RESEARCH FUNDING IN AUSTRALIA: A VIEW FROM THE NORTH*

Ken Green

This paper seeks to contribute to the continuing controversy in Australia on the best way to deploy that country's scientific and technological research and development (R & D) resources. It puts forward and discusses some policy options relating to the 'restructuring' of the Australian R & D system currently underway, for the consideration of the research community and those responsible for the research policies. In particular, the paper comments on how overall objectives and priorities for R & D can be set, the need for evaluations of the research and development that is conducted, the need to develop a dialogue between the public and the scientific community over the setting of research and development directions.

Keywords: science policy, research and development funding, research and development evaluation, public participation, Australia

* The paper is written by a British academic (from the 'North' of the globe), working for a few months in 1984-5 in the Commonwealth Department of Science. I came to Australia with views on policies for R & D based on my observations of the British scene since the mid-1970s, particularly on the controversies of the last few years over the large cuts in some parts of the British R & D budget. My arrival coincided with the aftermath of the announcement of the 1985 Australian budget, which was being strongly criticised by many scientists as grossly inadequate to the R & D tasks at hand. I pondered on the comparisons that might be made between the situations in the two countries. Fortunately I was able to consider the comparisons more deeply following a series of interviews which the Department of Science arranged for me in March-April, 1985. The interviews were conducted with 30 people in a variety of research funding bodies, research performing organisations and scientists' professional organisations, in government departments with some interest in research and development policy, and with actual and potential research users — all opinion leaders on research and development matters as well as often being involved themselves in the administration, funding and/or performance of R & D. Since the interviews were conducted in confidence, I do not identify the source of all quotations, but I wish to acknowledge the contribution of the people I interviewed to the formulation of the views presented here. I hope they, and others, will find the paper stimulating, even if they do not agree with my views, or my interpretations of theirs. The paper does not necessarily represent the views of the Department of Science. A longer version of the paper is available from the Department of Science, Public Relations and Information Section, Belconnen, ACT 2616.

INTRODUCTION

> Minor changes in budgets are taken as a major crisis within the scientific and technical communities. . . . . .Any percentage drop in funds is seen as disastrous for scientists and research performers, particularly those at universities. They speak as if they have little capability to adapt, substitute and compensate. In contrast, for an increase of a few percentage points, they promise truly significant differences in performance or rate of discovery, and yet the new resources will not be used much differently than the old resources.[1]

Scientific and technological research and development in Australia is not what it was. As one senior member of the Australian Academy of Science put it to me:

> In the old days, influential people in the scientific community talked to influential people in politics and the cash just came; we have been slow to realise that this is no longer the case.

Over the last few years, in all advanced capitalist countries — and Australia is no exception — the funding, organisation and direction of research and development (R & D) have become subjects of public interest and open political debate. In these circumstances, three things are clear. First, the growth rates in overall expenditure on, and personnel engaged in, the pursuit of research and development, rapid in the 1950s and 1960s, have slowed; real growth rates in the 1980s and 1990s will be more modest. Secondly, the distribution of the R & D 'budget' among the categories of fundamental research, strategic research and experimental development[2], among different research disciplines and sub-disciplines, and among research institutions is under close scrutiny. Thirdly, more emphasis is being put on linking all types of research, including fundamental, to national objectives, particularly economic ones.

The first of these is setting the pace in Australia's current reconsideration of the overall balance of its research and development effort. The governments, federal and state, which pay for almost 80 per cent of R & D conducted in Australia, are concerned to slow the growth of total public expenditure and have been nibbling at the R & D budget. (And, contrary to scientists' criticisms, it has so far only been 'nibbling', at least in comparison with a British government which has been taking big bites!) This continuing financial pressure is having two consequences (once again, this is true for all OECD countries). First, there is a greater focus on 'value for money' and greater accountability in the research programmes funded by public money; this implies increasing interest in the evaluation of inputs and ouptuts of the R & D system. Second, governments are re-considering how research and development objectives are established; this implies a rejigging of the mechanisms whereby research directions are fixed, with a larger role being proposed for those not involved in performance of research but who have some interest in its outcome (namely, the users).

Such considerations inevitably mean the redistribution of R & D resources and this must mean medium-term cuts in some research programmes, disciplines and even performing organisations, with corresponding increases in others. However, the means of evaluation and redistribution, the institutional mechanisms for setting objectives, and whose interests should be represented in objective-setting, are not clear and are bound to be the subjects of considerable controversy.

In this paper, after outlining the current debate over the state of Australian R & D funding, I make some comments on three topics:

- how overall objectives and priorities for R & D can be set, suggesting that some facilitating agency needs to be established to aid the process of linking national objectives more firmly with Australian research and development;
- the need for evaluations of the research and development that is conducted, using qualitative and quantitative indicators of inputs and outputs;
- developing the dialogue between the public and the scientific community over the setting of research and development directions so as to seek broader public support for scientific and technological research activities.

BACKGROUND: THE R & D DEBATE IN AUSTRALIA

The figures on the state of Australia's research and development effort are by now well known.[3] To summarise the main ones:

- at approximately $1.82 billion in 1984, Australia's total R & D spending is small in global terms; the US computer company, IBM, spends more than this on its own R & D; Japan's six largest electronics companies together spent more than four times Australia's whole R & D budget in 1985.
- for a 'medium R & D performing country' (comparable with Switzerland, the Netherlands, Sweden, Belgium or Canada) Australia's total R & D effort is below average, both in money terms (in its share of the GDP at 1 per cent) and in employment terms (in its share of total employees).
- its private sector R & D effort is very low; at 21 per cent of GDP, only New Zealand, Iceland and Portugal of OECD countries, are lower; in real terms, private spending has remained the same since

1976 (at about $270 million in 1979/80 prices); since the 1960s its share of GDP has halved and, despite all government urgings of the last few years, there are no signs of any upturns; the latest available figures, for 1983/4, show that while total private spending is about the same as in 1976/7, the labour power effort has declined by about 20 per cent.

- of publicly-funded R & D, about 60 per cent is carried out in the government's own research organisations with 42 per cent in just two of them, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Defence Science and Technology Organisation (DSTO); only 7 per cent is granted, or, to a much lesser extent, contracted out, to private industry; so Australian private industrial R & D, small though it is, is over 85 per cent self-financed, a proportion higher than that in all OECD countries except Switzerland and Japan.
- a large, if falling, proportion of the public R & D effort (15 per cent) is directed towards agricultural R & D, one of the largest proportions among the OECD countries; the objective of 'industrial development' takes up only 8 per cent of publicly-funded research, one of the lowest percentages in the OECD countries, thus in no way compensating for low private industrial R & D.
- Though definition is difficult, in 1978-9, a quarter of public R & D funds was counted as being spent on 'pure basic' research, with a fifth on 'strategic basic' research, two-fifths on 'applied' research and only 15 per cent on development.
- though the figures are not complete and rather old (1976), manufacturing firms which are under Australian control do not do any more R & D, in proportion, than subsidiaries of foreign-controlled companies; though this hides significant differences between 'high research intensive' industries, such as chemicals and electronics (in which R & D levels are high and in which Australian-controlled company R & D effort is greater than foreign-controlled), and 'medium-research intensive' industries, such as motor vehicles and metal goods (in which neither Australian nor foreign-controlled firms do much R & D).[4]

The figures on the output from Australian R & D are equally well-known, though there are fewer of them:

- 2 per cent of world scientific publications emanate from Australia, a high figure for Australia's population and attesting to Australian science's above-average contribution to global scientific knowledge; Australia's contribution to the medical and biological sciences is especially high and to the engineering and physical sciences, at least in quantitative terms, especially low.

- between 1963 and 1979 0.9 per cent of foreign patents awarded in the USA were Australian; though "Australia has a higher level of US-system patenting than would be expected from its level of manufacturing R & D. . . ."[5], it was still out-performed by small developed European countries.
- Australia's imports of high technology-based products is six and a half times higher than its exports of these products; on a *per capita* basis, this puts Australia's export performance at 21st out of 24 OECD countries (just behind New Zealand, Portugal and Spain, but in front of Greece, Iceland and Turkey).

What is to be made of these statistics? To the Business Council of Australia, their import is clear:

> A striking feature of Australian public research is the absence of any effective mechanism for responding to practical, user needs. . . . . .This lack of market influence and concentration on the research end of the spectrum results in part from the implicit career and promotion incentives of government and university scientists who influence the direction of their own work according to theoretical or academic values.[6]

In this view, Australia's R & D system is dualist in its nature. Its basic scientific research, performed in CSIRO and in the universities, is recognised in many fields as excellent by the international science community, but the organic links between such research and technological innovation within manufacturing industry (but not agriculture or mining) are weak. To some extent this dualism is inevitable in small population countries — scientific research effort spread over a large number of disciplines usually cannot reach the threshold at which indigenous research is sufficiently concentrated to be readily applied to manufacturing innovation. As Jan Kolm, chairman of the National Energy Research, Development and Demonstration Committee (NERDDC) and one-time research director of ICI Australia, puts it:

> The old linear model argument — still held by some in Australia — is of course that science produces technology and the research benefits are unpredictable but eventually flow into the economy. While this is probably true on a global basis, it is not in small economies . . . . .Individual scientists or small groups can compete with their peers overseas across all fields of science. . . .Collective units — local companies, even whole industries — very often cannot because of constraints of scale, markets, costs, time horizon. . . . .The net result is that isolated research findings in small nations *do not coalesce* into

> technologies, but feed the international science pool on which international companies draw. . . . .Our science feeds world science from which international technology grows and from which we import know-how or products.[7] (emphasis added)

However, this lack of coalescence is not inevitable. Other small population countries — Belgium, the Netherlands and Sweden — have much more innovative manufacturing sectors with high levels of private and public R & D. Their innovative success, however, is strongly linked to their geographical position within the large, well-established European economic region. Australia is, of course, adjacent to the even larger economic region of East Asia, but it has only recently begun to build with its region the same links that the small countries have traditionally had with theirs.

Australia's current economic problem has its roots in the import-replacing industrial policies pursued after World War Two, aimed at building up an indigenous manufacturing industry behind high tariff walls. Manufacturing industry development was based on the import of the necessary production technologies and this inevitably left its mark on Australia's emerging scientific community. As Kolm argues:

> Largely independent of industrial development, the government, CSIRO and the universities built a strong, likewise highly diversified network of centres of excellence. Thus, both the scientists and the (industrial) technologists became locked into *separate matrices.* Scientists looked to agriculture, overseas trends and peers and technologists looked to their international companies or licensors. Technically this was closer to co-existence than to symbiotic interdependence. Many scientists turned away from application and manufacture. This explains, in part, the overemphasis on the more esoteric fields. The areas which are most research sensitive (electronics, communications, chemicals, drugs and engineering) do not rank high on the national R & D bill.[8] (emphasis added)

The further development of these scientific and technological 'separate matrices' confirmed the vicious circle — the small amount of manufacturing-oriented scientific research meant that Australian firms would have to continue to draw on technologies innovated in other economically advanced countries. They would thus have no particular interest in expanding their own R & D beyond that which was necessary for local product and process adaptation. So there would be no large industrially-oriented magnet to draw universities into closer collaboration with Australian firms and this would confirm university research orientations to fundamental research, whose trends and fashions would be set by the much larger research efforts of northern hemisphere research systems.

It is in this context that current federal government emphases on the restructuring of Australian R & D should be viewed, as an attempt to make it contribute more directly to an internationally-competitive Australian manufacturing and high value service sector. There are four elements to current policies:

i) offering bigger tax concessions to make every $100 spent on R & D by industrial firms cost the firm only $31 (announced in the 1985 budget).
ii) putting pressure on CSIRO to do more manufacturing industry-related research and to encourage greater involvement of industrial users in setting CSIRO research directions.[9]
iii) putting pressure on universities to make better use of their government grant money for research (by urging concentration of effort).
iv) through the budgetary process (for broader financial management reasons) putting restrictions on overall increases in R & D spending with a bias to switching money to more mission-oriented research, though this is rather haphazard and is not a carefully considered policy.

The end result of these policies, as the Draft National Technology Strategy describes it, would be "to increase the level of performance and funding of R & D by business from 0.2 to 1.0 per cent of GDP by 1995"[10], improving the links between existing research performers in the public sector and manufacturing industry. This will mean more public cash for this kind of experimental development work, which will inevitably have implications for existing research bodies. The government's view is that enough is being spent on basic research and that though the methods of funding (through various semi-government agencies) of this research are not in need of change, some review of the distribution of basic research funds is necessary.[11]

In the interviews I conducted, there was a sharp split over this new emphasis on the applied/developmental end of the R & D spectrum. As might have been expected, technologists and industrialists supported it, some cautiously, a few relishing the criticism of fundamental researchers in universities and CSIRO they thought it implied. Some academics also supported it. Most, however, did not. Basic research scientists generally defended high (even increased) levels of basic research spending, many emphasising underlying infrastructural problems (the ageing — and therefore more expensive — researcher population, outdated equipment, the impossibility of getting Australian industrial support for fundamental research). Many asserted the 'obvious' long term benefits of basic research and criticised industry for its lack of interest in R & D since World War Two.

A few quotations from interviews illustrate the different positions:

> My organisation does not want money to unis and CSIRO to decline overall, though it should be redirected and topped up with industrial money. (an industrialist)
>
> University promotion should be based less on academic excellence and more on industrial liaison skills. And basic research need not be directly funded; it could be part of a whole deal in which industrially-relevant applied research was the main purpose; basic research could then ride piggy-back on applied. Why kill yourself getting $15K out of ARGS (the Australian Research Grant Scheme) when you can get $50-100K for a bigger programme with $15K of it going to basic research? (a public servant in charge of government-industrial liaison schemes)
>
> (In response) No. An excessive concentration on short-term so-called 'national objective-oriented research' might very well miss longer-term payoffs. . . . .Arguments for an increase in the level of private research are fine, but it doesn't follow that basic, publicly-funded research is at an adequate level. (an academic)

SETTING NATIONAL OBJECTIVES AND PRIORITIES FOR RESEARCH

Everybody I spoke to agreed that research, and that even included fundamental research, should be somehow serving national objectives. It is hardly surprising that there was no complete consensus on what the objectives actually were. Practising scientists are reared on the view that research contributes to a global pool of knowledge which, whilst not serving national objectives of a social or economic nature immediately or directly (and certainly not predictably), does serve them in the broad, long-term sense. Basic research, important for long term economic development, also has important cultural spin-offs; and in performing it, there develops a stimulating training environment for the future scientific and technological workforce. There was some concern that an emphasis on 'linking to national needs' was a way of avoiding discussing whether the levels of funding of university research were adequate to *any* declared task.

The only unequivocal overarching national policy objective declared by the current government is that research must somehow be oriented more to industrial needs. For strategic research this means a greater consideration of the application of research results to manufacturing industry (and, if more vaguely expressed, 'services'); for basic research, the orientation is never specifically described, possibly because the government is not quite sure exactly what contribution basic research *can* play in meeting medium-term economic development needs.[12]

Most of the research community people I interviewed (in universities and in other public research agencies) were cautious about the industrial emphasis in the stated government objectives for research — and with good reason, some would say. CSIRO, for example, while making many changes in its structure over the last few years to improve its efforts in technology transfer to manufacturing industry, has cause to be critical of an unsophisticated 'get-thee-to-industry' push. CSIRO's ex-chairman, Paul Wild, has recounted the problems the CSIRO has had in forging research links with the metal trades industry. While the industry's trade association officials (the Metal Trades Industrial Association, MTIA) were keen to arrange some MTIA-CSIRO liaison, individual member companies had been unable to agree on any common research needs. As Wild argued, "I believe we have been doing all we can to get closer to industry. I wonder whether industry has been making a comparable all-out effort?"[13]

This problem seems inevitable, given the (historic) lack of manufacturing industrial interest in university and CSIRO-based R & D in Australia, and is only partially soluble by such things as university-industrial liaison units and high tax concessions for R & D. It is nevertheless of highest priority as far as the current government is concerned. Indeed, though the government is not willing (some thought, not able) to give precise definitions of its research priorities in sufficient detail, it is obvious that merely by continually declaring a general priority, the government expects research organisations to have their collective minds focussed.

But there are other objectives, not exclusively industrial, to which researchers might be able to respond. The only substantial statement of national objectives for research is that drawn up by the Australian Science of Technology Council (ASTEC) in 1981, compiled by "a small number of eminent national experts" and modified following comments from "about 80 government, business and academic experts".[14] This list of 68 national objectives was one outcome of a long-term study of priority determination in R & D policy which ASTEC embarked on in 1978, based on a methodology devised by the United Nations Educational, Scientific and Cultural Organisation (UNESCO). The study (or, as ASTEC calls it 'experiment') was of limited success, the principal difficulty being "convincing the leaders of the scientific community of its value and allaying their fears that the method represented a shift towards greater 'direction' of scientific activity towards socio-economic goals".[15] In 1981, ASTEC decided not to continue with the experiment in Australia and little use of the preliminary results has been made subsequently to refine research objectives in specific disciplines or missions.

The UNESCO methodology was devised to help developing countries define research priorities to fit their national objectives, which are usually drawn up by central planning agencies. However, as Ronayne and Middleton have pointed out in a review of the ASTEC experiment, "there is no central planning bureau in Australia and the national objectives that were drawn up (by the 'eminent national experts' in the experiment) could have no political authority".[16] The priority-defining exercise thus lacked any political legitimation: this might suggest that *any* such exercise based on a top-down 'rationalist' approach to R & D policy making is unlikely to succeed in Australia. As if anticipating this, Ronayne had earlier reviewed for ASTEC the mechanisms used by the most research-conscious OECD countries in the late 1970s. Though he identified "a trend away from *laissez-faire* systems of organisation of research and development" in the countries he reviewed, he could not identify the use of any systematic methods of priority-setting. Indeed, as he puts it, "no evidence has been uncovered which suggests that priorities are set by means other than by advocacy, 'bartering' and 'horse trading' ".[17]

However correct may have been Ronayne's assessment of the priority-setting mechanisms of the 1970s, there are signs of changes in the 1980s. Over the last few years, systematic methods and mechanisms for setting national research objectives have begun to attract increasing interest by those concerned with science policies, as governments have sought the means to harness R & D more directly to economic goals in a continuing period of depression. Mechanisms for setting directions and priorities for both basic and strategic research have been suggested by two British science policy analysts, John Irvine and Ben Martin. Much of their discussion is based on what is happening in the UK, but it has a more general validity; I shall indicate what lessons it might hold for science policy initiatives in Australia.

Research trajectories in basic research are the outcome of the unplanned processes of peer evaluation of research projects submitted to research funding agencies. According to Irvine and Martin, various criticisms can be made of peer evaluation as it has developed over the last 40 years: the entrenchment of particular disciplinary interests in the decision-making committees, the difficulty in finding a sufficiently large pool of disinterested peers to do the evaluating and, most important now in a period of slow growth in funding, the unsuitability of peer evaluation in setting priorities *among* research disciplines and sub-disciplines.[18] It is Martin and Irvine's view that, left to itself, the scientific community will be unlikely to solve these problems of prioritisation, so some form of outside involvement may well be necessary to structure and catalyse change. To accomplish that change, Irvine and Martin suggest much more needs to be known than at present about the inputs (by discipline, sub-discipline and institute and in terms of equipment, wages, training schemes etc.) and of the outputs of the research process. In addition, there could be substantial improvements in the process of peer evaluation with the use of overseas peers (already well-developed in Australia) as well as wider assessment panels using lay people, including non-scientists, and a more open refereeing system. (They recommend the Dutch Science Research Council (ZWO) jury-based 'two-stage Delphi technique' for project selection.)

In *Foresight in Science,* Irvine and Martin review the mechanisms used in the USA, France, West Germany and Japan to establish objectives for strategic research.[19] In other publications, they have also described UK mechanisms.[20] In summary:

- they oppose scientific 'field surveys', which were conducted in the 1960s and 70s to identify up-and-coming research areas in particular disciplines (their examples are from the USA); such survey procedures, they consider, have been captured by scientists in that they are well able to identify under-supported sub-disciplines, but are not able to set priorities across disciplines; in periods of rapid research funding growth this did not matter — the emerging areas could get the lion's share of the extra money, but, as I have earlier argued, this in no longer the case.
- instead of 'scientist-led' priority-setting mechanisms, they favour mechanisms which develop the *process* of both national objective and research priority setting in the style of the French 'research colloquia' (conducted in 1981/2) and particularly of the Japanese MITI's so-called 'forecasting visions'. From various industrial sectoral plans, MITI constructs an overall 'vision' of the future for Japanese industry. Based on this, MITI and the Agency of Industrial Science and Technology draw up a long-term R & D plan, revised every three years or so, which attempts:

> . . . . . to pick up early research tendencies, to construct 'visions' of how new technologies are likely to develop, to formulate an appropriate overall R & D policy, to select priority research fields and to initiate special projects within them.[21]

Irvine and Martin conclude:

> What [France and Japan] have recognised is that foresight activities must go beyond just identifying new research areas of long-term significance and ensure the researchers and policy-makers in industry, government and elsewhere then act upon the results of the forecasts. The best way of

> achieving this is to involve large sections of these communities in the forecasting process itself. As a result, even though the National Colloquium held in France does not in retrospect appear to have constituted a particularly systematic approach to identifying promising areas of science, it did succeed in generating a level of consensus necessary to translate the results of the exercise into policy.[22]

In the light of the French and particularly the Japanese experiences, they suggest for the UK the establishment of some sort of facilitating agency (though they do not use this term) which would perform three main functions:

- from existing government statements and policies it would seek out and elaborate national objectives.
- it would tap into existing forecasts and plans being drawn up by local industry and by research planning agencies.
- it would facilitate liaison and negotiation over forecasts and priorities in research among industrial representatives, scientific and technological researchers, public servants and representatives of lay public interests.

It would definitely not be a top-down planning agency, because:

> Apart from being dependent on a narrower range of information inputs, 'top-down' forecasts and the resultant research priorities are more likely to antagonise not only the basic science community (which may feel that it has been inadequately consulted in the foresight process), but also industry (which naturally tends to feel that it is in the best position to judge the commercial prospects for strategic research). By integrating [a] wide range of interests into the process for establishing priorities, the Japanese approach by and large avoids the danger of alienating these two vital constituencies while at the same time minimising the lack of appreciation of current scientific and technological concerns often associated with centrally determined R & D plans.[23]

A crucial point, then, is that all of this should be ongoing; the results of the forecasts are less important than the fact that they are made by liaison and negotiation among various social interests, at all levels (national/regional, sectoral/sub-sectoral). To do the facilitating, the agency would obviously need to be in possession of data on the inputs and outputs of the research process, enabling it to analyse research trends both internationally and in the UK.

But is all this applicable to Australia? Not necessarily. One must be wary of assuming that the consensus style, which is reputed to be the basis of Japan's mechanisms for national objective co-ordination, can be transported to other countries whose political processes are more conflictual, like those of the UK and Australia. Tapping into industrial forecasts and plans is also much easier in Japan with its extremely high percentage of Japanese-owned firms; it is more difficult for the UK with its high penetration by transnationals, whose overall plans are not necessarily readily accessible. It would, therefore, be even more difficult for Australia with its even higher foreign ownership and dependence. However, anticipating this problem, Irvine and Martin point out that the development of national industrial forecasting can be encouraged by the facilitating agency asking for industrial input into its deliberations. There is nevertheless a weakness on the industrial side. The 'demand pull' which Irvine and Martin identify as crucial in coralling scientific research for non-esoteric purposes is not as strong in Australia as in Japan (or, for that matter, in the USA or Europe).

Nevertheless, there are some initiatives which are currently underway or are being discussed in Australia which might fit into the sort of facilitating agency which Irvine and Martin suggest for the UK. Those mentioned here are not intended to be exhaustive; they are intended only as an indication of the disparate activities underway which, either directly or indirectly, have a bearing on the setting of Australian research directions. I would suggest that these activities could be considered in terms of their potential for integration into some broader priority-setting arrangement.

The Department of Science is developing its international scientific intelligence-gathering abilities, having established a network of overseas scientific counsellors in, so far, five cities (with another four under consideration). An argument could be made for a substantial expanison of such activities — both by personal contacts and by more systematic monitoring of the international scientific and technological literature — as a means of reaping the benefits of the more 'coalescable' (to borrow Kolm's term) scale of US, Japanese and European R & D. The critical factors, of course, are how the intelligence gathered is disseminated and into what forums it can be fed.

In their recent review of Australia's science policies, the OECD Examiners proposed that the Australian government consider a much more systematic review of research requirements in various industrial sectors. They were at pains to emphasise that the sectors to be reviewed were to be industrial in the broadest sense, covering primary, secondary, tertiary and quaternary divisions of national production. The report nominates financial services, medical research, tourism, horticulture and high value agriculture, fisheries, consulting services and the public services as worth further consideration. To quote the Examiners' report:

We recommend that the government initiate a series of sector by sector

> *reviews aimed at establishing sectoral science and technology policies and practical recommendations.* Each sector's science and technology resources, needs and possibilities should be examined. This would include a survey of what is presently being done both within the industry and in connection with it, for example at universities, in CSIRO. . . . . .There should be wide-ranging discussions in order to try to reach a common understanding of what science and technology can be expected to do for the sector, and how this should be organised, directed and funded. . . . .[24] (original emphasis)

In my interviews, and from the discussions that took place when the OECD examiners presented their report in Canberra, it seems that the nature of a 'sectoral review' is not clear. Indeed, each of the three examiners presented a different account of what was meant by the term! (Interestingly for the discussion here about a facilitating agency, one of the Examiners, Emma Rothschild, made the point that sectoral reviews should be 'processes' with a 'light institutional structure' without any assumption that there would be some need automatically for government to act.) If such sectoral reviews, conducted in the way indicated, are to be considered further, then the role for some facilitating agency seems clear. Since the reviews are not intended to be restricted to industrial arrangements as presently constituted — the report points out that though for some sectors one specific government department could carry out the review, "the largest and fastest growing sector of 'industry', i.e. private and public services, has no specific ministry looking after it"[25] — then a facilitating agency outside the confines of one particular governmental department might be called for.

EVALUATION OF RESEARCH OUTCOMES

Various evaluations of Australian research are underway. The Department of Science has collected and published annually since 1980 indicators of the inputs, in terms of the costs of R & D in Australia, concentrating on the R & D that goes on in the public sector. (The levels of research funding in the private sector are also published, by the Australian Bureau of Statistics, but are available in a much less detailed form.) Much more extensive input indicators of this kind will be available soon. The annual Science and Technology Statements include very limited data on the outputs of the R & D system, by means of international comparisons with other OECD countries on such things as high technology export/import ratios. More output indicators will be published shortly.[26] They will not be restricted to measures of technological development or applied research and the contribution they have made to industrial output and trade. For the first time such indicators, with international comparisons, will be readily available for basic research as well, and will include data on the number of researchers in various scientific fields, the number of graduates and undergraduates, numbers of publications, etc. In addition, it is intended that bibliometric indicators will also be made available; these will point to emerging research specialities and to the place of Australian research activity in the global structure of those specialties.

My interviews revealed little awareness in the scientific community of the need for, or significance of, the types of research output indicators mentioned above, particularly indicators of basic research outputs, measured comparatively. Of the people I spoke to outside the Department of Science, only one volunteered any knowledge of such techniques; he was not enthusiastic about them, favouring international peer review. (The OECD Examiners commented on the "relatively undeveloped" practice of conducting evaluations.[27]) In published statements concerning research funding (from the Australian Vice-Chancellors' Committee publications, for example), output is said to be either 'measured' by peer review (through the excellence criterion) or merely justified anecdotally by reference to the economic/social efficacy of carefully chosen research projects.[28] Sometimes, the examples used are from international science rather than from anything specifically Australian.[29]

There is a need to explore the introduction of research output indicators and to consider what use can be made of the data so collected and presented. There is a large number of techniques to explore and in many OECD countries various methods are being tried and evaluated by research funding and planning agencies. However, as yet, there are no universally accepted procedures and scientists whose performance seems to be criticised by the publication of research performance 'league tables' are not likely to be very keen on the results of the analyses.[30]

Such indicators are particularly significant for Australian science policy. Because of the weak links between Australian science and indigenous technological developments, Australian expenditure on basic research needs extra careful examination to check that its contributions to the 'global pool' are balanced with contributions for specifically Australian objectives (which may also contribute to the global pool). Further, if there were to be a strategic priority list for 'key' industrial technologies, then bibliometric indicators could identify specialties emerging globally which might be more quickly pursued in Australia. It should not be thought that the only significance of research output indicators is to criticise comparative Australian under-performance in some research areas as a prelude to pruning them. Identifying relative strengths and weaknesses by a variety of objective methods can strengthen the cases made for increases in funding of the strategically important but currently weak areas.[31] However, it must be admitted that all evaluations in periods of low funding growth imply redistributions of funds between research areas.

Given the problems with establishing what are the most appropriate indicators, there is good reason to ensure a plurality of approaches to evaluation. There needs to be some debate over what indicators of output should be used (bibliometric, peer reviews, etc.); each individual technique has its limitations and though this is usually admitted by the protagonists of the different techniques, it needs to be spelt out clearly, particularly to those in the research community and amongst those policy makers who see the limitations to be proof of the complete uselessness of each technique. In addition, the indicators should not be too narrowly drawn; broader indicators of the 'worth' of research projects, as evaluated by the users (and there may be more than one type of user) could also be investigated, perhaps by an extension of the jury-based techniques which are part of the research evaluation process of the Dutch ZWO. (Thus, to take a hypothetical example, the Conservation Foundation might have views on what indicators to choose to measure the success of certain research programmes in achieving environmental goals.) The Department of Science could play a key role here in disseminating its specialist knowledge of research output indicators and in facilitating the process whereby a consensus between research planners, performers and users over the most appropriate techniques to be employed in evaluations could be reached.

Scientific and user organisations should be encouraged to carry out such evaluations themselves, using professional techniques, financed perhaps by some agencies independent of the Department of Science. This has been a weakness of British scientists. Part of their difficulty in disputing with the British government about the effects of the funding cuts on the state of British science was their inability to produce hard, non-anecdotal evidence of harm being done, because the data at their disposal to evaluate their own activities were hopelessly inadequate. This situation is now being remedied,[32] but the Australian research community should be able to learn from the experience of the British.

DEVELOPING THE DIALOGUE BETWEEN THE PUBLIC AND THE SCIENTIFIC COMMUNITY

There are many initiatives underway in Australia to seek broader support for science, either in pursuit of a longer term improvement in the level of Australia's scientific and technological culture or to persuade some potential research users to look more carefully at what research might do for them. The Commission for the Future, for example, was established early in 1985; its aim is to raise community awareness and understanding of the social and economic impact of technological change. In pursuit of more fruitful industry-research relations, a number of organisations have either established or proposed liaison committees to explore mutual interests. The Science and Technology Committee of the Business Council of Australia (which represents 76 of Australia's largest companies) has established a working party with the Research Committee of the Australian Vice-Chancellors' Committee. The Commonwealth Tertiary Education Committee (CTEC) has recommended the establishment of an intra-governmental committee on tertiary education-industry links, which could identify ways of increasing links between universities and industry. CSIRO is revamping its external communications systems to ensure that its research activities and its central role in Australia's R & D system is better known to the general public and to influential members of the decision-making class.

All these attempts at liaison with the users of research and to increase public understanding of science and technology matters beg the question of what an informed, more scientifically and technologically cultured public is expected to do. The people I interviewed saw action in terms of increased public support for scientific lobbyists' calls for higher research expenditure, as expressed through pressure groups and the electoral process. A more fruitful avenue to explore for CSIRO and other research funders and performers might be to identify more precisely which bits of the 'public' are likely to be the most influential and to instil recognition that they have a role to play within the priority-setting and research evaluation aspects of the research planning process, rather than just cheering on the sidelines. The aim should be *dialogue*.

The results of a poll of 100 'key opinion-leaders' in business, government, politics and academia conducted for CSIRO's External Communications Activities Review Committee certainly suggest substantial public dissatisfaction with that organisation's public responsiveness.[33] Asked how they rated CSIRO's responsiveness to the community, 49 of them judged it unsatisfactory, 21 adequate, 9 good and just 1 excellent. (Apart from its technical excellence, the opinon leaders were not impressed by CSIRO's other characteristics either.) The subsequent report of the Review Committee recognises that, to improve its responsiveness, communication between CSIRO and the community should be two-way and that this involves "the establishment of visible and well-resourced channels of advice into CSIRO from each of its consumer groups."[34] This view is reflected in the report's principal but general recommendation:

> Communication is an integral part of CSIRO's research process, both *in determining research objectives* and in advising the results of research.[35] (emphasis added)

Unfortunately, the report's specific recommendations concentrate on how CSIRO can improve its public image by a better communication *to* the public of what it is doing.

Public participation in the research advisory process is accepted, and indeed legally required, in CSIRO, in the Advisory Council arrangements. In my interviews, as well as in published accounts of current debates over CSIRO's restructuring, the public seems to have been repeatedly defined in terms of industrial management, who seem to monopolise the term 'research user'. The same is true of debates about the direction and form of university research, where liaison with industry preoccupies discussion.

There are three problems with this narrow focus:

- political: in the present climate, of the Accord and consensus, trade unions, whose members are also users of research results, also have some claim to consideration of their views (and, of course, as with business, these views are variable and underdeveloped.)
- democratic equity: other groups have claims to representation of some aspect of the national interest (state governments, consumers, environmentalists, representative community groups). As one person I interviewed commented: "You should get advice from a representation of all Australians, otherwise you don't get a wide enough range and you might miss something important."
- the research weakness of industry in Australia: the relative lack of a research orientation of both Australian-owned firms and subsidiaries of foreign firms means that there are likely to be gaps in any representation of industrial interests. The representative organisations of business interests are not at a stage to formulate any general business interest. This suggests the need to ensure that other sections of the public should be involved more systematically in the research advisory process. Indeed, the very narrowness of Australian industry suggests that research objective formulation needs a wider Australian public input if research directions are not merely to be dictated by the more technologically innovative economies of the Northern Hemisphere.

Some steps have already been taken by the National Health and Medical Research Council (NHMRC) to get greater lay involvement in the research programmes it funds. Its Medical Research Committee has been reconstituted, with representation from Australian consumers and social services organisations, though the medical researchers will still predominate on the committee.[36] CSIRO is currently restructuring its Advisory Council structure with all divisions having some advisory group. CSIRO also intends making changes to its review committees, which look at every division's work. Each committee will now have an external chairperson as well as an outside scientific expert, and representatives of the CSIRO Officers' Association, industry and the community.

However, in addition to representation on committees, there are other means whereby wider community interests can be involved in debating research priorities and the evaluation of research results. Some of these are described in a paper produced by a Canberra study group on new directions in scientific research policy.[37] They include community extension services in which sections of existing research-performing organisations provide research and consulting services oriented to a wide range of community groups, and 'knowledge shops' in which community groups with a researchable problem are put in touch with university researchers who might be able to help them.

In the present uncertainty regarding future funding levels and directions for research, particularly basic research, researchers could go two ways. As the OECD's Centre for Educational Research and Innovation (CERI) describes it, university researchers can yield to one of two temptations: they can either "hide away in a kind of 'scientific purity' and thus become isolated from the external world, counting on their 'excellence' but also the privileged relations that they have with the nation's other 'elites' to protect them from what they regard as a contamination of science"; alternatively, "wishing to be recognised by their peers but also by big industry and the State, [they can] strive to strengthen their links with both by directing their teaching and research, for example, towards what is regarded as useful and effective by them, but always from the same elitist angle that brings them to do battle with the 'competition' — high level non-university institutions". It is CERI's view that "neither of these two paths seems to us to offer much promise, beyond a short-term future on which the universities have little direct grasp".[38]

There is, however, a third path, involving greater public participation in research priority-setting and evaluation, though not excluding peer-reviewed fundamental research or contracts with industry and the State. Such public participation should be welcomed by researchers in professional organisations and scientific trade unions seeking new forms of legitimation — new supportive constituencies — for research activities. It suggests a way out of the sterile debates over the preservation of researchers' autonomy, supposedly threatened by more mission-orientation and industrial sub-contracting.

CONCLUSION

This paper has presented some innovations that should be considered in the reorganisation of the Australian R & D system, both by the research community and by the various bodies responsible for the funding and administration of R & D. More substantial evaluations of research and new forms of dialogue between the scientific community and the public seem to me to be priorities. They are anyway the easiest to envisage as they are extensions of activities already underway, if not with the emphases I suggest.

It is important that some consensus on the level of funding for scientific research in Australia be reached quickly. It would be most undesirable if the protracted debates over the levels of research funding that have characterised the last few years in the UK were to be repeated in Australia, risking grave damage to the country's research infrastructure. From observation of the actions of the British scientific community under similar funds-reduction pressures since 1980, it seems that scientists are likely to be more effective in their lobbying of politicians and the public if they pay considerable attention to the quality of their message. Proofs of the beneficial effects of research can never be conclusive. They must nevertheless be strong enough to bear the criticism of those who, armed with the results of policy evaluations, are casting doubt on the usefulness of some research in achieving national economic and social goals. Such people will not be convinced by a collection of anecdotes and specially chosen examples. Further, any evaluation of the efficacy of research could well reveal sectors of research activity which have not (or, at least not yet) justified themselves; in other words, a serious message would have to face up to possible arguments for cutting spending on some research areas and favouring others. Whilst there are some encouraging signs — the formation in 1985 of a federation of Australia's scientific and technological societies (FASTS), for example — I am not confident that the Australian scientific and technological community, particularly fundamental researchers in universities and the CSIRO, are learning the lessons of the recent British experiences.

The government's concern about the mal-distribution of Australia's limited research funds is, in general, justified. Mere repetition of the arguments in favour of more basic research will not be taken seriously in the absence of any articulate, powerful constituency to back the funding claims of basic research when there are so many better organised claimants on the public purse. Nor will there ever be a supportive public constituency if the research community assumes it has merely to explain itself to the public for the public to understand and support. If basic research is important, then some sustained consideration has to be given to its justification, and in the context of specific Australian circumstances rather than in the global terms that have sustained Australian science since the 1940s.

However, evaluations of research cannot be made in an institutional vacuum; they require yardsticks and this means some attempt to specify national priorities for research more precisely. The facilitating agency I propose is put forward as one way to develop and maintain liaison among government departments, research performers and research users over what those priorities should be, acting as a vehicle for consciousness-raising within the whole R & D system in the longer-term.

What sort of body would a facilitating agency be? Since it would be seeking to come to some consensus on national research and development objectives across the whole range of industrial public interest sectors but without research performing or operational responsibilities, it would need access across the departmental spectrum. But is not this the role of a co-ordinating government department? That there should be some sort of co-ordinating agency for science and technology policies across all government departments has been the subject of discussion in Australia for the last ten years. That no satisfactory resolution to the question has been reached is clear from the history of departmental portfolio attachments of science and technology matters since 1972. Geoff McAlpine, reviewing the various options for a Department of Science and Technology (DST) in the 1980s, argued that it should be a co-ordinator of the general science and technology field.[39] ASTEC, he thought, would continue to provide an additional perspective to that of a DST and CSIRO. McAlpine laconically concludes, however, that, except for key departments like the Prime Minister's and the Treasury, the lack of programme responsibility weakens a department, and that this type of co-ordinating role is not well precedented.

In the OECD Examiners' report, the need for a Science and Technology co-ordinating ministry is repeated, and it is even suggested that ASTEC should report, not to the Prime Minister, but through the Science and Technology department. However, the reduction of the DST to a Department of Science with technology being transferred to a new Department of Industry, Technology and Commerce, in January 1985, is the latest confirmation that it is surely not possible to envisage the setting up and survival of a powerful Cabinet-level co-ordinating ministry for Science and Technology in Australia. Any facilitating agency, therefore, which would be able to range over the whole research area would need to be associated with some more powerful ministry; in my discussions there were only two nominations, the Prime Minister and Cabinet Department and a revamped Department of Industry, Technology *and Science.*

Whatever the ministerial arrangements might be, the organisation of the facilitating agency would need to be different from that of the body to which it would seem most similar, namely ASTEC. ASTEC is an advisory body of 14 members, including 7 academics and 5 business people, best known publicly for its reports on scientific and technological matters referred to it by the government or self-initiated. However, as the OECD Examiners' report says:

> [ASTEC's own view] is that its most influential role is in providing briefing to the Prime Minister on proposals which are before the Cabinet. In addition to this the organisation's role in *ranking new policy proposals* in each budget year is considered both inside and outside the organisation as a highly important one. In the current financial year, ASTEC will rank some 70-80 proposals and, although this priority establishment role is never a very popular one, it appears that line Departments are happier that the ranking is done by an organisation which has a sympathy with the sense of what the proposals aim to achieve, rather than for example by the Department of Finance or the Treasury.[40] (emphasis added)

ASTEC's Annual Reports are silent on how the Council performs its "most influential role". For reasons of Cabinet confidentiality, it is not surprising that ASTEC's view of the individual scientific and technological proposals before the Cabinet are not available for public scrutiny; however, it should be possible for ASTEC to organise greater inputs from the scientific community and from public interest groups into the general principles which govern its annual rankings. Such activities would bring ASTEC closer to the facilitating agency functions outlined earlier.

ASTEC has been moving over the last three years from a 'policy for science' role (in which scientific experts are asked to comment on funding arrangements for some aspect of a nation's research endeavours) to a 'science for policy' one (in which the government now asks for advice on how research and development can contribute to the government's goals, both overall and those of individual government departments). There remains, however, a conflict between these two roles. With its preponderance of academic research-oriented scientists, ASTEC is well qualified to judge the worth of various specific scientific research projects in terms of their excellence in relation to world science, and to review Australia's research funding schemes in comparison with those in other countries; but there is no reason to believe that scientists have any special skills, and should necessarily be in a majority when it comes to 'science for policy' matters. The definition of objectives, the evaluation of the contribution of research to those objectives and the relative worth of different programmes are the issues on the 'science for policy' agenda rather than the organisational details of funding schemes. A facilitating agency would require a much broader membership with a majority of research users rather than producers.

NOTES AND REFERENCES

1. Harvey Averch, *A Strategic Analysis of Science and Technology Policy,* Johns Hopkins University Press, Baltimore, 1985, p. 9.
2. Basic research is "orginal investigation with the primary aim of a more complete knowledge or understanding of the subject under study". It is sub-divided into pure basic research (or fundamental research), which is research carried out for the advancement of knowledge without positive effort to apply the results to practical problems, and strategic research, which is "basic research carried out with an expectation that it will provide a broad base of knowledge necessary as the background for the solution of recognised practical problems". Experimental Development is systematic work drawing on existing knowledge gained from research and/or practical experience that is directed to producing new materials, products or devices, installing or substantially improving new processes, systems or services. For further definition see Jarlath Ronayne, *Science in Government,* Edward Arnold, Melbourne, 1984.
3. Unless otherwise indicated, the figures in this section are taken from the Department of Science, *Science and Technology Statement 1984-85,* Australian Government Publishing Service, Canberra, May 1985; *Science and Technology Statement, 1985-6,* AGPS, Canberra, November 1985; and from Australian Science and Technology Council, *Public Investment in Research and Development in Australia,* AGPS, Canberra, 1985, Appendix B.
4. Department of Science and the Environment, *Project Score: Research and Development in Australia 1976-77,* AGPS, Canberra, 1980.
5. Department of Science, *Science and Technology Statement 1984-85, op. cit.,* p. 48.
6. Business Council of Australia, *Comments on National Technology Strategy Draft,* 1984, mimeo, p. 10.
7. Jan Kolm, 'Universities and industry: potential for and impediments to interaction in a small economy' undated, mimeo, p. 8.
8. Jan Kolm, 'Science and technology transfer to Australia' in A.T.A. Healy (ed.), *Science and Technology for What Purpose?: an Australian Perspective,* Australian Academy of Science, Canberra, 1979, p. 292.
9. See the recent report of the Australian Science and Technology Council, *Future Directions for CSIRO,* AGPS, Canberra, 1985.
10. *National Technology Strategy: Revised Discussion Draft,* Department of Science/Department of Industry, Technology and Commerce, Canberra, 1985, p. vi.
11. "I firmly believe that a country's scientific effort should include a proportion of basic research of the highest quality. To endorse basic research, however, is not necessarily to say that it has to be at the same level as at present, nor that every basic research endeavour or area presently in progress is unquestionable." Senator John Button, speech to National Meeting of Concern on Science and Technology, Canberra, April 1985.

12. When government departments have tried to be more specific in what they perceive national objectives to be, their perceptions have not been greeted with enthusiasm. In particular, from my interviews it was clear that those responsible for university basic research were unclear as to how universities and the granting agencies that support research in them are expected to re-orient their activities to meet them. For example, the list of 'Priority Areas of National Interest' produced for the consideration of those seeking National Research Fellowships came in for criticism. The NRF list was compiled by asking individual government departments what they deemed to be of 'priority' in the research field; they were definitely not negotiated within any priority-setting overview body. As a result, they are insufficiently defined to be of much use in identifying basic research directions. For example, the priority topic 'Provision of services; e.g., welfare, transport, health care' is a very broad category and one could be forgiven for believing that almost any research project in aspects of service provision, however esoteric, could be made to serve it. Further, there was some disquiet as to whether the list of 'national priorities' matches what Australian researchers actually can do. For example, in its Annual Reports, the ARGS states where it considers Australian research strengths lie. It was put to me that it might be useful to develop more workable national priorities for basic research funding from these strengths.
13. Paul Wild, speech to Australian Industrial Research Group Symposium, Canberra, 1985.
14. ASTEC, *Basic Research and National Objectives,* AGPS, Canberra, 1981.
15. Jarlath Ronayne and Bruce Middleton, 'Priority identification in science and technology policy: an Australian experiment' in Department of Science and Technology, *Proceedings of the Australia/China Science and Technology Policy Symposium,* DST, Canberra, 1984, p. 202.
16. *ibid.*
17. Jarlath Ronayne, *The Allocation of Resources to Research and Development: A Review of Policies and Procedures,* report to ASTEC, 1980.
18. John Irvine and Ben Martin, 'What direction for basic scientific research' in Michael Gibbons *et al.* (eds), *Science and Technology Policy in the 1980s and Beyond,* Longman, London, 1984.
19. John Irvine and Ben Martin, *Foresight in Science: Picking the Winners,* Frances Pinter, London, 1984.
20. John Irvine *et al., Research Evaluation in British Science: a Science Policy Research Unit Review,* SPRU, University of Sydney, 1983, mimeo.
21. Irvine and Martin, *Foresight in Science, op. cit.,* pp. 117-8.
22. *ibid.,* pp. 141-2.
23. *ibid.,* p. 143.
24. OECD, *Reviews of National Science Policies: Australia, Report,* Paris, 1985, mimeo, paras. 67-8.
25. OECD, *op. cit.,* para. 69.
26. See Ron Johnston and James Hartley, *Formulation and Development of High Technology Indicators: Final Report,* Centre for Technology and Social Change, University of Wollongong, Wollongong, June 1985.
27. OECD, *op. cit.,* para. 88.
28. Australian Vice-Chancellors' Committee, *University Research 1982,* AVCC. 1982.
29. Thus, the Australian Research Grants Scheme's 'Case for the ARGS for 1985' seeks to justify basic research expenditure in *Australia* by referring to recombinant DNA which, it claims, is a 'spin-off' from a grant of $5,500 from the *United States* National Science Foundation to Max Delbruck to study bacterial genetics in the 1950s. This general proof of the ultimate economic value of basic research is of little help in deciding the level and project distribution of basic research funds in Australia.

30. For an Australian discussion of the debate over the relevance of bibliometric indicators see Jarlath Ronayne, *Australian S & T Indicators: Feasibility Study,* DST, 1983.
31. See Ben Martin *et al.,* 'The writing on the wall for British Science', *New Scientist,* 8 November 1984, pp. 25-9.
32. For a brief account of what is happening in the UK see *New Scientist,* 18 April 1985, pp. 10-11.
33. PA Management Consultants, *The Community's Perceptions of the CSIRO,* report to the committee reviewing CSIRO's external communications activities, December 1984, mimeo.
34. CSIRO External Communications Review Committee, *Report,* CSIRO, Canberra, June 1985, para. 4.8.
35. *ibid.*
36. See National Health and Medical Research Council (NHMRC), *Report of the Committee of Review of its Organisation. Functions and Membership.* NMHRC, Canberra, 1984.
37. Gabriele Bammer, Ken Green and Brian Martin, 'Who gets kicks out of science policy', *Search,* 17, 1-2, 1986, pp. 41-6.
38. CERI, *The University and the Community: the Problems of Changing Relationships,* OECD, Paris, 1982.
39. Geoff McAlpine, *Co-ordination in Science and Technology Policy,* Department of Science and Technology, Canberra, 1982, mimeo. For further discussion of co-ordination see Ron Johnston, *Mechanisms for the Co-ordination of Research,* Department of Science and the Environment, Canberra, 1979; and Geoff McAlpine and Rod Badger, *Bases for Science and Technology Policy,* Department of Science and Technology, Canberra, 1981.
40. OECD, *op. cit.,* para. 33.