Wider and Deeper

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Acknowledgment

This monograph forms part of the AFI Research Program into 'Creating and Sustaining Social Foresight', which is supported by the Pratt Foundation.

ABOUT THE AUSTRALIAN FORESIGHT INSTITUTE

The Australian Foresight Institute (AFI) is situated in Swinburne University of Technology, Melbourne, Australia. AFI is a specialised research and postgraduate teaching unit. It was established in 1999 to develop an innovative set of postgraduate programs and research in the area of applied foresight. Apart from supporting the University in developing its own forward-looking strategies, its main aims are:

- provide a global resource centre for strategic foresight
- create and deliver world class professional programs
- carry out original research into the nature and uses of foresight
- focus on the implementation of foresight in organisations
- work toward the emergence of social foresight in Australia.

AFI is intensively networked around the world with leading futures/foresight organisations and practitioners. These include World Future Society and the World Futures Studies Federation. In 2001, the Director of AFI was elected as President, World Futures Studies Federation. AFI therefore, has access to leading international expertise in the field.

AFI also offers a nested suite of postgraduate programs. Based on coursework, the programs are offered through the Australian Graduate School of Entrepreneurship at the University.

The specific focus of AFI however is not merely on the creation and dissemination of standard academic knowledge. It is primarily concerned with the implementation of foresight across the board i.e. government, business, education and in the third sector (civil and non-government organisations).

Thus the work of AFI covers a very wide territory. It is therefore vital that those working in this context are comfortable with the breadth and the depth of this type of work and willing to utilise knowledge and skills from widely distributed sources.

Overall AFI aims to set new standards internationally and to facilitate the emergence of a new generation of foresight practitioners in Australia. It offers a challenging, stimulating and innovative work environment and exceptionally productive programs for its students who come from many different types of organisations.

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Wider and Deeper:
A review and critique of science and technology foresight exercises in the 1990s

Monograph Series 2003
No. 3

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Swinburne University

First published 2003

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John Street Hawthorn
VIC 3122 Australia

ISBN 0 85590 792 4

Editor: Rowena Morrow
Design: Swinburne University of Technology, Press Art Department

Printed in Melbourne by Mercury Print Team

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INTRODUCTION

Science and technology foresight (S&TF) exercises have been undertaken for the last four decades in over twenty countries. This monograph evaluates S&TF exercises from the perspective of critical futures studies. It first looks at the various objectives and methodologies that have been used in S&TF exercises during the 1990s. The success of the United Kingdom's 1995 Foresight Programme in setting new research priorities and establishing new networks is evaluated. An assessment is made of how S&TF could benefit concepts from the wider field of futures studies, and how several concepts could be fruitfully integrated into S&TF. Finally, a critique of the process used by Australia in 2002 to set national research priorities is included as a case study.

S&TF exercises have been performed by a number of countries in the 1990s. Countries undertake S&TF exercises to gain economic advantage over their competitors. This monograph is a positive critique that moves the discussion forward in practical ways by answering this question: how can S&TF work incorporate wider and deeper concepts and methods from futures studies to improve the relevance and robustness of the outputs? Some options for including wider and deeper futures concepts and methods into S&TF are examined. First, the broader concepts of layers of futures capacity are examined. Then some of the deeper futures methodologies are described. Some options for including these deeper methodologies into S&TF are suggested.

The exercise undertaken in Australia during 2002, to set priorities for the national research effort, is a case study that is critiqued. Judging from public sources, the Commonwealth Government did not use S&TF concepts or methods to set national research priorities, even though the issues canvassed by the setting of research priorities fell into the realm of S&TF. The case study demonstrates that the process shared a few of the characteristics of S&TF. The process and underlying rationale of setting the priorities are assessed using the concepts of critical futures studies. There is an opportunity for incorporating many of the concepts and methods of futures studies into any future effort to set Australian national research priorities.

WHICH COUNTRIES SET WHICH OBJECTIVES?

In the 1990s, countries set a variety of objectives for their S&TF exercises. A crucial distinction to note is that when the term 'countries' is used, as in 'countries set research priorities', this is adopting convenient shorthand for the actions and decisions made by the decision makers in each country. The danger with using this approach is that it appears that each country behaves as a rational individual, making choices from a wider range of possible alternatives. Dr Allison, in his analysis of the strategies of the protagonist nations in the 1962 Cuban Missile Crisis, developed the thesis that the actions of a country are more likely to be the result of a complex interaction between the political system and the organisations that make up the government.[1]

General Objectives

In general, S&TF work is undertaken by national governments to secure the scientific and technological infrastructure and skills necessary to be competitive in the global marketplace of goods and services.[2] The purpose of creating a national economy that is competitive in the global economy is to enhance the life and well being of the citizens of that nation. This is achieved through the growth of the national economy so that the citizens can afford all the goods and services that they demand. Most developed, Western countries see themselves as competing with one another in a global marketplace, in much the same fashion that individual firms compete in the markets inside a country. Some countries assess what needs to be improved to increase their international competitiveness by using the model of how a firm operates. An example of one common measure is improving the internal communications between the producers and the users of research. Better communications has the dual result of allocating resources more efficiently to those areas of greatest profit, and to develop a sense of a common purpose and vision of where the firm is going. Based on this model, countries see that developing better networks is a useful action.

Several factors have resulted in S&TF being more widely practised in the 1990s.[3]

1. Technology increasingly played the key role underpinning continued economic growth and prosperity, by creating greater levels of productivity, and creating new products and services.

2. The cost of performing the R&D required to create new technologies has greatly increased, which means that most single companies can no longer afford to develop new technologies. Instead, companies must work in teams, either in loose networks or strategic alliances in order to pool their resources to fund the necessary research.

3. New technologies increasingly result from multidisciplinary research. This required the formation of new networks and strategic alliances to allow companies to engage in the social process of innovation.

4. Governments have a reduced freedom to spend as much money on science and technology. This is the result of many factors, including:
   - the increasing costs of performing R&D
   - the increased competition in national budgets from the increasing costs of welfare and health spending.

5. Right-wing governments in Western countries have reduced the proportion of Gross Domestic Product that results from government spending, i.e. trying to reduce the effect that government spending has on the efficient operation of the market.

All of these factors have resulted in a decreasing proportion of government budgets allocated to R&D. In addition, there has been an increasing demand by business for governments to demonstrate accountability for their expenditures, which had the effect that increased funding for R&D, must show an economic return to the nation. In the 1990s, S&TF became a framework for addressing all of these factors in one exercise, by engaging the different stakeholders in discussions to create a common set of priorities, creating a shared vision of where research effort should be placed, and enhancing levels of connectivity between the players in the R&D system.

Specific Objectives

1. Many countries have sought to assess the capabilities of their own National Innovation System (NIS).[4] The NIS of a country is the sum total of all the sources of innovation, whether in universities, private sector R&D laboratories or firm-based innovations. The NIS also considers the framework conditions that can enhance or dampen innovation occurring, such as rules and regulations, the availability of finance, or the level of

networking between the public sector developers and the private sector users of research.[5] Countries that have sought to assess their NIS include Austria, Australia, South Africa, The Netherlands, Ireland, New Zealand, China, South Korea, Taiwan, Singapore, Malaysia, Thailand, Indonesia, Canada, Argentina, Brazil, Peru, Uruguay, the Czech Republic, Hungary, Poland, the Russian Federation and Ukraine.[6] Generally, it is the smaller countries that are less developed and have to make more critical choices about allocating resources that set this objective.[7] The idea behind this objective is to make an assessment of the scientific and technological competencies within a country, to identify possible gaps or deficiencies between supply and demand for technological knowledge. For many countries in Eastern Europe, an S&TF exercise that assesses their NIS has become part of the process for joining the European Union.

2. Another objective is to perform explicit benchmarking of the NIS against those of other countries. This objective is set by those countries that believe they are of the first rank in many fields of science and technology, and wish to examine which of their areas of research competence face competition. Countries that have set this objective include France, Italy and Hungary, the USA and the UK.[8]

3. Another objective is to identify those areas of research in which international collaboration is required in order to make progress.[9] Countries that have set this objective include Germany, Japan and the UK.

4. A common objective for many countries has been to build a collective vision across both public and private sector researchers and users of research of the future development of science and technology.[10] There are two reasons for setting this objective. The first is to help make the future more predictable or more likely to happen, by ensuring that all stakeholders are working towards the same vision of the future. The second is that as part of the process of creating a collective vision, new networks will be formed as a result of the meetings and conferences. The United Kingdom, Germany, Japan, Austria, New Zealand, Australia, Ireland, Hungary have all set this objective for their S&TF exercises.[11]

5. The establishment of priorities to guide present-day decisions is one of the most frequent aims of S&TF exercises.[12] There are three forms of such priority-setting S&TF exercises. The first of these is to set priorities for both public sector research and industrial R&D. This has been the most common variety, with the United Kingdom, Australia, New Zealand, Germany, Japan, Austria, Ireland, Hungary, South Africa, China, South Korea, Taiwan, Singapore, Malaysia, Thailand, Indonesia, Canada, Argentina, Brazil, Peru, Uruguay, the Czech Republic, Hungary, Poland, the Russian Federation and Ukraine all setting this objective.[13] However, some countries have set priorities for a more limited

set of research performers. For example, the USA has used S&TF to set priorities for only its public-sector research. Italy, France, The Netherlands, Spain have used S&TF to set priorities for only industrial R&D.[14]

6. The creation of new networks has been the most common objective of S&TF exercises.[15] All countries mentioned so far have included this aim as part of their S&TF exercises. The networks formed benefit the overall health of the NIS of a country, especially when formed between public sector creators of research and the private sector users of that research.

MATCHING METHODOLOGIES TO OBJECTIVES

This section examines the range of methodologies that can be used to achieve the objectives described above. For each methodology the key features are summarised and then some pros and cons are described.[16]

SWOT

Countries that seek to assess their NIS use a 'Strengths Weaknesses Opportunities Threats' (SWOT) analysis.[17] The 'strengths and weaknesses' part of the analysis is an opportunity for evaluating the different components of the NIS, e.g. the location of scientific and technical competencies and areas of excellence or deficiencies. Often this assessment can lead to a better understanding of what is going on than traditional indicators such as patents and levels of R&D expenditure.[18] The 'opportunities and threats' part of the analysis allows for an assessment of the future, and is used to set targets that respond to the challenges found in the strengths and weaknesses part of the analysis. However, SWOT analyses are vulnerable to bias issues if participants in the exercise all come from the same background, or share the same worldview. This can show up in suggestions that do not display much diversity.

Delphi

The Delphi survey is the method of choice for meeting several objectives: explicitly benchmarking a country's NIS; identifying needs for international collaboration; vision building; priority setting for both public sector and industrial R&D; and the creation of new networks.[19] A Delphi survey works by surveying experts in a particular field by means of successive iterations of the same questionnaire in order to bring about a convergence of opinions and to identify a possible consensus.[20] Delphi surveys work best when participants know the subject well, but they can be very time-consuming and labour intensive to administer. A drawback of this technique is that interesting ideas can be excluded from the final outcome as a result of the forced convergence of opinion.[21]

Expert panels, conferences, and consultation workshops

These are used for similar purposes as the Delphi surveys. These methods have the advantage of being less resource intensive and providing greater opportunities for networking and discussions amongst experts in a given field. These methods are used when countries seek to explicitly benchmark their NIS against international competitors, build visions, set priorities for both public sector and industrial R&D and create new networks.[22] Shortcomings of these methods include: the risk of over-dominance by strong personalities; panellists may share a common bias, perhaps nullifying the potential benefits of this approach; and like the Delphi survey, if reaching agreement at all costs is the goal, this can stifle creative thinking.[23]

Scenarios

Scenarios are most commonly used for building common visions of the future opportunities for science and technology. They are also used for setting public sector and industrial R&D priorities.[24] Scenarios are alternative visions of the future drawn from carefully constructed research into forces driving change. They are most useful when supported by high quality research, but can be wrongly perceived by users as being the only possible futures.[25]

Megatrends

Megatrends are used for building visions directly, or as part of the research work that feeds into the development of scenarios.[26] Megatrends are trends that are assessed to be especially critical because they can affect the demand for certain goods or services. Questions to ascertain the probability of various megatrends in the world or in a particular country often form part of the questions of Delphi surveys. The Delphi survey is expected to provide a timeframe for a megatrend becoming apparent. The concept of a 'megatrend' is a problematic one in critical futures studies, as their identification is often the result of unexamined worldviews and assumptions.[27]

Key Technologies

The key technologies technique is used for priority setting for both public sector research and industrial R&D.[28] It seeks to identify those key or strategic technologies that should be developed by a country to underpin the creation of a sustainable market advantage. Technologies are assessed against sets of special criteria to evaluate their importance.[29] The assessment process can be vulnerable to paradigm and bias issues if they are not included in the criteria.

PATTERNS OF S&TF WORK

Outline of a foresight process

The Foresight Planning Unit at the Swinburne University of Technology in Melbourne, Australia, has developed a useful model of the generic foresight process. The complete foresight process consists of six stages:

1. Collection of inputs: the organisation examines the wider environment and collects information that will be relevant to the later stages of the foresight process
2. Analysis of the inputs: the inputs are evaluated to try to detect major changes that affect the issues being examined
3. Interpretation: deeper understandings of the issues are developed
4. Prospection: the alternative futures are explored
5. Outputs: the options for action are developed
6. Strategy: the decisions are made that some options are actioned, and others discarded.[30]

How does a typical S&TF exercise, as described earlier, fit into these six stages? In stage one, the government science policy unit collects information that is deemed relevant to the S&TF exercise. The unit then analyses the inputs in stage two, but nearly always skips over the deeper analysis that occurs in stage three, as that level of analysis and critique might be regarded as being outside the terms of reference. Stage four is the main arena for activity: the expert panels meet and Delphi surveys are conducted. The products of this stage are the consensus opinions of the experts on what will happen in the future. Stage five is back in the hands of the science policy unit, which takes the visions for the future and converts them into policy options, which are then presented to the decision makers, who, in most cases, are the elected government of the country.

Evolution of S&TF work

S&TF work has evolved over the past thirty years through three 'generations', although most individual exercises combine generations.[31] The first generation was characterised by S&TF work being conducted by technological experts and professional futurists who were solely interested in forecasting the development of existing and new technologies. These forecasts were driven mainly by the internal dynamics of how technologies were created and commercialised through the process of research and development.

The second generation of S&TF work was still focussed on the development of new technologies, but in the larger context of how the market influenced the development process. The rationale for including the market in S&TF work was that of market failure. The key market failure was where individual firms had short-term horizons, and thus did not direct resources to activities, such as R&D, that would produce profits in the

long term. Thus intervention was seen as necessary to stimulate those firms to take a longer-term view, and thus place a higher priority to performing research and development to create new sources of profits. Second generation S&TF exercises have been most successful when the priorities established through the exercise were taken up by firms and new networks were formed between academia and industry.

Third generation S&TF exercises integrated technology, markets and the wider social context. The rationale for this generation of foresight is that of system failure, which occurs where there are insufficient networks in the socio-economic system, which means that problems are not as easily addressed and solved as they could be. Thus the purpose of third generation S&TF is solving socio-economic problems, and these are often suggested by stakeholders who are little concerned with the technicalities of the development of new technologies. The role played by government becomes more important, as organisations that are less concerned with science and technology and more concerned with enhancing the public good, such as health, the environment, workplace safety, become more involved with choosing the problems to be solved. Evaluation of the success of this generation of foresight is more problematic, as the aim is to create a foresight culture where participants in the S&TF work continue to use their new skills to address socio-economic problems.

Looking at the development of the three generations of S&TF work overall, S&TF has remained largely within the 'pop futures' level of futures work identified by Slaughter.[32] This level is characterised by the idea that science and technology will always make our lives better and better. The main evolutionary change between the generations of S&TF work has been the ever-widening definition of what can be considered relevant problems that require solution. As S&TF work is trying to solve problems, one might draw the conclusion that S&TF work falls in the 'problem solving' level identified by Slaughter. This is not a correct analysis, as the only solutions envisaged by S&TF are those resulting from new R&D. To be correctly placed at Slaughter's 'problem solving' level, S&TF work would have to suggest other solutions appropriate to that level, such as social and institutional responses, and new laws. In addition, since nearly all of the national S&TF work has been facilitated by governments, deep critical or epistemological futures work has very rarely occurred. Thus many problems have not been seriously addressed, as real and lasting solutions would require questioning the history of the problem. This in turn would reveal how the problem arose as part of the historical social construction of reality. Government does not readily address such issues, and so more practical solutions are sought, such as building more networks and commercialising new technologies.

Another useful way of characterising the pattern of S&TF work analyses who is involved (either professionals in the field; the decision-makers; or the public) at each of the three broad stages of foresight work:

- Formation of the possible futures
- Assessment of the relative desirability of those alternative futures
- Making the final decision on which strategies to pursue to achieve the desired future.[33]

As part of the gradual evolution from second generation of S&TF to the third generation, there has been an increased use of the public to provide suggestions for the problems needing solution, and ideas for alternative solutions for those problems. In S&TF work, the formation of possible futures was the responsibility of professionals, sampled through expert panel discussions and Delphi surveys. The assessment of the relative desirability of the alternative futures was the responsibility of the science policy unit, i.e. another group of professionals, while the final decision was left to the decision-makers. The value of the typologies developed by Taipo and Hietanen is that they propose a spectrum of seven alternative paradigms for the roles of professionals, decision-makers and the public in the strategic decision making process. By doing so, they open up the possibilities for alternative ways that S&TF work might be developed, and, in so doing, get in touch with the real problems that people face.

EVALUATION OF THE 1995 UK FORESIGHT PROGRAMME

In this section the 1995 United Kingdom Foresight Programme is evaluated. Some important points for policy makers who might be considering running a similar foresight program are highlighted.

The UK Foresight Programme was launched in the 1993 Science White Paper.[34] The Programme had two main objectives that related to the existing state of UK science policy. The first objective was to set national priorities for both public sector science and industrial R&D to allow for the coordination of research and innovation agendas. The idea was that increased national prosperity would result from UK industry increasing its use of public sector research. The second objective was to foster networks between the academic producers of research and the industrial users of their research.[35]

Priorities were set through the processes of expert panels and Delphi surveys. As discussed above, the level of 'thinking outside the square' in the results gained from these methods can suffer when the emphasis is on getting a convergence of views. The more outlying views can be left out. In the UK Foresight Programme, the panel members were encouraged to come to a consensual decision. This was to be an example of 'a non-partisan, depoliticised, and rationally-driven framework for making choices'.[36] However, it appears that few members of the panels were able to shed their partisan bias towards their existing fields

of research. This was the result of most of the panel members relying on the results of the panel deliberations for future funding that would be based on those new priorities. Instead of a new rational, consensus-building process, what appears to have happened was that panel members came to a compromise on the basis of representing their personal fields of study, rather than representing a disinterested view.[37] As could be expected, this resulted in 'new' priorities that were little different from the existing research programs.[38]

So what has been the effect of these new priorities on academic research programs? For the largest sector of UK research, in the health and life sciences, apart from those areas judged as being priority areas, the new foresight-derived priorities and funding have had limited impact if at all.[39] This was due to the small amount of money affected by the new priorities, in essence only a small amount of new funding, which was itself only a fraction of all the research funding granted by the government.[40] The government's case was not helped by pre-existing high levels of scepticism in the academic research community about the government imposing top-down directions on basic research. The situation was not improved by the relatively narrow base of advocates for the program, who were confined to the Minister and the science policy bureaucrats in the ministry.[41] The academics were further dissuaded from accepting the results of the foresight program when they saw that the research councils didn't incorporate the new priorities. Since the research councils decided which research projects were funded, their failure to use the new priorities undermined the government's cause.[42] The research councils continued using their own judgements of scientific merit instead of using the new priorities. Thus the priorities set by the UK Foresight Programme have had only a limited effect on what research is now being conducted in the health and life sciences sector of UK science.

The second objective of the UK Foresight Programme was to build new networks to benefit the whole of the United Kingdom. This was to be facilitated by the priority-setting expert panels, which provided fora for discussions and meetings between representatives from the public and private sectors. So how did this work in practice? In the first instance, only a relatively small number of people participated in the expert panels, about 10,000 altogether. Secondly, while the purpose of the priority-setting panels was to have non-interested experts discussing opportunities for the country as a whole, there is evidence to suggest that the main beneficiaries of the networking opportunities were those panel members who were able to gain something for their own organisations.[43]

Thus the UK Foresight Programme has had some mixed results. On the one hand it developed research priorities, and enabled a small number of experts to create new networks. On the other hand, the program appears to have created a rationale for UK science and industry to carry on doing what they were doing before. One benefit is that both sectors now have a better idea of what each other are doing.

FUTURES CONCEPTS IN S&TF

In the case of the 1995 UK Foresight Programme, the result was to reaffirm the existing priorities. This wasn't necessarily a problem, as long as the larger environment would remain fixed and static for all time. For example, if the UK will be competing against the same nations for all time, new science and technologies would not be developed, and the consumers of the UK would not change their habits and needs. In addition, the assumption was made that new environmental or social problems would not develop, or that new global structures would not affect overseas markets. If, however, some of the assumptions of 'business as usual' could change, then it would make sense to incorporate those possibilities into thinking and planning. How could this be done? Futures studies has several key concepts and ideas that could be used by S&TF work to ensure that continuing change is considered. There are two futurists who have drawn up lists of key concepts of futures studies. One list is drawn from the work of Sohail Inayatullah, and the other from the work of Richard Slaughter.[44] This section will compare the lists of concepts with the 1990s S&TF exercises, and examine if S&TF already incorporates those concepts in its practices.

Inayatullah's summary list of the distinctions between futures work and planning is considered first. His first point is that futures work considers long time frames, from five to fifty years. S&TF work usually covers from five to thirty years, so there is already a common timeframe being considered. His second point is that futures work is more concerned with creating rather than predicting the future. S&TF is more concerned with predicting what will happen in the future, and then using this prediction to guide present actions. However, as was demonstrated with the UK Foresight Programme, often the predictions of what will be important in the future look remarkably similar to what is important today.

Inayatullah's third point is that futures work seeks to illustrate alternative futures. S&TF seeks to identify a few most likely futures. Thus S&TF work might have problems dealing with possible or preferable futures that differed from the probable future. Fourthly, futures work is less likely to be applied to one customer. S&TF is usually done for the government, or just the science policy department. Fifthly, futures work makes use of multiple interpretations of reality. S&TF makes use of the interpretations of reality or world views of the scientists, academics and industry representatives involved in the expert panels and Delphi surveys. Other worldviews are not considered as they are deemed, usually by the government, to be not relevant to the outcomes desired from S&TF. Sixthly, futures work is participatory, involving people from all possible stakeholder groups. S&TF defines its stakeholder groups narrowly, including mostly subject matter experts and policy makers.

Seventhly, futures work is concerned more with the process than the outcome of the work, as this can involve more people and more networks of people. S&TF is often equally concerned with the process (networking) and with the outcomes (priorities). Inayatullah's

eighth point is that the goals of undertaking futures work may be for many reasons, and not just for profit and power, depending on the variety of stakeholders involved. The goals of S&TF are largely about maintaining a country's competitive advantage to ensure continued economic growth. Lastly, futures work covers a range of activities, from research to social movements. It is often about more than creating alternative scenarios; it is also about performing actions to create the desired future. S&TF also shares this view in a very limited fashion. For example, governments set priorities to encourage public and private sector researchers to perform actions based on the outcomes of the S&TF work. Overall, there are some areas from Inayatullah's list that show potential for inclusion, and there are a couple of areas of overlap.

Let's now turn to Slaughter's list of concepts from futures studies. His first concept is that 'a wide variety of futures exist at all levels'. Generally in S&TF the focus is on science and technology futures that assume little or no change elsewhere in society. The second concept is that futures 'are commonly divided into possible, probable and preferred futures'. In S&TF only preferred futures are discussed, as the less likely ones are often discarded through the process of refining the results of a Delphi survey. The third concept is that these different futures 'suggest a need for conscious choice, participation and purposive action'. These concepts are also found in S&TF work in a limited fashion: conscious choice and action is required to follow a particular research field to the point where it becomes a commercial product.

Slaughter's fourth point is that 'the future is not predictable or predetermined, but may be affected by individuals or groups'. This is also found in S&TF work, but only a small part of the wide range of possible actors who able to affect the future are considered, for example the government, academics or the private sector. The actions of other possible actors, such as non-governmental organisations or the education sector, are not considered. His fifth point, that 'human actions and decisions (or their lack) shape the future' is reflected in S&TF in a narrow fashion – only considering the decisions and actions of a limited range of actors.

Slaughter's sixth concept, 'the present period is unique and will affect all future generations'. This concept is not found often in S&TF work. Generally, the S&TF appears to be taking place in a sort of timeless present, with present decisions only affecting the levels of national competitiveness. If S&TF work considered that the present was unique, then the implications of short-term decisions, such as to develop certain technologies with commercial benefit, might be more clearly thought through. The seventh concept is that 'it is necessary to exert human control over change processes'. In S&TF work generally the market is the preferred method of ensuring that control is not exerted over change processes. That is, many processes are not controlled for fear of restricting the ability of the market to operate efficiently.

Slaughter's eighth concept is that pre-action is preferable to crisis management. S&TF work shares this perspective. The ninth concept is that 'holistic, global and long range perspectives are indispensable'. In S&TF work the ideas of holistic and global do not appear. The emphasis is instead on nation competing against nation for medium term competitive advantage. Finally, 'images of the future guide actions in the present and affect what seems possible in the future'. This is another concept that S&TF already recognises and incorporates into its work theoretically. However, as shown in the example of the UK Foresight Programme, what happens in reality is often governed by present day preconceptions of a single solution (i.e. free markets) and thus does not allow for alternatives to be seriously considered.

So, what is the result? 'S&TF seems to have some overlap with some concepts of futures studies, but in most cases these concepts are applied in a very limited fashion'. Applying some of the under-utilised concepts from futures studies would require rethinking some of the key assumptions of S&TF, which would improve the robustness of the results of S&TF work.

Other futures ideas for inclusion

Some ideas that have been suggested for alternative perspectives that can be added to S&TF are briefly explored. Other ideas, such as greater 'width and depth' and the environmental scanning frameworks of Wilber, Graves and Voros, are considered later in the monograph.

One promising approach would be to query the 'business-as-usual' assumption that underlies much of S&TF work and to provide alternatives to this assumption. The usual assumption is of the 'business-as-usual' scenario, where no changes are envisaged to the world and/or country, not even as a result of developing new technologies. What alternatives exist? Slaughter proposes four alternative sets of scenarios:

1. breakdown (where something important went wrong)
2. repressive or over-managed societies (where fascism returns, perhaps to fight terrorism or ecological threats)
3. ecological decentralism (where benign 'soft energy paths' are developed and limits to growth are implemented)
4. transformational societies (where perhaps people/machine interactions occur on a equal basis, or perhaps spirituality leads in new directions).[45]

By incorporating the consideration of these alternative futures into S&TF work, more useful and relevant outcomes would result. Using alternative scenarios would create opportunities for technologies that are less relevant to a 'business as usual' situation to

be made a priority. For example, the science and technology that would be most useful in a 'breakdown world' would be quite different from that which would be useful for a 'transformational world'.

Another concept from futures studies is to use deeper methods of analysis to deconstruct the assumptions that frame the problems under consideration.[46] For example, the problems of resource allocation in national budgets that have led to priorities being set can be deconstructed to result from the emphasis that many governments place on expenditure with poor economic returns. There is often an undue emphasis on defence industries and the arms trade, and the government subsidising industries that have large political weight but relatively little economic benefit. While this is often the result of the way that democracies function, and the operation of the golden rule aka 'he who has the gold makes the rules' when considering the future it is important to consider alternatives.

Other ideas that could be usefully deconstructed in S&TF work include:

- That economic growth is seen as being the only way to enhance the well being of citizens. Looking deeper, economic growth in Western democracies is privileged as the result of the power structures that have been constructed over the last few centuries, and the result of ignoring other, non-material, but non-profitable ways that well being can be enhanced.
- The problem of poor networking between the creators and users of research can be seen as being the result of the historical development of universities and commercial firms. In addition, there are the associated differences in how each sector recruits new members. In the private sector there is a strong emphasis on making a profit, while in the public sector the emphasis is on self-directed research without much thought for practical or commercial application. Perhaps the time for this historical demarcation has passed?
- Defining who should participate in an S&TF exercise. For example, people who are experts are included on expert panels and in Delphi surveys – but who defines the idea of being an expert? It is clear that only those people with an interest in perpetuating the existing power structures are included.[47] People who might have alternative views on what is important, and on what the long-term consequences of developing certain technologies are left out of such processes unless they are judged to have scientific or commercial experience.

Greater width and depth

S&TF work would be more robust (that is of more use to suit changing circumstances) if it included more of the 'wider and deeper' methods and concepts from futures studies. Futures studies shares with psychology and many other social sciences the metaphor of a layered approach, where one may move both horizontally and vertically through an analysis of a

subject or problem. The idea of horizontal movement is that one is remaining at the same depth of analysis, but trying out different ways of analysing that problem. The metaphor is one of making choices of which door to open, while remaining on the same floor of a hotel, for example. Behind one door is a technological analysis. Behind another door is an economic analysis. Behind a third door is an extrapolation based on a 'business as usual' scenario, while behind a fourth door there is an extrapolation based on a 'transformational' scenario.

The key idea is that these horizontal options can exist at different vertical levels of analysis. Moving vertically means to take into account shallower or deeper accounts of reality, to uncover the underlying patterns and causes of events. An example of depth is the practice of critical futures studies, which provides tools to probe under the surface of language and concepts; to look for the underlying relationships and worldviews that shape the author's perception of the world. For example, in Inayatullah's methodology of Causal Layered Analysis, the top or shallowest layer is the litany layer, which is the same as the 'pop futures' layer described by Slaughter.[48] Remember that this is the land of the thirty second sound bite about how science and technology is making your life better and better. While this may be at the top layer and thus talked about as being 'shallow', there are still horizontal options to be explored here, such as whether the sound bite comes from Sky News, delivered as entertainment or from the BBC, delivered as a documentary. The deepest layer in Causal Layered Analysis is the myth/metaphor layer. At this depth (or vertical layer) the opportunities for horizontal choices are almost infinite, but can be understood as being about how we regard one another and ourselves. Behind one door we find a world where centre-periphery relations are key, and behind another door is a world structured around the idea of infinite resources and opportunities.

As discussed earlier, S&TF work operates mainly on one vertical level: the shallowest or 'pop futures' level of Causal Layered Analysis. The reasoning for this is that S&TF work is concerned with solving problems (such as sustaining economic growth) by inventing new science and technologies to solve the problem.[49] At other vertical levels, the answers to such a problem may be to invent new laws, or to challenge the nature of the understanding of the problem. Take for example sustainable production. Rather than analysing the reasons and causes for our current system of unsustainable production, S&TF work is used to develop research that will deliver new methods of sustainable production. As Alan Fricker notes 'R&D has become largely a surrogate for social action'.[50] If new technology is invented to solve the problem then our current behaviour doesn't have to change. In terms of horizontal options, S&TF work operates mainly inside one horizontal doorway – the one that reads 'business as usual'. S&TF work rarely considers larger societal influences, except when they manifest themselves as 'problems' for government or industry or the research community.

Thus for S&TF work to take in some wider and deeper options would mean changing several of the basic assumptions of S&TF work.

Frameworks for further examining 'wider and deeper': Ken Wilber, Spiral Dynamics, and the Voros combination

Two frameworks have been developed for futures studies in the late 1990s that could provide useful insights to improve the width and depth of S&TF work.

American philosopher Ken Wilber has developed a four-quadrant or integral approach with which to view the world. The central idea is that all phenomena fall into one of the four quadrants and that evolution and change in one quadrant will affect all other quadrants:

- Interior individual: individual subjective awareness, such as hopes, joys, dreams, cognitive capacities and intentions
- Exterior individual: objectively measurable aspects or behaviours of individual people
- Interior collective: the results of individuals exchanging their beliefs and experiences with other, which develops a shared awareness, or worldview
- Exterior collective: communities or societies of individual people, and their external interactions.[51]

Dr Clare W Graves developed the central foundations of Spiral Dynamics, which is a theory for looking systematically at how people think about their world.[52] It is based on the ways that individuals express the potential that exists within every one of us. The ideas that Spiral Dynamics assess lie within Wilber's interior-individual quadrant and concern the ways that people view their relationship to the external environment. Basically, changes in how people view their environment lead to changes in the sets of values that they exhibit, and the types of societies that they live in. This is an example of how change in one of Wilber's four quadrants, the interior individual, can affect the other three quadrants.

Voros has expanded on the work of Slaughter to explicitly recognise that inputs from environmental scanning, which occurs at stage one of the generic foresight process can come from any one of eleven (or more) possible levels located within the four quadrant framework of Wilber.[53] Voros has also developed a useful terminology to recognise and analyse the perceptual filters that affect one's perception of what is important or relevant: that is, what is the litany? Voros makes an important contribution to lifting the veils of filters that we place in front of our senses. By developing his '4Q/11L' system, he allows us to better identify our perceptual biases, and to become more aware of those quadrants and levels that are not covered by our environmental scanning system.[54] Identification of our perceptual biases does not necessarily change them, but can force us to recognise that there are alternative sources of information that we automatically overlook.

Opportunities for including 'wider and deeper' into S&TF work

The practical question of how 'wider and deeper' concepts and methodologies could be incorporated into S&TF work is now considered. Slaughter provides a useful framework to show how the methods and concepts of critical futures studies can be included in S&TF work. Slaughter identifies four stages in undertaking foresight work:

1. Develop a conceptual analysis of the near-term future
2. Establish an environmental scanning system
3. Assess significant emerging issues through paradigmatic method(s)
4. Build scenarios and formulate strategy.[55]

These four stages reveal many opportunities for modifying S&TF work. The next sections consider some of the alternatives that exist at each of the four stages.

Stage 1: develop a conceptual analysis of the near-term future

The first stage is where a conceptual analysis of the near term future is developed. This analysis will then inform the environmental scanning process that follows.

In S&TF work, the conceptual analysis of the near term future is based upon the concept that each nation must (or does already) compete with other nations through science and technology. Unless the nation is competitive, the living standards within that nation will decline.[56] Slaughter locates this level of analysis on the litany level, as the key trends focus on technology, and the sources of future good news are 'mainly new gadgets'.[57]

Thus the S&TF analysis of the near term future is rather simple. Adding a paradigmatic method would make the conceptual analysis more realistic. Critical futures studies can help to analyse the issues we are seeking to address and Causal Layered Analysis is one method of critical futures studies that can help to analyse otherwise unregarded biases and alternatives.[58] Critical futures studies asks such questions as why has this issue gained prominence now? What has been the history of the issue and has the issue always been the important one, or is now important due to a convergence of short-term factors? What important issues are being swept under the carpet that might have a larger impact? What emerging issues might arise in the future that could have major effects?

Informed by the results of the critical futures studies, the issues can be reframed as being much wider than solely scientific ones. An example of how a paradigmatic method can unpack the underlying issues in a problem is the introduction of genetic engineering (GE) in agriculture into New Zealand. Alan Fricker analyses this issue using Causal Layered Analysis.[59] At the litany level, Fricker identifies that GE is promoted as a solution to some current and future global problems, such as feeding the world's hungry and reducing

crop losses. This naturally ignores the already existing critique of how these problems arose in the first place. At the social causes level Fricker find little information, largely because the issue is too new for much quantitative research to have been completed yet. So we are left without the 'authoritative' arguments usually made at this level about X% increase in productivity, etc. At the worldview level the Western capitalist system is revealed as the motivating force behind the introduction of GE. There is little consideration of the value of alternative worldviews. At the myth level, the only operative one is that 'the market decides all'. Thus moving between vertical layers will change the conceptual analysis of the current situation.

Horizontal layers can also be incorporated into the conceptual analysis. For example, a useful horizontal choice at any vertical layer is to decide to develop different alternative futures rather than just the 'business as usual' future. This will change the sorts of information that is sought. Under the 'business as usual' future, one would seek information that supports or refutes only this understanding of the situation. By allowing for alternative situations, one can gather more information than you'd otherwise do so just by looking at if the basic case will happen or not. Similarly, appreciating the implications of the existence of possible, probable and preferred futures can also open up many horizontal (and vertical) alternatives. Perhaps one pitfall of the 'business as usual' analysis is that attention is focussed on the preferred future of the people funding the S&TF work.

There are a wide variety of other general concepts from futures studies that can be included, to stimulate more horizontal choices at any given vertical layer at the conceptual analysis stage. These have been discussed earlier. For example, there would be great value in making use of other interpretations of reality, not just the interpretations of the experts or of the people paying for the S&TF work. One useful framework here is that of Spiral Dynamics (introduced above) which classifies different sets of values and beliefs. Briefly, people with an Orange perspective undertake most S&TF work done by the OECD.[60] This perspective values the role that science plays in producing economic growth to enhance individual material well-being. What would happen if the primary perspective of those doing S&TF was Green, i.e. to enhance the well-being and personal development of communities?

What could be the results of including these horizontal and vertical options into S&TF work? One result could be that economic growth is seen as not the only way to deliver improvements in the quality of life of the citizens of a country. Just changing this one assumption would create a whole new arena for S&TF work, and remove much of the rationale for the current breakneck pace of technological development. Thus how you choose to analyse and understand the present will determine your options for the future. The choices that you make here will inform what information you will seek in stage two when you establish an environmental scanning system.

Stage 2: establish an environmental scanning system

The environmental scanning system is the systematic way of acquiring specific information about what is happening, by using a consistent process to choose information that is relevant to the issue being addressed. In S&TF work the environmental scanning inputs are provided by the assembled panels of experts in the fields of science and technology under consideration. Experts are chosen to be members of discussion panels based on their experience in the topics for discussion, for example the process of catalysis or the commercialisation of R&D. Thus the sorts of information that they bring to the table are: the rate of progress in their chosen field of study; what research breakthroughs are likely and when; which fields of study are the most promising for the development of commercial spin-offs, and so on.

Practitioners of S&TF can use Wilber's four quadrants to suggest new sources of information related to S&TF work.[61] Traditional S&TF work has been confined to the exterior collective quadrant, for example, by considering the infrastructure required to support the growth of a modern, developed economy. By opening the environmental scanning stage to the other three quadrants, S&TF work potentially opens up vast vistas that were locked away because they were not deemed relevant to the science and technology being considered, or tossed into the basket marked 'too hard to understand'. By addressing this extra source of material, S&TF can move out of the rut of what Wilber calls 'flatland' and develop innovative solutions for issues.

What if S&TF work used the environmental scanning framework of Voros, as described above? Panel discussions in S&TF work are based around extrapolations of what scientific and technological developments might be expected to occur in the timeframe under consideration. The developments that are regarded as being important are usually those that have a commercial application. Using the nomenclature established by Voros, these developments are coming from an Orange viewpoint focussing on the exterior collective quadrant.[62] Different stages of development along the spiral provide opportunities for horizontal choices. For example, a person using a Red or Green worldview filter would have different perspectives. A person with a Red perspective might look for more weapons technology to enhance the power of their country, while a person using a Green perspective might look for sustainable, people-inclusive technologies.

Thus the effect of making these changes to environmental scanning is to include more inputs to the conceptual analysis. Note however, that these inputs could be disregarded unless the conceptual analysis of stage one allows for such 'weird' information to be included.

Stage 3: assess significant emerging issues through paradigmatic method(s)

Generally S&TF work doesn't challenge the identification by experts of the emerging issues. In S&TF work this information would be treated as data and simply plugged into the final recommendations and priorities. Van der Meulen notes that creative methods (such as brainstorming and science fiction) can do some of the work to challenge strong beliefs and vested interests that arise from the interactive and expert-driven phases of foresight work.[63] However, unless this process of challenging is informed by paradigmatic methods, it is most likely that the challenging will only occur on one horizontal layer. More rewarding challenging will occur if different vertical layers are used in the process.

Using the methods of critical futures studies allows the examination of the history of an issue, and how one paradigm now dominates thinking about the issue. Using Causal Layered Analysis, we can examine the work through the layers and see how the data may indicate different alternatives at the different layers. The two main layers that could be incorporated are the worldview/critical layer and the myth/epistemological layer. At the worldview layer we are interested in alternative ways of framing the issue from alternative worldviews. In S&TF terms, this would mean interpreting the information through alternative worldviews. In one worldview profit might be valued, but in another it may not be. What we are doing by moving amongst worldviews is to move along the line of development described in Spiral Dynamics that sits in Wilber's interior-individual quadrant.

The effect of including a paradigmatic method at this stage of the analysis is to open up more opportunities to identify issues, drivers and trends that are really driving change. This reduces the danger that the S&TF work is solely concerned with the litany about a problem, or overwhelmed by empirical data that deeper patterns are lost. The upshot is to allow for more opportunities to move out of 'flatland'.

Stage 4: build scenarios and formulate strategy

In S&TF work many exercises take the data from the environmental scanning system and then seek to prioritise it according to discussions by panels of experts. As mentioned before, what they are doing here is extrapolating into a 'business as usual' world. S&TF work would be better and more robust if it considered alternatives at the horizontal level as well. The sort of S&T priorities that are developed for a 'business as usual' world would be quite different from those that would be developed in a 'catastrophe' scenario, of the sort favoured by climate change activists. This would again be different from those developed in a world transcending to a higher state, perhaps through the use of human/computer interfaces.

One useful way of stimulating ideas from people based on alternative scenarios could be the method of using 'near-future landscapes', as described by Slaughter.[64] The idea

of near-future landscapes is to show some of the possible impacts and interactions of present day decisions. They can also be used for backcasting, that is, if this is our desired future, what steps did we have to make in order to reach this future?

There is a very useful distinction to be made here between the sorts of images of the future that one sees in popular literature, and the sorts of near future landscapes we are talking about here. Slaughter discusses the differences:

> In brief, futures images are useful when they illuminate choices, strategies and options. They tend to mystify when they are presented as entertainment and when they repeatedly highlight a restricted range of images…while, at the same time, obscuring a far wider range of unexamined possibilities.[65]

Slaughter provides some useful examples of near future landscapes:

> [These figures] show how contrasting images of near future landscapes can be used to highlight some basic choices for the future…they portray some of the options and dangers before us in ways that are concrete and more 'real' than the often abstract arguments in books and journals. Moreover, such images can also be 'problematized', that is, explored in terms of their inherent assumptions, cultural bias, values etc. They can be expressive of worldviews and different types of speech communities. Such images can be approached and understood on at least two or three distinct levels. They are therefore a rich source of accessible interpretations and ideas about futures.[66]

Images of near-future landscapes could be used to inform panel members involved in S&TF work about some of the possible consequences of their present day decisions, and to make explicit their assumptions about the effects that new technologies would have on daily life. In this role near-future landscapes could have a similar effect to scenarios. However, while scenarios usually are expressed in words alone, the use of near future landscapes touches people in different ways. On the other hand, the images could be used as normative goals that inform current day decisions. In both cases, the value of the near future landscape is to make explicit the assumptions that underlie some key decisions.

Costanza outlines one such framework that combines some of the ideas discussed above.[67] He provides four alternative scenarios, and he invokes visual images of possible near future landscapes by referring to popular images of the future to distinguish between the alternatives. For example, his four scenarios of the future are called 'Star Trek' 'Mad Max' 'Ecotopia' and 'Big Government'. Costanza's four scenarios are distinguished by 'one's degree of faith in technological progress to solve the world's ills'.[68] He constructs a two by two matrix. Along the first axis are two worldviews: the technological optimist and the technological sceptic. The optimist position is that technology will cure all the

ills of the world if only its full potential is unleashed from regulatory controls, while the sceptic position argues that technology should be the servant of larger social goals. Along the second axis are two possibilities for the real state of the world: that either the technological optimists are right, or that the technological sceptics are right. Note that Costanza doesn't discuss the fallacy of relying on an empirical, 'real state of the world' and whether it can be truly known.

Thus four scenarios are created:

1. 'Star Trek' is a world where the worldview of the technological optimist operated, and the real state of the world supported the assumptions of the optimists. The result is cornucopia resulting from nuclear fusion power providing vast amounts of cheap energy.
2. 'Mad Max' is a world where the worldview of the technological optimist operated, but that the real state of the world supported the assumptions of the sceptics. The result is constant wars over the remaining sources of fossil fuels.
3. 'Big Government' is a world where the worldview of the technological sceptic operated, and the real state of the world supported the assumptions of the optimists. Thus an over-regulated world muddles its way through the transition to sustainability.
4. 'Ecotopia' is a world where the worldview of the technological sceptic operated, and the real state of the world supported the assumptions of the sceptics. This world transitions to a low-consumption sustainable vision.[69]

Costanza puts forward his alternatives with the point that we should all endeavour to ensure that nothing like the 'Mad Max' scenario actually occurs.[70]

The result of including these alternative scenarios and near future landscape methods into S&TF work would be that participants in S&TF work would take the opportunity to consider the long-term consequences of their decisions. Not just the linear, straight-line projections of trends of increasing profits etc, but also the synergistic effects of their priorities and forecasts.

CASE STUDY

Australia's process for setting national research priorities in 2002 (NRP 2002)

This case study evaluates the process used by Australia in 2002 to set national research priorities against the principles of S&TF work and futures studies described above. Two issues are examined. First, an evaluation is made whether NRP 2002 can be considered a S&TF exercise. Second, the rationale and the process used for setting national research priorities are critiqued, using the critique developed for S&TF exercises. While NRP 2002 did not use many of the methods of S&TF work, it shares many of the same limitations of S&TF work.

The process of NRP 2002

From publicly available resources, the process adopted by the Australian government for setting national research priorities commenced in May 2002 with the release of an issues paper. The issues paper outlined the rationale for setting priorities, the process to be followed, and the selection criteria to be used to develop the short list of priorities.[71]

There followed a series of public consultation meetings across Australia, in capital cities and major regional centres, which sought feedback on the proposed nature of priorities and the selection criteria. The results of the consultative meetings were written up in a report which was submitted to government.[72] After the publication of the final selection criteria one month was allowed for the nomination of research priorities.

The next stage was the formation of the Expert Advisory Committee (EAC) which was composed of twelve eminent Australian researchers. Their task was to sort through the submissions and prepare a short list of priorities for government decision.[73] Half of the members of the EAC were professors; one-third were women. Many had extensive experience in business. According to the terms of reference they were selected for their 'capacity to assimilate issues beyond the scope of their field and background, including relevant social, commercial, economic and environmental issues'.[74] The selected priorities will then be implemented by the various Commonwealth funded research agencies, such as the CSIRO, the Australian Institute for Marine Science, and the Australian Nuclear Science and Technology Organisation.

Selection of the priorities

The priorities were selected on the basis of two key concepts. The first concept was the scope of priorities, and the second was the selection criteria to be used by the Expert Advisory Committee to short-list the priorities.

The priorities were to be '…priorities that provide a broad view of where Australians aspire the nation to be in the future…the Government will ensure that national research priorities…point to a national vision for research and are aspirational…capture the imagination and support of the community…[and] produce measurable outcomes'.[75] The type of priorities should 'stimulate a collaborative approach to solutions' which means that different research agencies should collaborate to develop solutions, rather than developing solutions in isolation from one another, and competing for limited resources.[76] The selection criteria seek priorities that provide 'scope for increased Commonwealth research effort in the priority to deliver a measurable and significant positive impact…scope for Australia to build the capacity needed to achieve that impact…scope for Australia to capture the benefits of the research, through the potential of the research'.[77]

A total of 167 submissions were received, with over 200 proposals for priorities.[78] Each submission was requested to make suggestions for thematic priorities, and a number of specific research fields under each theme. Of the 167 submissions, twenty-two, or thirteen per cent, were from individuals. A mixture of government agencies, government funded research agencies, industry or research associations, universities, and businesses submitted the rest. Less than ten per cent of all submissions were from non-government organisations or from the community sector. None were from political parties, or religious organisations, or people one would consider the 'mums and dads' or 'the battlers' or 'the aspirational voters' of Australia. Of course, in a democracy like Australia, the views of the Australian people would be taken into account when the Federal Government considered the recommendations of the EAC.

In the submissions, there are a number of common themes: a sustainable environment; making use of Australia's unique biodiversity; creating a healthy Australia; sustainable growth by using Australia's mineral wealth; healthy and productive ageing for all Australians; improving Indigenous Australia. The word sustainable occurred very often: sustainable mining, sustainable agriculture, sustainable economic growth, and sustainable environment. (Of particular interest to the author was one submission that nominated the establishment of an Australian Institute for Future Studies that would study current trends, provide advice to government, and educate the people of Australia of the need to think long term).[79]

So what sort of future did the Federal Government decide that Australians aspire to? The government decided that the future would be the result of the following research priorities:

- An environmentally sustainable Australia
- Promoting and maintaining good health
- Frontier technologies for building and transforming Australian industries
- Safeguarding Australia.[80]

Was NRP 2002 a Science and Technology Foresight exercise?

By evaluating NRP 2002 as a S&TF exercise one can see opportunities to critique the process and outputs, and make suggestions for improvements. Although not officially described as a national S&TF exercise, NRP 2002 was concerned with creating a better future for Australia through R&D – a central aim of S&TF work. The process was described as seeking to choose national research priorities only, but the Minister for Science, the Hon Peter McGauran MP stated that 'There's been an excellent response [to the request for submissions] and many high quality submissions with great visions for Australia's future'.[81] This is evidence that the Minister for Science regarded the research priorities as 'visions for Australia's future'. The framework statement provided additional evidence that the Government was seeking 'priorities that provide a broad view of where Australians

aspire the nation to be in the future'.[82] Thus there is the implication that NRP 2002 was to be about Australia's future, and how R&D could bring about that future, rather than being narrowly focussed on doing better R&D.

How does the NRP 2002 process compare against the six stage generic process of foresight exercises developed by the Foresight Planning Unit at the Swinburne University of Technology in Melbourne, Australia? The first three stages (collection, analysis and interpretation of inputs) were undertaken in the minds of each of the individuals and organisations that made the submissions. The fourth stage of the generic process (exploring alternative futures) occurred when the public made submissions on possible priorities. The fifth stage (developing options for action) was handled by the EAC when it developed a short list of priority areas for research. The Federal Government performed the final decision-making stage. Unfortunately, there is little information publicly available concerning how the submissions were created, so it is only possible to speculate how the authors of each submission analysed the wider environment in order to create their proposals. On this basis it is hard to classify NRP 2002 as S&TF work, as the first three stages that develop a common understanding of the forces shaping the future, are central to the performance of S&TF work.

Broadly speaking, NRP 2002 has some features in common with S&TF work done in the 1990s. Among their aims, many S&TF exercises sought to develop priorities for science and technology, and to develop new networks. NRP 2002 shared both of these aims. The process used in NRP 2002 employed both public consultations and an expert panel. These are methods also used by S&TF work. However, unlike most S&TF work, NRP 2002 did not employ the use of Delphi surveys, expert panel discussions on specific sectors of the economy, scenarios, or key technologies. Based on the methodologies employed, NRP 2002 cannot be classified a S&TF exercise.

From the description of the generations of S&TF work, NRP 2002 could be categorised as a third generation effort. Remember that a third generation S&TF exercise seeks to solve socio-economic problems through more R&D and improved networks. The underlying rationale for Australia setting national research priorities was to increase community support for research that produced positive outcomes for Australia.[83] One of the aims for setting national research priorities was to create new opportunities for collaboration between government funded research agencies to solve problems of interest to the Australian community.[84] Previously, it had been up to each individual research agency to improve its own links with industry and social stakeholders, and that continuing work was outside the scope of NRP 2002. In NRP 2002, there was some attempt to involve the Australian community in the submission of research priorities, but, as shown above, non-researchers made only thirteen per cent of submissions.

When considered against the seven typologies of futures studies developed by Taipo and Hietanen, the NRP 2002 process fits into two possible categories: optimistic humanism (most likely) or critical pragmatism (if one was feeling generous). The comparison against optimistic humanism goes like this: for the first part of NRP 2002 professionals (universities, research agencies etc.) submitted proposals for possible priorities. Professionals, in the form of the EAC, evaluated the alternatives. Decision-makers, in this case the Federal Government, made the final decision on the selection of strategies. It could conceivably be argued that the public were also involved in the submission of proposals, but since very few did so, one is inclined to not categorise the process as an example of 'critical pragmatism'. Critical pragmatism is characterised by the public's involvement in the formulation of alternatives and their involvement in the evaluation process. In the 2002 NRP process, the public was invited to participate only in the formulation of alternatives stage (by making submissions), and was entirely excluded from the evaluation stage. One could argue that the public was involved, if at a distance, through the election of their democratic representatives. However, this form of public involvement is included in the definition of decision makers. NRP 2002 offered the Australian public the opportunity to make submissions of priorities, but relatively few took up the opportunity. The next section examines some possible explanations for the poor engagement of the Australian public.

Critique of the process

NRP 2002 could not be classified as a S&TF exercise. How might the use of the concepts and methods of S&TF work, as modified using ideas from critical futures studies, improve the quality of how Australians think about the future of Australia?

Firstly, there could have been better opportunities for the active involvement of the public, beyond their role in electing their democratic representatives in a federal election in November 2001 that was dominated by the implications of the 'war on terror'. From the description of the process it is clear that NRP 2002 was an effort that relied largely on tapping into a pool of pre-existing possible priorities developed by researchers and industry. An alternative process, informed by S&TF work and futures studies, could have been a concerted effort to stimulate national discussions of the opportunities for Australia, and what visions of the future could be achieved through R&D, as well as the limitations of relying on R&D to solve problems. As well as improving the diversity of suggested priorities, this process could have stimulated a greater awareness of the usefulness of foresight and long-term thinking.

Instead, the Federal Government provided no opportunities for educating the public on what could be achieved through R&D, such as holding public workshops or encouraging a national debate. The round of public consultation meetings that were held emphasised the refinement of the selection criteria for the priorities, and not the discussion of what

possible priorities might be. The four Australian Academies (for Science, Technological Sciences and Engineering, Social Sciences, and the Humanities) ran an invitation-only forum to discuss possible priorities. The process was designed to collect pre-existing ideas from the research community about what that community thought should be the goals for their research. In addition, by biasing the selection criteria towards those economic benefits that could be captured by Australia, the process was designed to filter out those research priorities that could not be demonstrated to be a worthwhile economic investment for the government. It was clear that the government wasn't looking for surprises.

The types of priorities, selection criteria and composition of the EAC provide a window into the worldview of the third Howard Government. Using the Spiral Dynamics terminology, the types of priorities and selection criteria reveal an Orange worldview in operation. The language is that of economics: measurable impacts, capture the benefits, etc. As discussed above, the danger in using only one filter to view the world is that information that provides early warnings of new problems can be filtered out. The 'restricting' effect of the selection criteria on the nominations, in terms of who submitted them, and what they submitted, has already been noted. People who were not able to frame their submissions to answer the selection criteria were excluded from the process. People who didn't think that further R&D could achieve their aspirations for Australia were also excluded from the process. There were no futurists, management consultants, young people, old people, indigenous Australians involved in the EAC that might provide some thoughts from outside the conventional box, or who might surprise the Government with a spot of lateral thinking.

Critique of the rationale for priorities

The key issue with the rationale for setting research priorities is the underlying belief that any problem can be solved, if only we do enough research and apply the results. This is a classic Western scientific viewpoint. This viewpoint ignores the difficulties with the conception of any issue as a 'problem,' by overlooking the history of the issue, and how it came to be called a problem.[85] The research priorities exercise demonstrates a naive belief that the government will actually follow through and solve the identified problems, for example, doing all it can to create an environmentally sustainable Australia. Even if the research is done and solutions found, is there any guarantee that the solutions for these problems will be implemented? For example, the CSIRO recognises that the science component of solving the problems through their National Research Flagship programs may only be some ten to twenty per cent of the work required, and that the other eighty per cent of the work will be through changing regulations and behaviour.[86] There are many existing possible pathways to create an environmentally sustainable Australia, such as those that call for a reduction or change in consumption patterns, but these solutions have not been implemented. What if the research resulting

from the new national research priority calls for such a change in people's behaviour? As argued above the solutions that have the greatest chance of being implemented are those that can create an economic benefit to the Australian community. Reducing consumption hardly seems likely to create such a benefit.

It is apparent from the above discussion that few of the participants in NRP 2002 applied a central point of critical futures studies: that the filters used to analyse a problem is analysed naturally constrain the answers that are proposed to solve the problem. As the rationale for setting research priorities was framed in the language of economics and science, not surprisingly the favoured solutions will be those from economics and science. Alternative analyses are available, but they were disregarded as they challenged the existing power structures, which are based upon mastery of economics and science. To use the terminology of Ken Wilber's four quadrants, since most of the national research priorities fall into the lower right quadrant, only methods legitimated in the lower right quadrant will be used to solve those problems. Solutions that use methods from the left upper and lower quadrants are less likely to be considered.

Suggestions for the future

The key question that arises from this discussion is: given that nearly every other Western economy in the world undertakes S&TF work, why doesn't Australia? Unfortunately there is little public information available, but we do have the history of the Australian Science and Technology Council (ASTEC) S&TF exercise in 1994–95 to consider.[87] This S&TF exercise used many of the concepts and methodologies of S&TF to improve the networks of Australia's NIS, and to identify economic opportunities for Australian science and technology. The ASTEC S&TF exercise was completed in late 1995, but the incoming Liberal Government did not implement most of its findings as it was not involved in the exercise, and it was committed to an ideology of economic rationalism and the role of market forces.[88] So perhaps it is not surprising that the same Liberal government should not want to use S&TF for an exercise that, although about the future of Australia, was, judging from public sources, narrowly focussed on targeting R&D on current Australian problems.

Some might argue that it is not the role of the government to hold taxpayer funded junkets to educate Australians on the usefulness of long-term thinking, such as the Commission for the Future. However, if it is not the responsibility of government to stimulate discussion on Australia's future, then who does hold that responsibility? In Australia, there have been many instances of business forums, government departments and non-governmental organisations hosting such discussions and running formal foresight exercises, but there has been little opportunity for the wider Australian public to participate in, or let alone learn from, such discussions.[89]

If the Federal Government were to run a similar process for updating the national research priorities, the government could make use of some of the methods of S&TF work to improve the usefulness of the selected research priorities in changing circumstances. The essential unpredictability of the future was entirely glossed over in NRP 2002, and the chosen priorities reveal a preoccupation with solving Australia's current problems, and not preventing future problems from arising. The government could use a variety of future scenarios to 'wind tunnel' any proposed short list of priorities. There are many sources of 'off-the-shelf' analyses of the future that could be adapted for the purpose.[90]

CONCLUDING THOUGHTS

Countries have made use of S&TF work to attempt to predict and control the future by developing a sustainable competitive advantage over other countries, to ensure that the material well being of their citizens always improves. S&TF work uses few futures concepts as it is concerned with reducing the levels of uncertainty in the future, rather than to open up new alternatives. As the evaluation of the UK Foresight Programme demonstrated, governments see uncertainty in the future only regarding levels of economic competitiveness, and they have already decided that there is only one way to meet that uncertainty: by setting research priorities and improving networks.

S&TF work is currently trapped in the worldviews and filters of the people in power, who rarely consider the outside world or a different set of needs or motivations to their own. Members of the public do not get involved in S&TF exercises – you have to be an expert to participate in a panel or be on a Delphi survey. The way that ordinary people have interacted with S&TF work is by electing the politicians who decide that S&TF is a good idea, and who choose on their behalf the R&D priorities the politicians believe will deliver the economic growth their citizens demand.

The ways that deeper analyses of the problems are defined and could be incorporated into S&TF were examined. Incorporating some or all of these 'wider and deeper' options from futures studies would greatly change the purpose and process of S&TF work. Instead of pursuing S&TF work in a world where the 'business as usual scenario' operates, where only subject matter experts discussed new ways to become personally wealthy and perpetuate the existing power structures, a new, more inclusive and democratic S&TF could result. Although its emergence would be long and hard, it would be a worthwhile task.

For Australia, the selection of national research priorities in 2002 was a missed opportunity to engage the Australian public in a discussion about the role of R&D in shaping the future of the country. There has to be a concerted effort by all people interested in the future of Australia to engage the wider Australian community in a continuing debate about the alternatives for Australia's future, and to improve the involvement of the public

with any future round of national research priority setting. What occurred in 2002 was a process where the researchers were able to nominate their fields as national research priorities. There should be a more critical appraisal of the way that these national research priorities might solve the problems identified. The Australian people will probably accept the argument that all we need to do is dedicate our best minds to a problem and it will be solved. However, it appears to be very unlikely that any Australian government would have the willpower to actually implement any solution that requires significant government intervention, or a significant change in our way of life or standard of living. In the meantime, new issues may be emerging on the horizon, but the process used in 2002 would only devote research to solving these issues when they have become problems of national importance. An early warning system, such as science and technology foresight, would prevent such problems from arising.

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