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Australia

Designing an effective science and technology policy advisory system for the Australian government

Ron Johnston

The S&T policy advisory system in Australia has been through three distinct stages — the centralist model, the pluralist model and the new model for the 1990s. What is now needed is to provide top level S&T advice, improve co-ordination between the agencies responsible for S&T policy decisions, serve the community and improve the quality of S&T policy advice within a pluralist system.

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> "History teaches that advisors have been employed by all political leaders, from tribal chiefs to Roman Emperors. Some counsellors have been chosen for their wisdom and special knowledge; some for magical powers to prognosticate or entertain; some because of their outreach to powerful constituencies that a leader might want to pacify."[1]

WHILE ADVISORS MAY HAVE been around as long as there has been governance, it is essentially only since about the 1920s that governments started to turn to scientists for advice, and this only became firmly established during World War II. The 50 years of experience with science and technology (S&T) policy advisors have seen substantial changes in their role and influence. These changes have perhaps been at their greatest in the past decade.

The establishment of formal advisory systems in most countries in the 1950s and 60s was based on the view that not only were scientists able to provide advice on technical issues beyond the competence of government officials and ministers, but they also brought a special objectivity and rationality to decision-making on all issues, not only those with a major scientific and technological content. Their influence in the political world rested almost paradoxically on their perceived separation from politics.[2]

Brickman and Rip,[3] in one of the few internationally comparative analyses of science-govern-

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ment relationships, have noted that the first generation of science policy advisory councils around the world were created:

> "at a time when government's financial and operational responsibilities in science and technology were growing at a rate and on a scale too high to ignore, but before regular institutional mechanisms were perfected to handle the complex and esoteric questions which such involvement raised."

Considerable emphasis was placed on the distinction between 'policy for science' and 'science for policy'. The former was confined to matters internal to the S&T system such as the allocation of the nation's scientific and technological resources and the health of the science system.

Advisory bodies on policy for science could thus be considered:

> "as a sort of general staff for the nation's science and technology, aimed at producing a coherent and concisely stated national science policy. It should look outward from science and technology towards the government, seeking opportunities for science and technology to serve national goals, but also planning the grand strategy of the nation's scientific and technological institutions."[4]

On the other hand, science (and technology) for policy was concerned with objectives outside of the S&T system, such as the establishment of appropriate environmental controls over technology or the role of research in competitiveness. Brooks has argued that science for policy should start from the policy interests of the government, treating S&T as a resource for the formulation of effective policies.

Nine functions have been identified as common to all S&T advisory bodies (at least in the USA). These are: [5]

"1. Personal, confidential advice and counsel to the president
2. Policy planning and priority setting through the budget process...
3. Coordination of certain transagency functions within the bureaucracy
4. Reciprocal communication with the scientific and, recently, the industrial community
5. Reporting to the Congress...
6. Reporting sporadically to the public
7. Communication with state governments
8. Nomination of scientific 'goodies' that can be used as bargaining chips in foreign policy negotiations...
9. Symbolising the importance of science and technology on the presidential agenda..."

The changes which have occurred in the nature and environment of science policy advisory systems can be seen as a result of changes within the science/technology system (including perceptions of its role) on the one hand, and changes in the practices and machinery of government, on the other.

Changes in S&T system

The privileged role of scientists, and the advisory bodies of which they were members, arising from their perceived superior objectivity has undergone considerable erosion, for a number of reasons. First, analysis of the nature of scientific knowledge and the social processes on which it is based have had the effect of reducing the perceived authority of science. It no longer commands such an advantageous position in the hierarchy of knowledge. This has affected not only the authority of scientific knowledge, but also the political authority of science, which can no longer provide such a powerful legitimation for policy objectives.

This decline in authority was accelerated by a series of controversies during the late 1960s and 1970s (for instance, over the anti-ballistic missile and supersonic transport controversies in the USA, and nuclear power in many countries). These debates provided the spectacle, for the political and general community, of a deeply divided scientific community, bitterly critical of the quality and objectivity of each other's advice.

An analysis of the role of scientific advice in a series of controversies demonstrated that, rather than it leading to a best-objective opinion, it only served to increase the polarisation of debate.[6] These disputes also led to a call for the establishment of a code of practice for scientists involved in the provision of advice.

The second major change in the S&T system, and in the environment in which it operates has come with the growing importance of technology, and more generally knowledge, in international competitiveness. To choose just one piece of evidence, the extraordinary growth in the technology-intensive sectors, particularly in information technology, estimated to constitute 25% of world trade by value in 1992, demonstrates the high returns achieved by firms through investing in the strategic development, management and application of intellectual capital.

With this growth in the importance of R&D and intellectual capital there has come a dramatic increase in the level of the competition to develop, capture and apply these intellectual products. Many of the changes that have been occurring in the structure and management of the research system can be understood as a response to the increasing levels of competition.

The effective production of potentially valuable

The recent changes in the economic role of S&T have made it more important, but paradoxically less special: it is to be managed in the same way as any other important resource

research results is, of course, not sufficient to produce economic returns. This process is seen as being so critical in the research-production cycle that a range of new mechanisms and management techniques have been developed to ensure effective linkage and rapid transfer between the two stages. There is continuing experimentation in the development of new and more effective linkages of knowledge production and knowledge exploitation, within firms, between firms and across the public/private sector boundary.[7]

In simple terms, these changes in the economic role of S&T have made it more important, but paradoxically less special. It is to be managed in the same way as any other important resource.

However, it is changes in the machinery of governments, and the assumptions on which they are based, that have had the biggest effect on the organisation of science and technology policy advice.

Changes in government

One of the most general shifts in thinking about the process of government has been a recognition of the limited role of rationality. Lindblom[8] has emphasised the practice, and appropriateness, of learning by doing, or "disjointed incrementalism" in the bureaucratic environment. Moreover, few issues arise from rational problem definition. Rather it is either a crisis or the influence of a vested interest that gets issues on the political agenda.

A second change has been "the domestication of science and technology policy"[9] by institutionalisation into the regular processes of government. In response to the challenge to manage the S&T processes more effectively, we have seen the growth of specialist analysis and advice capabilities within the bureaucracies of government. As ministers were faced with greater responsibility on S&T issues, they naturally wanted in-house sources of advice, and capabilities to manage programmes.

The growth of this S&T bureaucracy was further accelerated by a general trend towards 'pluralist' systems of S&T organisation in which responsibilities for the support and application of S&T, and for S&T-based advice were decentralised to relevant ministries, rather than concentrated in some central ministry or authority. This has led to a proliferation of S&T-focused bureaucratic subunits within government departments, and of S&T advisory bodies to a range of ministries.

A third change in government mechanisms which has impacted on the structure of the S&T policy advisory system has been the growth, within Westminster systems of government in many countries, of the practice of appointing personal advisers to ministers, in keeping with a tradition more commonly followed in the USA. The role of these advisers has been to provide a minister with an alternative source of advice and analysis to that provided by the bureaucracy. In addition these advisers have been used, on occasion, to drive programmes through recalcitrant departments.

This growth in the size and variety of 'insider' sources of analysis and advice on S&T issues for government, has in general reduced the dependence of governments on formal outsider advisory bodies. They were:

> "at least in part victims of their own success. Each had lobbied for a more coherent, reasoned and institutionalised approach of Government in its involvement with science and technology. The achievements of their respective governments in this respect — abetted by the general law of bureaucratic expansion — eventually undermined the possibility of the councils to perform a unique and desired function for their political sponsors."[10]

Thus it can be seen that the environment for science and technology advisory systems has undergone considerable changes over the past 25 years. While there have been many incremental adjustments to these systems, it is not evident that there has been a systematic re-evaluation in keeping with these changes.

Developments in Australia

Since the 1970s, the Australian S&T policy advisory system has passed through three stages which reflect the growth of an S&T bureaucracy and a pluralist management system, together with changes in the political value of S&T policy advice. The first stage was marked by the establishment of an S&T advisory council (ASTEC) and a continuing centralised portfolio for S&T.

In the second stage, ASTEC developed an insider and outsider role and considerable authority, providing independent reports to the Prime Minister but also advising on S&T budget proposals. At the same time, the S&T department was abolished and a pluralist system of S&T responsibility began to emerge.

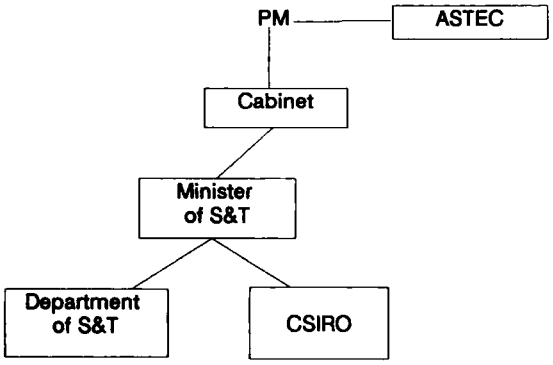

Figure 1. Centralist model of the late 1970s

The third stage involved the imposition of new arrangements for delivering S&T advice at the highest levels on the existing model and attempts to introduce some much-needed co-ordination into the rapidly evolving pluralist government system for S&T policy and advice.

Centralist model

The S&T policy advisory system of the late 1970s is outlined in Figure 1.

ASTEC was established as a statutory body, with independent membership drawn from industry, trade unions and academia, in 1978: it provided advice directly to the Prime Minister on matters of science and technology commissioned by the PM, and on issues it considered to be of national importance. There was some expectation among the scientific community that ASTEC might act as their representative, but it rapidly demonstrated its independence in providing critical analyses of issues, such as the adequacy of research and government support in medicine and marine science, the case for a new optical telescope in the 1990s, and the role of S&T in international co-operation and development assistance.

The second element of the system was a Minister of Science and Technology, of quite junior rank, supported by a small department. Another and quite separate source of advice, frequently influential, was the Commonwealth Scientific and Industrial Research Organisation (CSIRO) — Australia's largest public sector research organisation.

To a large extent these various sources of advice operated at different levels, though there were instances of direct conflict.

Pluralist model

The S&T policy advisory system underwent significant changes in the early 1980s, largely through the emergence of a pluralist system of S&T organisation, as shown in Figure 2.

During this phase, under the chairmanship of Professor Ralph Slatyer, ASTEC's position was considerably strengthened. It was it called upon to carry out major studies and advise on such critical issues as the organisation and effectiveness of the public research institutions, including CSIRO and the Australian Atomic Energy Commission, and more controversially, Australia's role in the nuclear final cycle. It also played a special role in advising Budget Cabinet directly on the suitability, weaknesses and priority of all Budget proposals that were deemed to have an S&T content.

In this period, as Gilmour[12] has argued, ASTEC operated as an independent insider body in its relations with Cabinet and Prime Minister, and was privy to the workings, and bound by the require-

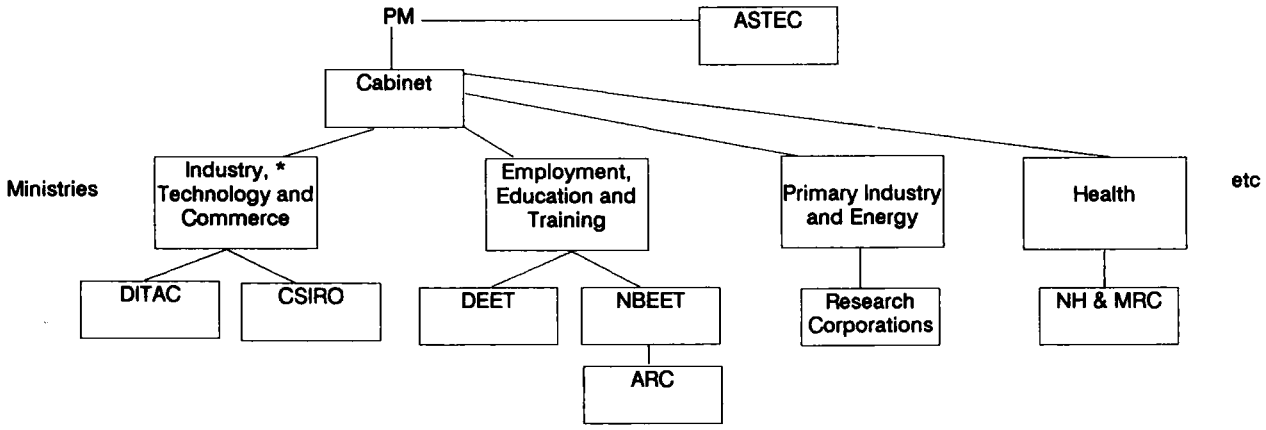

Figure 2. Pluralist model of the early 1980s

Notes: * A junior Minister supporting the Minister of Industry Technology and Commerce has responsibilities for Science and Technology
DITAC - Department of Industry, Technology and Commerce: CSIRO - Commonwealth Scientific and Industrial Research Organisation: DEET - Department of Employment, Education and Training: NBEET - National Board of Employment, Education and Training; ARC - Australian Research Council; NH & MRC - National Health and Medical Research Council.

ments of, Cabinet secrecy. At the same time, in its preparation of reports for public dissemination, and its recommendations concerning government policy, it operated as an outside group. The separation between inside and outside roles was carefully, and successfully, maintained, essentially through resort to 'Chinese walls' (strong barriers).

The second feature was the emergence of a pluralist structure for the management of S&T. The Department of Science and Technology was abolished, and its functions absorbed into either DITAC or DEET. A Minister of Science and Technology was retained, but as an assistant to the Minister for Industry, Technology and Commerce. Clearly, research, science and technology were to be directed to the interests of industry and commerce.

This pluralistic approach was more a consequence of the combination of a series of departments and agencies into mega-departments, rather than any explicit policy with regard to S&T. The larger departments found themselves with a very considerable responsibility for funding research, promoting technology development, and addressing major issues with a significant S&T content. In these circumstances, public sector research-performing agencies such as CSIRO, found their advisory influence substantially reduced.

A couple of examples will illustrate the form of this emerging pluralism. The Department of Primary Industry and Energy (DPIE) found itself with responsibility for more than a dozen rural and mineral industry research-funding bodies, with a total budget in 1986-87 of A$132 million. First the number of these bodies was reduced through amalgamation. Second, based on successful experience with 'marketing boards', the research councils were transformed into corporations, with independent Boards responsible to the Minister (who in effect was a proxy for the shareholder *viz* the Commonwealth Government). A third measure, designed to provide some co-ordination and overview advice, has been the establishment of an internal Primary Industry and Energy Research Committee.

A second illustration is provided by the Department of Employment, Education and Training. In order to obtain advice on this range of issues, a National Board was established with four sub-councils representing research, higher education, schools and skill formation, with an independent membership. The Australian Research Council (ARC) in this new guise has retained its role as the primary provider of competitive grants to university researchers, has added responsibilities in post-graduate training, has more than doubled its budget allocation, and has a special role to advise the Government (and not just its Minister) on national research priorities.

This second phase thus saw two countervailing trends — the strengthening of centralised advice on S&T matters to the Prime Minister, and the strengthening of management and advice within departments and to ministers.

The pluralistic approach was more a consequence of the combination of a series of departments and agencies into megadepartments, rather than any explicit policy with regard to S&T

New models

The evolving structure of the pluralist S&T policy advisory system was, to a significant extent, turned upside down in 1989, with the establishment of three totally new institutions for the provision of advice and co-ordination. The first was the appointment of a Chief Scientist to the Prime Minister. That the first Chief Scientist, and the architect of these changes, was Professor Ralph Slatyer, earlier chairman of ASTEC, serves to demonstrate that in the world of government policy and structure, there is still room for personalities to be influential.

The second new institution was a Prime Minister's Science Council, composed of the six Ministers with major 'science' responsibilities, and a few key figures from the industrial and academic world. This Council was to meet about three times yearly to examine major S&T issues and to recommend policy action. Topics that have been investigated have included global climate change, value-added in the food-processing industry, and science and mathematics in the formative years.

The third new organisation was the Coordinating Committee on Science and Technology, chaired by the Chief Scientist. Its membership was made up of a senior official from each Department with S&T responsibilities and the major research-funding bodies. This Committee was designed to provide the co-ordination which is essential to establish overall direction and minimise overlap in a pluralist system. However, I believe it would be fair to say that territorial imperatives have thus far prevented the Committee from addressing much more than marginal issues.

A schematic of the stage three model of the S&T policy advisory system is presented in Figure 3.

The establishment of this new advisory structure to the Prime Minister has inevitably reduced the influence of ASTEC, and raised in many minds questions about its remaining role. Its special relationship with Budget Cabinet had already been dismantled, again not as a consequence of a specific decision about S&T advice, but resulting from

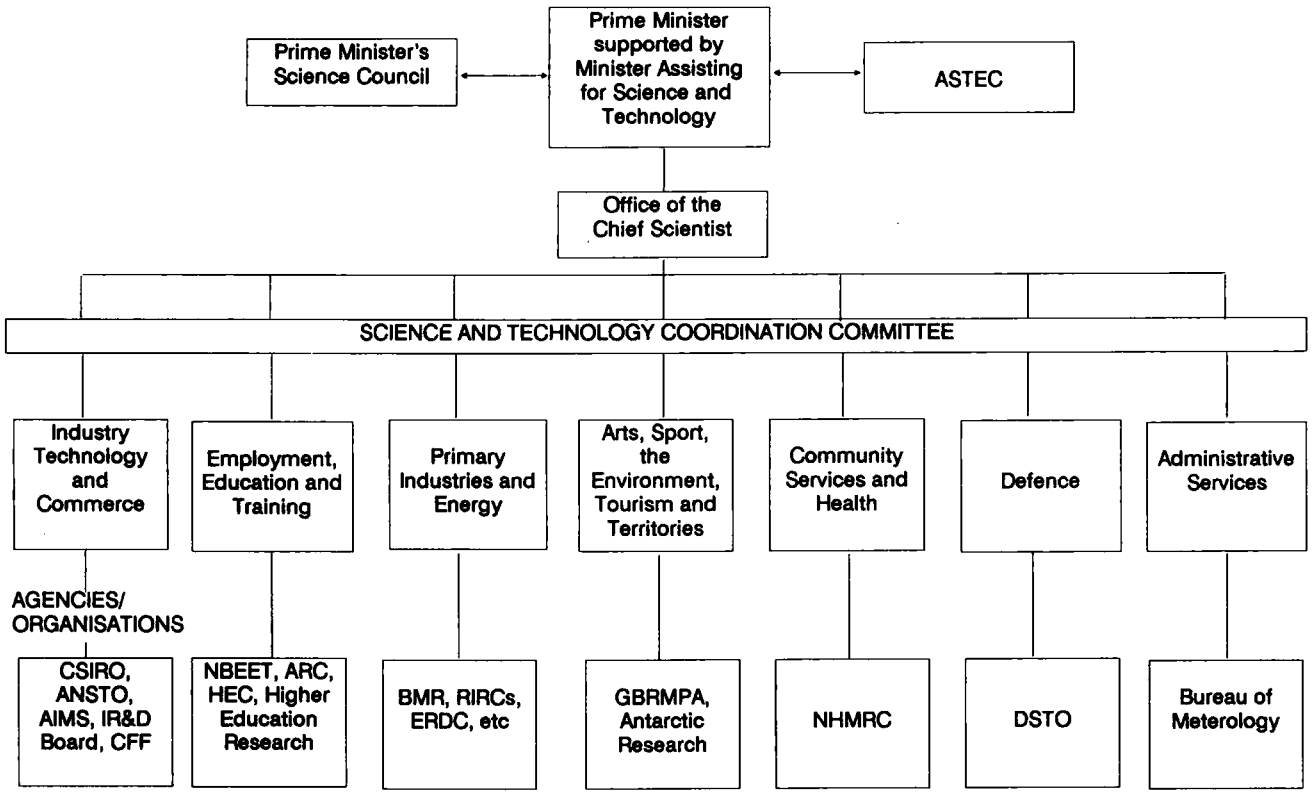

Figure 3. New model of the 1990s

Notes: ANSTO - Australian Nuclear S&T Organisation; AIMS - Australian Institute for Marine Science; CFF - Commission for the Future; HEC - Higher Education Council; BMR - Bureau of Mineral Resources; RIRC - Rural Industry Research Corporations; ERDC - Energy R&D Corporation; GBRMPA - Great Barrier Reef Marine Park Authority; DSTO - Defence S&T Organisation.

the devolution of greater budget responsibility to ministers and the mega-departments. ASTEC's advice to the Prime Minister was required to go simultaneously to the Chief Scientist.

Meanwhile the departments and agencies continued to strengthen their pluralist S&T management systems, their internal bureaucratic expertise and their own external sources of advice.

The most recent adjustments have come with the change of Prime Minister in December 1991. A new Minister Assisting the Prime Minister, who happens also to have the portfolio of science and technology has become a new key link in the S&T policy advisory system. Both ASTEC and the Chief Scientist have been instructed to report to this minister.

Advice in a democratic society

The role and function of knowledge, and expert advisers, for government in a democratic society has been the subject of a long line of analysis and debate. Thus, for the early analysts of the State and its functions, a central question was the application of knowledge and wisdom to the good of the whole community. Accordingly, Aristotle was able to identify three kinds of government that are inherently good — monarchy, aristocracy and constitutional government — and three that are bad — tyranny, oligarchy and democracy.

A recurring theme of the 20th century, the origins of which can be traced to the earlier writings of the social philosophers Francis Bacon, Saint-Simon and Auguste Comte is that of the technocracy. The essence of the technocracy is that the world has become so complex and the issues underlying its management so dependent on expert knowledge, that comprehension and effective decision-making are now beyond the capability of the general public, and their elected representatives.

Hence decisions, or at least the basis for decision-making must be left to the experts.[12] Such a 'government by experts' has, not surprisingly, been the subject of stern opposition from those who see the technocracy as simply another form of tyranny.[13]

This raises one of the central questions about the role of advice and advisers to a democratic government. What is the appropriate balance, and how can it be struck, between the needs of governments for expert advice to avoid decision-making in ignorance, and the danger that, as a consequence, power slips into the hands of an apolitical, or worse, interest-oriented, élite. Thus, the association between knowledge and power represents a considerable challenge to modern societies, apparently faced with a choice between democratic ig-

norance and informed autocracy.

There is, in addition another deep polarity which faces S&T advisory bodies, namely the appropriate strategy to adopt with regard to independence or engagement. In many countries, advisory bodies have regarded their independence as all-important. While this places them comfortably outside (though rarely above) the political system, such distancing has not infrequently led to charges of impotence or irrelevance. On major issues in particular, their advice is likely to be ignored.

At the other end of the spectrum, engagement with the political system to increase influence and the likelihood of successful implementation of policy recommendations, almost inevitably leads to the advisory group, if only through shared knowledge and secrecy, being drawn into a cosy relationship with government, and losing the status and apolitical standing of its independence.

These tensions about the place and price of knowledge, and of the appropriate balance between independence and engagement for advisory bodies underlies most analyses of, criticisms of, and proposals for, S&T policy advisory systems. Thus Doern, in one of the first detailed analyses by a political scientist, as opposed to a scientist, of the operations of an S&T advisory council, remarks upon the members' limited conception of the policy process in Canada:

> "Because it is composed of a group of scientists and engineers one should not be surprised to discover that the council developed a very rationalistic conception of the policy process, of its role in it, and of how societies ought to be 'steered' in a post-industrial technological era."[14]

Doern notes that this rationalist philosophy became most evident when they turned to issues of science for policy. Thus:

> "The council felt that if it was going to advocate the use of science in achieving national social and economic goals it would have to attempt to define Canada's national goals, even though these 'first principle' goals did not, once derived, apparently have a very strong influence on the policies subsequently proposed."[15]

This approach to policy, and the assumptions underlying it, presented significant problems for the council in determining its practical political strategy, such as what were the appropriate boundaries of its brief, and its strategies for the short term, and how it should relate to the time frames of politicians and bureaucrats. Although the Council was operating in (and to some extent recognised it) an intensely political environment, it did not (and perhaps did not know how to) develop its own political skills and strategies.

The determination of appropriate boundaries represents a fundamental challenge to outsider S&T policy advisory bodies: they are almost inevitably drawn into a wide range of issues in which council members frequently have no relevant expertise

The determination of appropriate boundaries represents a fundamental challenge to outsider S&T policy advisory bodies. Because S&T are largely means rather than ends, and because of the very pervasive nature of S&T, policy advice on S&T is almost inevitably drawn into consideration of a wide range of issues. But in such wide-ranging issues, the council members frequently have no relevant expertise, and their legitimacy is open to question by politicians, interest groups, and the general community.

This exposition of the deep differences in ideology and practice between the independent advisory council and the machinery of government leads Doern to conclude that such councils are most effective in playing an outsider role:

> "The unique feature of central advisory councils is surely that they are intended as public forums. They are 'policy ombudsmen'... The logic of this aspect of their role seems to imply that central advisory councils perhaps ought to be as much advisers to Parliament and other policy 'critics' as they are the policy 'makers', the Prime Minister and the Cabinet."[16]

In this view independent advisory councils are just another element of the complex system of 'checks and balances'.

In contrast, Wenk sees an important insider, but arms-length role for S&T advisory institutions as the 'radar for the ship of state'.[17] This radar, providing by various means a view of what is ahead, in both geography and time, is the necessary basis for a government to identify strategic future and long-term issues, and hence to have a capability to steer the political system, as opposed to acting merely as a power broker between the various interest groups and influences as issues emerge.

Baehr, in an analysis of the advisory process to governments in democratic societies based on the experience of the Netherlands Scientific Council for Government Policy, identifies six criteria for success in playing both an insider and outsider role:[18]

- reports which serve a function in public debate, for example by contributing to consensus formation or providing new insights;
- the choice of subjects to be studied marked by policy relevance, particularly in agenda setting;
- policy recommendations that are feasible and valuable to ministerial departments;
- value to, and receptiveness of, Parliament and its members;
  good relations with, and value to, the press;
- the quality of its work, as judged by scientific peers and against scholarly canons.

A further criterion implicit in Baehr's evaluation, but not drawn out, is the role of such councils as brokers, mobilising the knowledge available in the country, and, very importantly in my experience, translating that knowledge into policy-relevant insights and recommendations.

From this brief analysis, it can be concluded that there is a variety of distinct roles to be played by an S&T policy advisory system, and that these roles are sufficiently different to require a number of distinct organisations, with *modus operandi* suited to their various objectives. These roles include the provision of:

- insider expert advice to government, in accord with the government's political agenda;
- an independent, and uncommitted 'early warning system' to government on future opportunities and hazards;
- broker and translation services, tapping a nation's (and international) knowledge and translating it into policy relevant form;
- an independent source of information, and channel to government, for the Parliament and the general community.

It does not include a role as an interested representative of the S&T community; they should seek to represent their interests through the channels available to all.

Designing a new advisory system

Critical S&T issues for Australia

The design of an effective S&T policy advisory system for Australia in the 1990s must take into account the critical S&T issues for the country in this period. Some of them may be universal; others are likely to be specific. Among the many problems facing Australia in the 1990s, three stand out as systemic, long-term, deeply structural, and offering significant returns for an appropriate solution.

The first, and the ultimate determinant, is the international competitiveness of the Australian industry and economy. Australia faces an extremely difficult economic future as a consequence of a chronic deficit in the balance of payments, a record and growing national debt, a commodity-based economy with a low level of export of manufactured, particularly elaborately transformed, goods, an industry structure marked by high levels of concentration and dominance of the fastest-growing sectors by foreign multinational companies, and 'non-intended' displacement of Australian goods from export markets arising from the trade 'war' between the USA and Europe over agricultural goods, and now between the USA and Japan over manufactured goods.

The second major problem is an internal one, common to many countries, though perhaps exhibited in its most damaging form in Australia. This is a consequence of the multiple levels and arms of governments, with, as a consequence of bureaucratic and career imperatives, and a national culture which enshrines the primacy of rugged individualism, extraordinary levels of overlap, incompatible policies and minimal levels of co-ordination. The direct costs arising from overlap, and the far greater indirect costs of ineffective and failed policies, places a premium on the establishment of a culture, and mechanisms, to promote co-operation and co-ordination in Australia in the 1990s.

The third problem is economic, social, and most importantly environmental, namely the determination and establishment of the conditions for environmentally sustainable development in Australia. While 200 years of white settlement has produced a high level of economic prosperity, it is now emerging that these riches have been purchased at a price of enormous land- and water-system degradation in a quite peculiarly fragile environment. The economic problems previously described cannot be solved by adding to these environmental costs. On the contrary, the achievement of environmentally sustainable development will require major investments in repairing problems of the past and creating new infrastructure adequate to meet the needs of the future.

In the light of these three major problems, I propose four significant changes in the present S&T policy advisory system in Australia. Of course a more radical transformation could be considered. However, I have been guided by the experience of the generally evolutionary nature of S&T policy, and of the uncertain outcomes of the few radical experiments that have been undertaken.

Top level S&T policy advice

The Prime Minister's Science Council established under the previous Prime Minister, has been an extremely powerful symbol of the importance of science, and to a much lesser extent, technology. But there must be some doubt over its effectiveness. Getting onto the agenda of a Science Council meeting has become a means of attracting recog-

nition of the significance of an issue, and as a consequence has become the subject of intense lobbying, without as yet much evidence of a substantial outcome.

The membership of ministers, industrialists, academics, and more recently representatives of educational and professional groups betrays, to my mind, considerable confusion over the purpose of such a Council. Moreover, that such a group should meet at the most three times a year, to be briefed on and discuss an extremely wide range of issues, suggests that in the main it can serve little more than ritual purposes.

However, there is without doubt a need for a mechanism for the serious consideration of S&T issues which cross portfolios, or have major or long-term implications, at the highest government level — Cabinet. The present form, membership and function of the Prime Minister's Science Council does not permit this. It might be far more effectively replaced by an S&T Committee of Cabinet, supported by its own small secretariat, where S&T issues of the kind described above could not only be considered, but be the subject of decisions — an outcome which is extremely unlikely in the present insider/outsider organisation.

Of course, where appropriate, the Committee or its secretariat could draw on outside expertise in the preparation of briefing papers. The present ASTEC might be a significant contributor to this process.

Effective co-ordination

I have described above the low levels of co-ordination, and on occasion intense competition between the various Commonwealth departments and agencies responsible for decisions on matters with an S&T content, the support and application of S&T, and the performance of research. This fragmentation is further exacerbated by Australia's federal structure, with significant responsibilities in these three areas being held by each of the six States and two Territories.

It would appear that a Co-ordinating Committee on S&T made up of the heads of each of these Commonwealth departments and agencies, even if chaired by the Prime Minister's Chief Scientist, is unlikely to make great progress in tackling large issues, and that indeed appears to have been the case. But the issue of improved co-ordination is paramount in achieving either the economic or the environmental necessities for Australia's future.

The issue of improved co-ordination is paramount in achieving either the economic or the environmental necessities for Australia's future: it should be in the hands of a body outside the competitive pressures of government

While there would be inevitable opposition from bureaucrats, I believe it is necessary for the pressure for such co-ordination, and the monitoring of progress, to be in the hands of a body outside the competitive pressures of government. This would appear to be a function that is entirely appropriate to the present ASTEC, with its outside membership.

This would require a redrafting of the objectives of ASTEC, to focus on its early warning function, and this enhancement of co-ordination. These two roles would move ASTEC more towards independence, and away from a partial position of engagement, which has only served to confuse its position and reduce its influence. This would also allow it to carry out more effectively its role as knowledge broker and translator.

Serving the community

In the current situation, both the Prime Minister's Science Council and ASTEC are regarded in part as providing a channel for the public to reach the government on S&T issues. However, in practice, the level and range of their consultation processes rarely go beyond the professional community and their interest groups. Special mechanisms such as commissions, tribunals, and the courts are more commonly used for issues arousing public interest or division.

Over the past few years an increasingly strong S&T interest group, the Federation of Australian Scientific and Technological Societies (FASTS) has emerged. While such a group will inevitably maintain the representation of its members' interests as its primary responsibility, a case can be made for this objective to be linked with a wider concern as a source of education and information for the general public. While governments sometimes have difficulty in supporting "the creation of their own critics",[19] there would appear to be a case for both encouraging and supporting FASTS, perhaps in association with the learned Academies of Science, Technological Sciences, Social Sciences and the Humanities, to positively and visibly expand their activities to include this function.

Improving the quality of advice

Notwithstanding the concerns about improving co-ordination, the complexity of technological issues, and the range of their application to the responsibilities of distinct areas of government make a pluralist system of S&T management far more appropriate to a modern industrial society than the previous centralised model. Indeed there is a need

for further development, extension of capability and refinement of the pluralist system.

Perhaps the only significant barrier to the achievement of this objective is the number of staff available with adequate S&T policy training and experience. The general reduction in public expenditure, and hence in resources for government, along with the requirements of the pluralist S&T management system, has produced an apparent shortage of bureaucrats equipped to work in S&T policy.

It is not only a problem of an absolute shortage. This situation, together with the imperatives of moving through a range of responsibilities to achieve career advancement, is leading to a significant loss of learning, and not uncommonly to relatively superficial work.

While an obvious solution is to expand the training and intake of S&T policy graduates, it is not a very likely outcome in the present circumstances. An alternative is to substantially increase the level of contracting out of departmental S&T analysis needs to academics and consultants in this field. However, while such an approach is adequate to meet short-term and well-defined needs, addressing longer-term problems, and developing a deep capability requires a different approach.

There is a case for departments further sponsoring, as an investment (and not just through the education portfolio) the development of outside S&T policy research units with the capability of meeting their future needs. Such an approach would need to be conducted outside the presently extremely restrictive contract conditions, which positively oppose the development of working relationships and the sharing of knowledge. It would also require a greater recognition of the possibility of serious professional analysis of S&T issues, as opposed to a reliance on the practical and managerial experience of leading scientists.

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