggests that lack of accuracy may be as much a sign of success as failure.

A problem facing many business decision makers seeking forecasts for key economic variables, is who to believe? A survey of economic forecasters by *The Economist* in 1991 revealed that for a selection of key economic indicators the average of their forecasts was better than most of the individual forecasters' efforts. Therefore, a decision maker may be better off with the average than choosing one of the individual forecasters. While there is no economic logic for using an average forecast, businessmen 'cannot avoid using economic forecasts to plan future stocks (inventories) or investment'. *The Economist* argues that average forecasts are probably a safer bet for business decision makers, avoiding the need for

them to evaluate the performance of different forecasters and to acquire an understanding of forecasting. Furthermore, average forecasts may be an effective way for decision makers to follow changing market expectations. Armed with these arguments, each month *The Economist* now polls the economic forecasts of large international banks for 13 industrial economies.

The difficulty with average forecasts is that decision makers that use them gain little understanding of the forecast variables, how they are generated or how they relate to each other and to other key variables in the business environment. Whether or not better decision making occurs is unknown.

One of the great strengths of scenario planning is that it is a learning process. Decision makers are involved. Scenarios do lead to better decision making because they improve the decision makers understanding of the world (Kahane, 1991).

### What is scenario analysis?

Scenario analysis, or scenario planning as it is also referred, is a strategic planning tool or method for improving decision making against a background of possible future environments. In simple terms, a scenario is an internally consistent account of how the business environment or the external environment in which an organisation operates might develop over time. An organisation assessing long term prospects with the aid of scenarios as part of its strategic planning would typically build up multiple scenarios to make sense of the large number of diverse, but inter-connected factors in the external environment, and to deal with the critical uncertainties that could affect the organisation's future direction.

Scenarios are not predictions or forecasts of the future, nor are they science fiction stories constructed merely to titillate the imagination (Schoemaker and Van der Heijden 1992). Scenarios are stories, about the future. Each story comprises a number of plots. A plot binds together the elements of a story or scenario. Plots within a scenario are based on the key variables, like the key characters in a story or film. According to Schwartz (1992, p.144), 'in most good scenarios, plot lines intersect, just as a good film often includes several sub-plots'. A scenario planner is like an author or script writer. The planner considers the converging forces in the plots and attempts to understand how and why they might intersect. From that analysis and understanding, coherent pictures of alternative futures are constructed. These are the scenarios.

Scenarios are a tool for individuals and organisations. The method allows managers and organisations to perceive unexpected influences in the business environment. They enrich and expand the perceptual limitations of individuals and organisations by unlocking the mental maps or mind-sets of the managers and exposing them to previously unthinkable events. Galer and van der Heijden (1993) define scenarios as 'tools for organisational perception'. They argue that 'what an organisation sees in the outside world is determined by its traditional modes of thinking'. Peirre Wack (1984), one of the pioneers of scenarios at Shell, chose as the title of his seminal article on scenarios, '*Scenarios: The Gentle Art of Reperceiving*'. The poor record of forecasters in the early 1970s and the increasing uncertainty in the business environment shaped his thesis that the solution to effective account of the future in strategic planning and decision making is not in looking for better forecasts or forecasters, but in the acceptance and understanding of uncertainty, and making



it an integral part of the individual's or organisation's reasoning. Shell found that the scenarios technique was 'more conducive to forcing people to think about the future than the forecasting techniques' used formerly (Benard 1980 - quoted in Wack, 1984).

Scenarios address:

- issues, trends and events in the current environment that are of concern to the organisation's decision makers;
- elements in the environment that are determinable and somewhat predictable - predetermined events or variables; and
- elements in the environment that are more uncertain, trend breakers that affect a system in unpredictable ways, but with understandable dynamics - turning points in the business environment, identifiable in the present although often as weak signals of change.

The test of a good scenario is that it is plausible to a critical mass of managers in a group or business, it is internally consistent, it is relevant to the topic or issue of interest, it is recognisable from signals of the present (the weak signals of change), and it is challenging, containing some elements of surprise or novelty in directions where the organisation's vision needs to be stretched (encouraging managers to 'think the unthinkable'). However, there should be links to the existing organisational mental maps. Galer and van de Heijden (1993, p. 7) suggest that 'a good starting point for a scenario program is an exploration into what managers directly concerned believe is currently going on in their world'

### The development and use of scenarios in strategic planning

The origin of scenarios lies in military planning. Herman Khan refined scenarios in the 1960s as a tool for business prognostication. Their early use was largely to quantify alternative outcomes of uncertain events. These 'quantitative scenarios', as Wack labelled them are not helpful to decision makers, mainly because they are developed independently of the decision makers. The importance of involving key decision makers in the process is that they gain an intimate understanding of the business environment and how it might unfold. That understanding and learning leads to better decisions. 'First generation' or quantitative scenarios gave way to 'decision scenarios' in the early 1970s, largely the result of the pioneering work of Wack at Shell.

Many organisations use scenarios to varying degrees to assist their strategic thinking and planning. However, as Millet (1988, p.66) found, 'few of these have been written up because of the business sensitivity of the matter'. However, the development and use of scenarios in business is well documented for Shell, who are the recognised leaders in scenario planning. Following a period in which scenario development was an episodic activity, Shell fully integrated scenarios into their strategic planning cycle in the early 1980s. Shell use scenarios to develop business strategies, to identify investment opportunities and to prepare for discontinuities and sudden change in the business environment. Shell develops global scenarios as part of its strategic planning for the whole organisation, and focused scenarios for the assessment of more specific strategic issues, at various levels in the organisation. Global scenarios are developed for the long term, usually 30 years into the future. Shell also

develops short-term scenarios, for 2 to 3 years hence. Focused scenarios may be developed using the global scenarios as a back drop, or they be developed from scratch.

### Scenarios and forecasting

It was earlier stated that scenarios are not forecasts. In fact, the use of scenarios developed from a dissatisfaction with the performance of forecasts for use in strategic decision making. Despite this, however scenarios do not abandon forecasts all together. They are used to provide an understanding of the forces shaping particular outcomes and events. For example, the role of economists in scenario planning is to explain the interaction of economic variables. Economists explain what happened in the past and indicate how changes in fundamental conditions will affect economic magnitudes over the long term. From this understanding the past insights are gained into how the future might unfold. Shell does not restrict the role of understanding the past and formulating scenarios about the future to economists. As well, there are scientists, historians, political analysts, social scientists, business analysts, commodity analysts, engineers, anthropologists and professionals from other disciplines contributing to the organisation's understanding of the past and the formulation of scenarios about the future. Shell seeks the expert assessments of these professionals from around the world when they are formulating their global scenarios.

Forecasts are generally produced for single variables, such as production, interest rates, income growth, population growth and prices. Individual forecasts have to be combined with other relevant information in decision making. Scenarios bind individual forecasts and plots together to make a plausible, coherent story about how the future may unfold from identifiable events and trends in the present. While scenarios focus on the critical uncertainties they also embody predictable or pre-determined elements as part of the story. Predetermined elements do not depend on any particular chain of events. If it seems certain, regardless of what might occur in the future, then it is a predetermined element. Predetermined elements include *slow changing phenomena* such as population growth and the building of physical infrastructure, *constrained situations* such as government regulations or goals, *decisions or events already in the pipeline*, such as the Australian government's reduction of tariffs and the size of the teenage population in the next decade. In some situations *inevitable collisions* are predictable, such as

### Scenario methods - alternative approaches

As the use of scenario analysis has grown, a number of alternative approaches have been developed. These can be grouped in two major categories - 1) intuitive logics, and 2) cross-impact analysis.

#### *Intuitive Logics*

The intuitive logics approach was developed by Royal Dutch/Shell (see Wack, 1985a,b) and is also practiced by SRI International and GBN. An important characteristic of this approach is the emphasis given to participation by executive and management staff of the organisation undertaking the scenario exercise.

The intuitive logics method covers eight steps:

1. Define the topic and scope of the analysis.

The focus is on key organisation decisions with long range consequences eg. market strategies, investment, diversification etc. The narrower the scope of the decision or strategy, the easier will be the task of scenario development. Close interaction with management and staff typically occurs in this step.

2. Identify key decision factors.

These are the factors which most directly influence the outcome of each decision eg. market size, price trends, resource availability etc. The usual approach is to use standard business analysis tools, although interviews with key executives can add much insight. Shell for example typically conduct extensive series of interviews at this stage of the scenarios process.

3. Identify the key environmental forces.

These forces encompass social, economic, political and technological factors such as demographic patterns, economic conditions, geopolitical influences etc. The relevant information may be obtained from modeling analysis, environmental monitoring and scanning, specialised information services and the futures literature. Interviews with international experts in various important areas are conducted by Shell planners to gain further insight into environmental forces.

4. Analyse environmental forces.

Discussion papers are prepared for each environmental force summarising historical trends, critical uncertainties and interrelationships between them. The aim is to identify explicitly the significant driving forces for change. It is in this stage that the critical uncertainties and predetermined elements are identified.

5. Define scenario logics

Scenario logics are defined as "the organising themes, principles or assumptions that provide each scenario with a coherent, consistent and plausible underpinning." They are not simply optimistic/pessimistic or high/medium/low scenarios, but present alternative futures eg regulated or deregulated market, and require iterative development often using workshops.

6. Elaborate the scenarios.

This step involves combining scenario logics with the results of the environmental analyses and may involve use of formal models. A key aspect is to set out explicitly the underlying logics and key assumptions.

7. Analyse implications for decision factors.

The implications which each scenario has for the key decision factors from step 2 are identified and presented to decision makers.

8. Analyse implications for decisions and strategies.

The analysis in this step covers the identification of threats and opportunities suggested by the scenarios, issues which need to be addressed, and factors to be monitored

The major strength of the intuitive logics approach noted by Huss and Hinton (p.23) is the development of "flexible, internally consistent scenarios from an intuitive, logical perspective" which may be tailored to the particular needs and political environment of the

organisation. However, Huss and Honton (*op.cit.*, p.23) caution that the intuitive logics approach "relies strongly on the reputation and communication skills of the team members and is less likely to be successful in a modeling or scientific environment which would require a more quantitative approach".

### *Cross Impact Analysis*<sup>9</sup>

The desire to give greater realism to qualitative forecasts by taking account of the interrelationships between key events lead to the development of cross-impact analysis. One of the most popular of these is the approach developed and practiced by the laboratories of the Battelle Memorial Institute, known as BASICS (Battelle Scenario Inputs to Corporate Strategies). There are seven steps which make up the BASICS approach:

1. Define the topic and scope of analysis.

2. Identify influencing factors.

A comprehensive list of influencing factors is prepared eg. social, political, technological, economic etc., and developed using nominal group, Delphi, literature reviews and expert interviews.

3. Define the key variables or descriptors; prepare essays on each descriptor; and assign initial probabilities of occurrence to each descriptor state.

The areas of influence are reduced to a "reasonable number (usually 15-25)" and refined into "descriptors". Descriptors are "factors, trends, events, developments, variables or attributes that serve to describe the topic" and are defined to include possible outcomes or "states". That is each descriptor is divided into a comprehensive set of mutually exclusive descriptor states - outcomes at a particular time i.e. a forecast, or trends eg. x% growth in GNP by 2000, or mini-scenarios. An essay is prepared for each descriptor covering definition, importance, background information, projected outcomes, alternative states with associated probabilities of occurrence and identification of cross-impacts with other descriptors.

4. Complete cross-impact matrix and run program.

A simple example of a cross impact matrix taken from Huss and Honton (1987, Table 1) is shown in Table 1.

The example in Table 1 relates US defence expenditure to US strategic nuclear defence vehicles (US SNDV's). In response to the question, how would the occurrence of the column state (different levels of defence expenditure) change the probability of occurrence of the row state (the probability shown in brackets for different numbers of SNDV's, a number is selected from a -3 to +3 index scale. In the table, the numbers selected reflect the expectation that a high level of defence expenditure will increase the probability of a high number of SNDV's, and a lower level of defence expenditure will have the reverse effect. A software package is available to assist with the completion of the cross impact matrices. The BASICS computer simulation model is run once the cross-impact matrices are completed and

---

<sup>9</sup> Huss and Honton (1987) identify three major categories of scenario analysis - intuitive logics, trend-impact analysis and cross-impact analysis. Because of the overlap between the latter two approaches, consideration here is restricted to discussion of the cross-impact analysis only. For details of the trend-impact analysis approach, the reader is referred to the Huss and Honton article.

systematically identifies the groups of descriptor states which will most likely occur together. These groups represent alternative scenarios.

Table 1: BASICS Cross-Impact Matrix

US SNDV'S	US Defence Expenditures		
	9-13% GNP	6-9% GNP	3-6% GNP
>2400 (0.10)	2	-1	-2
2000-2400 (0.30)	1	0	-1
1700-2000 (0.40)	-1	0	1
<1700 (0.20)	-2	-1	2

5. Select scenarios for further analysis and refinement.

The cross-impact approach generates many alternative scenarios, perhaps up to 12, and it is necessary to reduce these to a more manageable number for decision making purposes. Similar scenario types can be combined and a final selection of two to four scenarios is made on the basis of being most likely, most consistent or having the greatest impact on the company. Building on the computer output and the descriptor essays, detailed descriptions of each scenario are prepared covering development of the scenario over time and implications for the company.

6. Undertake sensitivity analysis.

Sensitivity analysis is undertaken by introducing low probability, high impact events such as an oil embargo, a political assassination, or a technological breakthrough. Such highly uncertain and one-of events affect the other descriptors but are themselves fully independent variables.

7. Make forecasts and study implications.

Sessions are held with company managers to assess how well the company can address the scenarios should they eventuate and develop the strategies to deal with the associated opportunities and threats.

Advantages noted by Huss and Honton (*op. cit.* p.28) are that BASICS generates a distribution of scenarios based on consistency and relative likelihood of occurrence; and that by using ranges of key variables and uncertain events, greater flexibility as well as a broader set of outcomes is achieved. The fact that the BASICS software is PC based is perceived as a further advantage.

The major weakness identified by Huss and Honton is that the computer program produces "state" or static scenarios at the end of the forecast horizon. The user has to create or assume the time dynamics which take place between now and then.

Selection of the most appropriate scenarios method should be made in light of the nature or culture of the organisation, including such aspects as existing strategic planning processes, resources available for strategic analysis and planning, management style, and the structure

of the organisation. The nature of the particular focus of the scenario analysis may also be relevant to the choice of method.

Regardless of the particular scenario building method used, there are a number of common steps in the process. These are:

1. Agree the scenario issue or topic and the scenario time horizon and other relevant aspect of focus, such as global/regional/national.
2. Identify and describe the drivers or variables in the business environment
3. Rank/analyse the variables and select the key drivers - the critical uncertainties

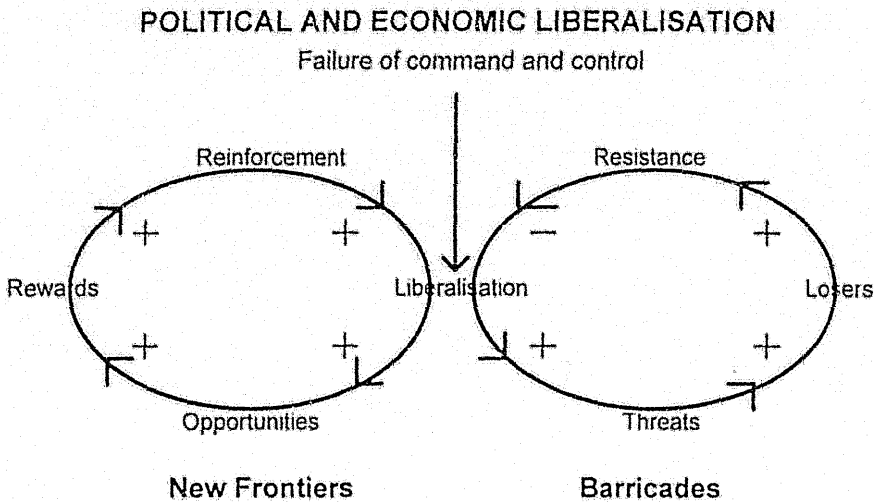
These stages are usually completed using workshops and/or interviews with key managers and relevant experts, supplemented by extensive desk-top analysis and review by the scenario analysts. Once the key variables (descriptors) have been identified, the methods differ in how the scenarios are created. The Shell approach to focused scenarios, for example proceeds to the scenario logics, beginning with the creation of story lines from the key variables. From the story lines, themes are discerned which form the basis of the scenarios. Before the scenarios are accepted they are subject to extensive testing and analysis. They are not finalised until the logic of each scenario is water tight. The Battelle approach, on the other hand, proceeds to assign probabilities to the states of each key variable and then to the determination of the cross impacts. These data are fed into Battelle's BASICS program and the scenarios are generated. Examples of the intuitive logics approach used by Shell and the cross impacts approach used by Battelle are presented below.

### Applications of scenario analysis - examples of the alternative approaches

#### *Shell's global scenarios, 1992-2020*

The development of Shell's global scenarios involves many man years of effort. The starting point is the identification of significant events of change in the recent past and current environments. For Shell's current global scenarios the event was the wave of political and economic liberalisation that swept the globe in the late 1980s and early 1990s. Particular events include the collapse of the former Soviet Union, the end of the Cold War and the reunification of Germany. Shell's management saw this as revolutionary change, with the collapse of the old bipolar world order and its replacement by dozens of new regimes aspiring to democracy and to liberal market economics' (Herkstroter 1993, p.2). From this event emerged two themes, based on divergent responses to liberalisation. Liberalisation, on the one hand can evoke enormous opportunities for individuals, groups and societies. On the other hand it can threaten national, religious and cultural identity as well as institutions, companies and industries. Shell developed these themes into two global scenarios - 'New Frontiers' and 'Barricades'. The figure below summarises the sequence of events which might occur for each scenario, from common starting point.

Figure 1: Shell's Global Scenarios - 1992-2020



New frontiers is a story of growth, turbulence and change. This describes a world where liberalisation continues and spreads. It is characterised by free interchange of ideas, investment and trade, with large new business opportunities in many countries. Economic growth in developing countries would be dramatic, especially in Asia and Latin America. Present industrialised countries would also benefit from the positive response to political and economic liberalisation, although growth would be below that of the developing world. It would be 'a very demanding competitive world for companies to operate in, and one in which they would be expected to be good corporate citizens' (Herkstroter 1993, p. 3). Barricades, the alternative world, describes a situation of resistance to the tide of liberalisation. In this world, rich and poor countries continue to conduct their affairs defensively and on a national basis. 'Political systems would continue to emphasise ethnic differences and regional or national boundaries. Development would be much more inward oriented, discouraging international trade and investment. It is a world of barriers and regulations and quotas for everything' (Herkstroter 1993, p.3).

These are two divergent scenarios with vastly different implications. From these scenarios Shell develops strategies which allow it to succeed regardless of what might happen. The scenarios span the breadth of possible outcomes. Reality is likely to be somewhere between the two. Kahane (1991, p.9) assesses the value of scenarios to Shell as follows: 'their purpose is to sensitise us to recognise signals of possible changes in the world - which will probably include elements of both scenarios - and to enable us to respond quickly and appropriately'. He argues further that while they may be less reassuring than conventional forecasts, they are more challenging and therefore more useful.

#### *Shell's Australia scenarios - Australia in 2000*

In 1978 Shell Australia commissioned a scenarios exercise to develop long-term scenarios for the nation, with particular attention to the interactions among economic, social, political

and technological change (Galer and Kasper 1982). They formed a study team comprising five external consultants and academics and two Shell Australia managers, with research assistance from the company's economics group. After a series of meetings with management and workshops and a survey of prospective technological changes, team members prepared reviews of their area of expertise, relevant to the topic. From these various themes emerged which the team developed through workshops, finally agreeing on two scenarios. In addition to a brief overview of the exercise and its findings by Galer and Kasper, the results were published in 1980 (Kasper, Blandy, Freebairn, Hocking and O'Neill 1980).

The scenarios developed by the team were, 'The Libertarian Alternative' and the 'Mercantilist Trend'. Under the libertarian alternative scenario Australia would remove its tariff and quota protection for manufacturing and mining and for other services, as well the many regulations and controls on markets. Economic reform would be accompanied by social reforms, including replacing the public sector social welfare system with a system of financial income supports, such as negative income tax and school vouchers. The long-term decline of the Australian manufacturing industry would slow, through a revitalisation of resource-based industries and investment-goods related activities. Leading edge technologies matching Australia's factor endowments would create growth industries as Australian growth picks up, including energy substitution, biotechnology and micro-chip technology for industrial process control. Growth of the 'oversized' service sector would also be checked, with resultant rapid productivity increases in many service industries.

The mercantilist trend scenario was described as muddling on with past policies. It describes a future Australia with numerous contradictions and social conflicts. Futile attempts would be made to reduce unemployment by interventionist means. Economic growth would be largely dependent on growth of the mining sector and the public service sector.

For Shell Australia this was a 'valuable educational exercise' (Galer and Kasper 1982, p.55). While the study and its findings became essential readings for Shell management, it was a key reference for a number of management training programs in the early 1980s. Galer and Kasper concluded that the study 'demonstrated the potential of a projection approach that is flexible and open to diverse future-oriented ideas and allows planners in large companies, while serving the needs of their own managements for reliable information and analysis, to interact with outside experts', and furthermore, 'the study contributed to the public debate over the choices that citizens and policy-makers must take and thus helped to focus public attention on the key decisions which will affect national development' (Galer and Kasper 1982, p.55).

### *Australia in 2018*

More recently, Kasper has undertaken an assessment of Australia's long-term prospects, into the twenty first century (Kasper 1992). Kasper presents two scenarios for Australia. The first is the Sheep Scenario which describes an Australia reliant on government solutions, imposed from on high, shepherding the nation by official plans, subsidies, taxes, penalties, summits and tribunals. It is a future of slow growth, with much political rhetoric on micro-economic reform and little more. It is a future that bears much resemblance with the past, especially in terms of the control of government. There would be much internal conflict, between labour



and capital and the state and citizens. Australia would not be attractive to foreign investment.

The alternative scenario offered by Kasper for the next 25 years is described as the Tiger Scenario. This is a future characterised by individual enterprise within a competitive environment fostered by government action - open markets to international competition, stable macro-economic framework, clearly defined property rights and so on. In this scenario business is left to business. Government concentrates on supply-side policy to promote growth - assisting with the elastic supply of capital, labour, skills and general infrastructure. Governments will ensure the efficient performance of the market, but at the same time ensure that those in need are effectively catered for. The manufacturing sector would grow strongly, reaching 25% of GDP.

Kasper defends the scenarios approach, especially for long-term views of the future. A single view of the future is nonsensical, as 'the long-term trend is not determined' (Kasper 1992, p.51). He argues that long-term visions of the future, while somewhat vague, are necessary for guidance and coordination, and 'crucial for those who want to remain master of their own fate' (Kasper 1992, p.61).

#### *Battelle's BASIC'S Approach*<sup>10</sup>

In 1988, Battelle was asked by REM<sup>11</sup>, an American multinational information-technology (IT) company to develop scenarios for the European IT market using the BASIC'S approach. The company was already operating in Europe but was facing increasing competition from other American, European and Japanese companies. REM's aim was to expand in Europe if there were favourable opportunities.

The terms of reference for the scenario's exercise given to the scenario team, consisting of Battelle analysts and corporate managers were to develop alternative sets of outcomes for 1992 and formulate proposals for alternate REM responses to achieve business goals. This would allow the company to develop contingency strategies to meet the changing circumstances of the European market.

The topics or key issues identified in the first step were:

- How likely was the EC to reach its single market cohesion goals by the end of 1992?
- Would an integrated EC market result in a "fortress Europe" with a policy of protectionism aimed at US-made products?
- How might a more integrated Europe affect the overall growth and competitiveness of the IT market (including hardware, software, data bases and networks)?

To determine the critical variables, a series of three group dynamics sessions was held using the Nominal Group Technique<sup>12</sup>. Two of these were held in the company's offices in Europe

---

<sup>10</sup> The Battelle example draws on Millet (1992)

<sup>11</sup> REM is the pseudonym given by Millet for the name of the company

<sup>12</sup> The nominal group technique uses a round robin poll to elicit the opinions of participants in a systematic and non-confidential way

and the US and involved REM staff specialist and the line managers who would implement the strategic decisions arising from the scenario's exercise. A third session was conducted at Battelle in Columbus, Ohio with Battelle technologists, economists and market analysts.

Once the various steps described earlier for the Cross-Impact approach had been completed, four principal scenarios were presented to top management in a report. The key features of these scenarios were:

*Scenario 1: "The EC Works"*

The EC would likely meet most of its single market cohesion goals by 1992. Features include:

- free movement of goods; standardisation of indirect taxes;
- growth in EC government control;
- trade policy which is no more and no less protectionist than the rest of the world;
- banking centralisation with a unified currency and monetary policy might not be achieved.

The growth in the market for IT would be medium to high.

*Scenario 2: "EC 1992 Disappoints"*

EC evolves much more slowly toward single market cohesion than in scenario 1. Despite this, growth of the IT market continues to be moderate.

*Scenario 3: "The EC Fails"*

Little or no progress is made by the EC toward the 1992 goal of a single market and the perception was that the EC had "fizzled". EC trade policies would be less protectionist than the rest of the world, and IT growth would be low.

*Scenario 4: "The US of Europe"*

Single market goals are achieved by 1992. Features include:

- centralised banking system;
- free movement of goods;
- EC would grow in power to a state of semi-sovereignty;
- no more or less protectionist than the rest of the world.

The growth in the IT market would be high.

Among the general conclusions reached were that:

- the concept of an integrated European market should be taken seriously;
- the prospect of "fortress Europe" was unlikely;
- IT market growth in the EC would be medium to high;
- there would be intense competition from European-based IT companies;
- REM should increase its presence in the EC in order to get closer to end-use customers.

After reviewing the scenario results, the REM management initiated a range of actions which included:

- increased local presence in the EC by expanding marketing and service networks;
- commitment made to maintain and expand its Brussels office;
- planned to expand industrial capacity in a particular EC country;
- introduced R&D and strategic technology initiatives to emphasise competitive advantages as a response to the expected increased competition not only in EC but worldwide.

- Revised and expanded the EC 1992 scenarios to 1995 to take account of the effects of the economic development of Eastern Europe.

It seems clear from these reported results that the REM decision makers were able to use scenarios analysis to identify business opportunities and threats in the EC and beyond and to develop strategies and actions to effectively deal with the futures identified by the scenarios.

#### Scenarios for research planning - an illustration of Shell's approach

The value of scenarios for research planning has been the subject of recent assessment by CSIRO's Corporate Planning Office. Part of that assessment included a secondment with Group Planning at Shell International Petroleum Company by one of the authors (Blyth 1993). The aim of that secondment was to gain first hand experience of scenarios and to determine whether or not the method had value in strategic planning for research.

A project was selected that had interest and relevance to both Shell and CSIRO. It involved an assessment of how research might be organised in the future, in terms of the following key issues:

- What kind of research will be required in the future?
- How will research be done?
- Who will fund research?
- Who will do research?

A review paper was prepared in which several trends, events and patterns were identified from data and information on R&D activity and management in many countries (see Blyth 1993). The review formed background for the participants in a scenarios workshop. The issue posed to the workshop participants was:

*How will research be organised to meet the needs of society in the period 1993 to 2020?*

The workshop comprised representatives from Shell research, Group Planning, and selected Shell operating companies. It was agreed that the research organisation scenarios would have greater relevance to Shell if they were developed in light of Shell's global scenarios for 1992-2020 (new Frontiers and Barricades), rather than building entirely new scenarios from scratch. This meant creating one scenario for New Frontiers and one for Barricades.

The group agreed on the following set of variables as drivers of the organisation of research. A variable is defined as an aspect of the future that you need to know about in order to organise and carry out R&D activities and which impact their success. The nominated variables were clustered into a smaller, more manageable set. Each variable therefore, comprises a number of other variables which follow a single idea or meaning. The full list of variables identified is included in Appendix A.

The key variables agreed upon are those ranked high for importance and uncertainty. They were *Funding, Perceived Return, Nature of Demand, Resource Pressures, R&D Management and Geographical Locus of Demand*.

The creation of focused research organisation scenarios effectively consisted of 'playing out' the identified key variables for each of the global scenarios, New Frontiers and Barricades. This resulted in two corresponding research organisation scenarios: "*GLUONS*" and "*LEPTONS*". These scenarios were developed from story lines drafted around the key variables for the two global scenarios.

The choice of names for the research organisation scenarios comes from particle physics. A gluon is a strong driving force in interactions between constituents, while a lepton is a small component which interacts through weak forces. New Frontiers features strong multilateral cooperation through concordance organisations, and hence the focus on the mediator of strong interaction, as defined by gluons. In Barricades, divisions and barriers limit the interaction between inward-looking regional blocks, and hence a focus on the weakly interacting particles, leptons. The groups assessment of the scenario elements for the key variables are presented in Table 2.

This scenarios exercise was not only a valuable learning exercise for CSIRO, but it provided some valuable lessons for Shell on both content and process. As far as a learning exercise for CSIRO, the application demonstrated the effectiveness of scenarios for perceiving the broad external environment which drives the structure and organisation of research. Preliminary assessments indicate that it would be a useful addition to the Organisation's current strategic planning cycle.

The research organisation scenarios were valuable to Shell research managers in identifying larger patterns in smaller steps taken in the present, such as technical cooperation in specific business areas. It was also discovered that the approach of looking at the organisation of research might be a more effective way for Shell to identify implications for Shell research of the global scenarios. Finally, the approach of developing focused scenarios in the light of the global scenarios for research was a useful approach, and a number of insights were gained into the effective conduct of such workshops.

Despite the promising outcomes, this exercise was largely an experimental. The scenarios were not subject to rigorous testing and could not be translated into any strategies for research. It was not established whether the scenarios exhausted the possible research organisation scenarios. Only after testing the variables in terms of how they are likely to trend or unfold over the scenario horizon for each scenario would it be possible to accept them as plausible views of the future.

The CSIRO Corporate Planning Office is continuing its development of scenarios for research planning. From preliminary assessments a number of lessons have been identified which should be heeded when introducing scenarios to a research organisation. These lessons are equally applicable to other organisations.

Table 2: Research organisation scenarios - 1993 to 2020

Key Variable	"GLUONS" (New Frontiers)	"LEPTONS" (Barricades)
Funding	.Governments & Business under funding pressure: - post-industrial society burdens, unemployment - high taxation regimes .At first curtailed R&D, later cooperation seen as means of increasing R&D effort	High government funding
Perceived Return	Elimination of: R&D waste, low quality and duplication	Measured by high-tech standards (costs less important)
Nature of Demand	NF customers more informed & wishing to participate in 'production' of goods and services	.Short term needs; driven by: - self-sufficiency/security - high-tech competition. .Supply-push of high-tech products
Resource Pressures	High energy demand, high carbon taxes, effect on R&D effort	Develop local resources (renewables)
R&D Management	.Variety of cooperations possible .International sharing of 'Big projects'	Bureaucracy, Command & control
Geographical locus of Demand	Developing world also new source of R&D demand	USA, Europe, Japan (lots of duplication)
Human Resources	.Developed countries may provide R&D for developing countries .R&D skills (people) will move around the globe	Supply < Demand: - Ageing - R&D 'uninteresting'
Role of Universities	OECD Universities starved of funds - go into partnerships with industry	Receive lots of funding, act as 'innovation centres', do more applied research (up S-curve)

Introducing scenarios to an organisation - Lessons for research planning

- Scenarios are a learning tool. They provide a better understanding of the external environment, and appreciation for particular trends and events once considered unimportant or irrelevant to research; furthermore they are an organisational learning tool, the learning outliving the individuals.

- Scenarios lead the decision makers to question their model of reality and change it as necessary to take actions of which they would be proud, and which they actively support.
- Global and focused scenarios - an organisation would need to consider the investment in global scenarios or macro scenarios, versus focused scenarios depending on how they are used in the Organisation and at what level they are pitched. Early experience suggest that there are significant advantages in starting from a base of global scenarios. GBN is a organisation which develops global scenarios for organisations (see Schwartz, 1992).
- Scenarios provide a stimulating and comprehensive backdrop to strategic planning processes in an organisation.
- Data and information needs and access are crucial for effective scenario creation. Regular monitoring of the external environment and identification of strategic issues is an important element in the successful implementation of scenarios in an organisation.
- Effective scenario building requires effective and dynamic workshop facilitation - planners as catalysts, must be willing to be daring and challenging to the participants in a way that encourages them to consider alternative perceptions of the future and to accept them as plausible.
- While challenging to managers, scenarios should not be a total surprise package. Management should be able to identify their own perception of the future, along with some alternatives. If there is too much of a surprise and challenge, the likelihood of scenarios being rejected by management is high.
- Scenarios probably should be pitched at lower levels in an organisation first, rather than at the organisation's strategic planning process. Recall that Shell spent over ten years using scenarios for analysing particular strategic events before they were fully integrated into the company's strategic planning cycle.
- The choice of scenario method should be left open to the organisation, depending on the organisation's culture and on the nature of the particular application.
- Scenarios are effective for organising a variety of seemingly unrelated information, including economic, technological, political, social and business, both quantitative and qualitative, and translating it into a framework for judgment, unlike any model can do (Wack, 1984).
- The ideal number of scenarios to develop for an exercise is between two and four. If three is selected avoid presenting a linear high, medium, low approach, but rather a 3-dimensional approach.
- Preparation, generation, iteration and digestion of scenarios, especially if they relate to discontinuities in the business environment is hard work and takes time. If scenarios are developed too quickly there is a risk that they will be extensions of the present. Simpson (1992) suggests that scenario planning could take from 5 to 9 months. Focused scenarios can be completed in less than one month, although they may rely on the existence of global or macro scenarios which take considerably longer to develop.

## References

- Australian Railway R&D Organisation, (1980), *Evaluation of Forecasting Techniques*, ARRDO Report No. 80:20, Melbourne.
- Bails, D G, (1993), *Business Fluctuations: Forecasting Techniques and Applications*, 2nd Edn., Prentice Hall, Englewood Cliffs, NJ.
- Blyth, M (1993), *Research Organisation Scenarios. An exercise in learning and developing the scenarios method*, CSIRO Corporate Planning Office working paper, December.
- Cline, W R, (1985), Long-Term Forecasts in International Economics, *American Economic Review*, 75:2, 120-26.
- Freebairn, J W, (1975), Forecasting for Australian Agriculture, *Aust J Agric Econ*, 19:3, 154-74.
- Galer, G and K van der Heijden, (1992), How Planners Create Organisational Learning, *Marketing Intelligence and Planning*, 10:6, 5-12.
- Galer, G and W Kasper (1982), Scenario Planning for Australia, *Journal of Long Range Planning*, 15:4, pp.50-5.
- Global 2000 Report to the President*, (1980), Vols I, II and III, US Government Printing Office, Washington DC.
- Herkstroter, C A J, (1993), New Corporate Frontiers, address to the 23rd. International Symposium of the St Gallen Foundation for International Studies, Group Public Affairs, Shell International Petroleum Co. Ltd. London.
- Huss, W R and E J Honton, (1987), Scenario Planning - What Style Should You Use?, *Long Range Planning*, 20:4, 21-29.
- Jain, C L, (1993), Developing Forecasts for Better Planning, *Long Range Planning*, 26:5, 121-28.
- Jones, H and B C Twiss, (1978), *Forecasting Technology for Planning Decisions*, MacMillan, London
- Kahane, A, (1991), *Global Scenarios for the Energy Industry: Challenge and Response*, Group Public Affairs Selected Paper, Shell International Petroleum Co Ltd. London.
- Kahane, A, (1992), Scenarios for Energy: Sustainable World vs Global Mercantilism, *Long Range Planning*, 25:4, 38-46.
- Kasper, W (1992), Advancing into the 21st Century: Visions and Challenges to the Downunder Economy, *Australian Economic Review*, 4th quarter, Oct-Nov, pp. 51-64

- Kasper, W, R Blandy, J Freebairn, D Hocking and R O'Neill, (1980), *Australia at the Crossroads - Our Choices to the Year 2000*, Harcourt Brace Jovanovich, Sydney.
- Miller, G L and S F Harris, (1972), *Price Formation, Price Projections and Commodity Marketing Research*, BAE Occasional Paper No. 13, Canberra.
- Millet, S M, (1988), How Scenarios Trigger Strategic Thinking, *Journal of Long Range Planning*, 21:5, pp. 61-8.
- Millet, S M, (1992), Battelle's Scenario Analysis of a European High-Tech Market, *Planning Review*, 20:2, 20-23.
- Perry, C and T Euler, (1990), Cost-Effective Forecasting: Lessons My Computer Programs Never Taught Me, *Omega*, 18:3, 241-46.
- Schoemaker, P H and C A J M van der Heijden (1992), Integrating Scenarios into Strategic Planning at Royal Dutch/Shell, *Planning Review*, May/June, pp. 41-6.
- Schwartz, P, (1991), *The Art of the Long View*, Doubleday Currency, New York.
- Schwartz, P, (1992), Composing a Plot for Your Scenario, *Planning Review*, 20:3, 4-9.
- Simpson, D G (1992), Key Lessons for Adopting Scenario Planning in Diversified Companies, *Planning Review*, May/June, pp. 7-10 and 47-8.
- Stoeckel, A, (1985), Towards 2001: Australian Agriculture, *Quarterly Review of the Rural Economy*, 7:2, May, pp.173-7.
- Tan Guat Cheng M, (1989), *A Comparison of Some Forecasting Techniques*, MSc Thesis, University of Melbourne.
- The Economist*, (1991), Disagreeing About the Consensus, July 27, p.59
- The Economist*, (1993), Rewriting the Future, May 1, p.69.
- Toft I and O McCarthy, (1983), *A Comparison of Forecasting Techniques. Industry Examples*, Research Report No. 15, Business Research Centre, Brisbane College of Advanced Education.
- Wack P, (1984), *Scenarios. The Gentle Art of Reperceiving*, Harvard Business School Working Paper, Cambridge.
- Wack P, (1985a), Scenarios: Uncharted Waters Ahead, *Harvard Business Review*, 63.5, 72-79.
- Wack P, (1985b), Scenarios: Shooting the Rapids, *Harvard Business Review*, 63.6, 139-50.



## **Appendix A**

### **Research organisation scenario workshop - Nominated variables**

#### **HUMAN RESOURCES (HR)**

- Supply of scientists
- Mobility of scientists

#### **R&D INFRASTRUCTURE (I)**

- Integration - Critical hub of demand, scientists and information
- Interdisciplinary/inter-organisational networking
- Benches to Brains (international)

#### **R&D MANAGEMENT (M)**

- R&D management effectiveness
- Personal follow-through (inter-functionality)
- Human infrastructural environmental and natural resource advantages
- Administrative vs. Technical management of R&D

#### **PERCEIVED RETURN (PR)**

- Better parameters of R&D success
- Cost rewards of R&D
- Market price of patents
- Marketing of R&D
- Level of risk: failures/liabilities
- Running out of molecules (diminishing returns)

#### **LEGAL FRAMEWORK (LF)**

- Intellectual property rights
- Anti-trust and sustainable pressure on patents

#### **FUNDING (F)**

- Cost of capital
- Strength of world economy
- Big science vs. small science
- Government deficits
- Future of defence
- Taxation policies
- Business profitability
- Alliances

#### **SOCIAL ATTITUDES TO SCIENCE (SA)**

- Shifting locus of creativity (up S-curve)
- Death of scientific rationalism
- Desire for visionary future
- Educational policies and attitudes
- Fragmentation of science
- Attitudes to science as culture

Changes in fashion of teaching science

**ROLE OF UNIVERSITIES (RU)**

University structure

Role of universities

**GEOGRAPHICAL LOCUS DEMAND (GD)**

National power shifts

Developing business areas

Sunrise industries

**NATURE OF CUSTOMER DEMAND (ND)**

Customer & market orientation

Customer knowledge & power

Shift to services

**RESOURCE PRESSURES**

Sustainable development - emphasis

Populist environmentalism

Global environment

Regulation ethical/environmental

Environmental pressures

**INTERNATIONAL COOPERATION (IC)**

Technical barriers to trade

Barriers to trade, FDI & environment of people

Technical dependencies of society

**CRITICAL DISCOVERY - TECHNOLOGICAL BREAKTHROUGH (TB)**