THE SENATE
25 JUN 1992
TABLED PAPER

THE PARLIAMENT OF THE COMMONWEALTH OF AUSTRALIA

JOINT COMMITTEE OF PUBLIC ACCOUNTS

DEPARTMENT OF THE SENATE
PAPER No. 7178
DATE PRESENTED
25 JUN 1992

REPORT 318

PUBLIC SECTOR RESEARCH AND DEVELOPMENT

VOLUME 1 OF A REPORT ON RESEARCH AND DEVELOPMENT

June 1992

The Parliament of the Commonwealth of Australia

Joint Committee of Public Accounts

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DUTIES OF THE COMMITTEE

Section 8(1) of the Public Accounts Committee Act 1951 reads as follows:

(a) *to examine the accounts of the receipts and expenditure of the* Commonwealth including the financial statements transmitted to the Auditor-General under sub-section (4) of section 50 of the Audit Act 1901;

(aa) to examine the financial affairs of authorities of the Commonwealth to which this Act applies and of inter-governmental bodies to which this Act applies;

(ab) to examine all reports of the Auditor-General (including reports of the results of efficiency audits) copies of which have been laid *before the Houses of the* Parliament;

(b) to report to both Houses of the Parliament, with such comment as it thinks fit, any items or matters in those accounts, statements and reports, or any circumstances connected with them, to which the Committee is of the opinion that the attention of the Parliament should be directed;

(c) to report to both Houses of the Parliament, any alteration which the Committee thinks desirable in the form of the public accounts or in the method of keeping them, or in the mode of *receipt, control, issue or payment of public moneys; and*

(d) to inquire into any question in connexion with the public accounts which is referred to it by either House of the Parliament, and to report to that House upon that question,

and include such other duties as are assigned to the Committee by Joint Standing Orders approved by both Houses of the Parliament.

TERMS OF REFERENCE

The terms of reference for the Inquiry are:

(1) to review public sector performed research and development, excluding that performed exclusively by the tertiary education sector, with reference to:

- its role in contributing to Australian development;
- the adequacy of current funding levels; and
- cost-effectiveness of the use of those funds; and

(2) to review Commonwealth support for private sector investment in research and development, with reference to the efficiency and cost-effectiveness of current programs.

PREFACE

Australia's people have a reputation for inventiveness and its scientists a high standing in their professions. What Australia is not known for is an ability to translate its research discoveries and inventiveness into dollars.

These facts were the starting point for the Committee's Inquiry into Research and Development (R & D) in Australia. The Committee sought to establish why this situation exists and how it can be remedied.

As a trading nation, Australia suffers from the disadvantages of being far from world markets, a lack of domestic demand, complaisant attitudes in much of the commercial sector and low productivity and financial dynamism. These factors impact on the nation's ability to enter and compete successfully on the world market Failing to convert the nation's research results to its economic advantage is part of the same constellation of disadvantages from which Australia suffers. There is now increasing recognition of this situation and a willingness to make greater efforts than before to overcome these disadvantages.

The crucial point in considering the contribution of R & D to the nation is its interrelatedness with many other facets of national endeavour and the policies determining them. The education system must deliver adequate numbers of appropriately trained scientists and research administrators to satisfy the demand for personnel. Accommodation and equipment must be supplied to the research institutions to enable them to continue to work with technologically sophisticated methodologies at the forefront of knowledge. If research developments are to be commercialised cost effectively, research must be an integral part of the industrial process, either conducted in-house or through the involvement of researchers and industry together at an early stage of the research. Above all, Australia needs a scientifically literate population, that understands the positive role that R & D can play in the nation's prosperity and international standing, and entrepreneurs with a set of mind based on this understanding.

In setting policies for R & D and the other areas on which the success of R & D and its commercialisation depends, there is a need for a very broad awareness on the part of policy makers of the implications of their actions on all other areas In a time of economic restraint, the necessity for choosing those avenues that will produce most benefit is particularly critical. This requires methods for prioritising among options and the selection of criteria for assessing priorities that take account of the broader needs of the country.

Making the right choices about what policies to choose or what areas of research to support depends on having available information about all the fields on which the success of R & D depends. Data on the numbers of personnel in training and available, areas of research strength, the R & D performed by the private sector and the costs associated with taking the results of research to the market are some of the types of information needed for effective decision making.

Research organisations have, for some time, been facing pressures to cut costs and focus increasingly on commercial applications for their research. As this has happened, it has become clear that a new balance must be found between the traditional roles of these organisations and their research staff and the new ones imposed by these recent developments. How should an organisation's research effort be divided between the short term process of developing applications for their research on the one hand and, on the other, long term basic research that may show no returns to the nation for many years, if at all? Can researchers cope with the demands of managing their research to tight targets, selling their ideas to industry and working within the constraints of a commercial timetable? Asking researchers to assume tasks additional to their research has required organisational changes and changes to the culture within which they work.

The balance that is struck between long term basic research and shorter term strategic and applied research is vital. From both the private and public sector came the warning that failure to maintain the nation's research capacity and the flow of information about the fundamental natural and physical processes of the world would be a fatal mistake. This information is the foundation of applied science and an important step on the path to the ultimate commercialisation of research results.

The source of the funds for research is a significant issue. The bulk of the support for R & D is provided by the Commonwealth and State Governments but, over the last decade, Australian business has provided increasing assistance. Businesses appear to be assuming responsibility for research that yields returns in the short term, a field on which the public sector should not encroach if business is willing and able to effectively undertake such R & D. This leaves government with the task of ensuring that longer term research and that which results in benefit for the community as a whole can continue. Environmental and public health research are examples of work that the public sector should pursue in the public interest.

With its examination of the issues relating to R & D and the detailed recommendations summarised in the next section, the Committee believes that it has contributed to a more effective role for Australian R & D. This has been done with the help of many organisations, individuals and businesses who provided information to the Committee and whom the Committee thanks.

The Hon G F Punch, MP
Chairman

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EXECUTIVE SUMMARY

1. The *Inquiry into* Research and Development (R & D) was commenced by the 16th Committee in September 1989 and continued by the 17th Committee after the election in March 1990. It was undertaken by the Committee in the context of events described in the Preface and the national significance of R & D in relation to public expenditure on it of over $2.6 billion and its employment of around 65,00 people. The Committee's findings are to be reported in two volumes. This volume deals with some of the general issues relating to R & D and its commercialisation and with the Government's support for R & D in the public sector. (Research carried out by universities is excluded.) Support for the private sector's performance of R & D and its economic exploitation will be examined in the second volume.

Guidelines for the Support of R & D

2. In the present economic circumstances, there are great pressures to cut costs and ensure the most cost-effective use of public funds. Wise management of the considerable assistance provided by the Government for R & D requires guidelines to aid decision making. The Committee promotes two such guidelines The first is that the public sector should not be involved in fields in which the private sector can expect to conduct R & D and gain economic benefit from it in the shorter term. The primary aim of public sector research organisations should be the conduct of longer term, basic research and research for the benefit of the community as a whole, such as that directed towards understanding the environment and the dynamics of our society. It is essential that, in the current emphasis on the commercialisation of R & D, the need to continue basic research and maintain the national capacity to do so is not overlooked.

3. The second guideline is that priorities for spending on research should be determined in the light of criteria selected to obtain maximum benefit for the nation. The criteria should include consideration of the wider public interest as well as possible economic returns. A method of applying such criteria for priority setting has been developmed by CSIRO and is being applied by a variety of organisations, in-house and within and across disciplines. It is a valuable approach and should be further developed and widely used in priority setting exercises.

4. For both these guidelines to be effectively used, information must be available to the decision makers. Much of the necessary information is lacking and several of the Committee's recommendations are directed towards ensuring that it is collected and accessible to those who need it.

Maintaining the National Capacity for R & D

5. For Australia to maintain its research effort at the highest international standard, the prime prerequisite is the availability of the appropriate infrastructure in the form of the necessary accommodation, equipment and staff. Funds to maintain research equipment and buildings and acquire new ones have been insufficient in recent years. Furthermore, the supply of future research staff is in question. Recommendations for more funds for capital works have been made, as have recommendations directed at the education system to ensure an adequate supply of appropriately skilled researchers and research managers. The latter relies, not only on the provision of training by universities for which they must be adequately staffed, but also on attracting very able students to study science and science-related subjects. Attracting able students to science will follow from raising the profile of science, and that depends in part on conveying the excitement, personal rewards and national benefit that R & D can deliver.

Commercialisation

6. The successful commercialisation of R & D depends on, among other factors, a closer linkage between the researcher and the market to which his work will be delivered eventually. One way in which this can be done is to involve industry at an early stage of R & D, a fact that has been increasingly recognised as being essential. The various mechanisms that exist for channelling research to industry include establishing companies, partnerships and joint ventures, using licensing agreements and patents, and employing brokers. A strengthening of these arrangements can be expected from the recent establishment of the Australian Technology Group. However, there is great concern at the lack of expertise in Australia in the marketing of R & D and this requires urgent redress.

7. Three further issues are of significance in relation to the commercialisation of public sector research. The first covers the need to be aware of the costs of commercialisation when public sector research organisations are charged with commercialising their work and to provide for these needs to be met. The second issue is that of ensuring that a reasonable rate of return is obtained from the Government's investment of public funds in R & D. Thirdly, what charges should be made for research contracted from public sector organisations by outside bodies? The Committee favours passing on the full cost of carrying out such work for the private sector but recognises that, other government bodies may be unable to meet these costs, unless provided with additional finds. A good case exists for such public interest projects being carried out without full cost recovery.

Planning and Review Processes

8. The planning mechanisms at the national, sectoral and organisational levels are of critical importance. Not only do the guidelines by which they operate require attention, as indicated above, the planning bodies must take account of as many points of view as possible and seek to coordinate the activities of the groups with which they are concerned. Some of the Committee's recommendations address these issues.

9. Regular review of any organisation is beneficial; it ensures that the organisation's work remains relevant and the organisation continues to operate with maximal efficiency as circumstances change. The Committee promotes the use of regular reviews at all levels of the national research effort.

The Major Public Sector Research Organisations

10. Five research organisations were examined in detail by the Committee: CSIRO, the Defence Science and Technology Organisation, the Australian Nuclear Science and Technology Organisation, the Australian Institute of Marine Science, the Office of the Supervising Scientist and the Bureau of Mineral Resources.

11. A number of common themes emerged from these organisations' evidence to the Committee. The shortage of funds for capital works and staffing difficulties were mentioned above and are the subject of recommendations. The efficiency dividend, imposed across the public sector on administrative expenses, has also been applied to research activities, which appears not entirely appropriate. Annual and even triennial funding does not provide an adequate framework for the planning and prosecution of very long term research projects, and should be extended. A concern to those organisations charged with raising a proportion of their funds from external sources was the impact of this task on their scientists' time and the organisations' ability to maintain their core research capacities and programs. The Committee's views of the appropriate balance between commercially driven and core research are given above, and are supported by its recommendations for increased funding for long term research.

12. Additional recommendations were also made with respect to:

- research into radioactive waste management, the provision of a nuclear waste repository and the regular inspection of ANSTO's nuclear reactors by independent observers;

- levying the tourist industry to help finance environmental research; and
- widening the responsibilities of the Supervising Scientist in relation to the provision of advice, information and expertise.

RECOMMENDATIONS

The Committee has made a number of recommendations which are listed below, cross-referenced to their locations in the text.

The Committee recommends that:

Setting National Research Priorities

1. The Government review on a regular basis the effectiveness of the mechanisms for establishing national research directions for Science and Technology White Papers. (paragraph 4.34)

2. The Commonwealth and State Governments take action to implement the options for improving intergovernmental coordination suggested by the Australian Science and Technology Council in its report, Research and Technology: Future Directions. (paragraph 4.40)

3. The Government give consideration to extending the membership of the Coordination Committee on Science and Technology to include high-level state and territory representation. (paragraph 4.40)

4. The Government take immediate action to facilitate the development of comprehensive, consolidated databases on various aspects of the Commonwealth-funded public sector R & D effort, including:

   - research that is planned, completed or in progress within the universities and research agencies;
   - public sector research expertise that is available to industry or other organisations interested in collaboration;
   - publicly produced knowledge that could be, but has not yet been exploited for commercial gain;
   - the level of contracting out of public sector research requirements to industry; and

- publicly performed research that has, or is being, funded by industry. (paragraph 4.64)

5. The Department of Industry, Technology and Commerce and the Department of Primary Industries and Energy consider means of coordinating the regular and systematic collection, synthesis and dissemination of detailed and comprehensive information on:

   - the characteristics of all sectors of Australian industry;
   - the nature and extent of private sector innovation and R & D investment; and
   - *the barriers to innovation faced by Australian firms. (paragraph 4.70)*

6. The Department of Industry, Technology and Commerce act immediately to establish a mechanism for the dissemination of information on international science and technology developments to Australian industry. (paragraph 4.75)

7. The Australian Technology Group synthesise and provide information on an ongoing basis on:

   - publicly performed Australian research;
   - international science and technology developments; and
   - commercial opportunities within domestic and international markets. (paragraph 4.89)

8. Funding for an initial three-year period be provided to the Academy of Science to enable the establishment of the Australian Science and Technology Information Service. (paragraph 4.102)

Infrastructure for R & D: People, Accommodation and Equipment

9. The Government review on an ongoing basis the salaries paid to public sector researchers, teaching academics and school teachers working in science and science-related areas, with a view to establishing more appropriate relativities for the salaries paid to these professionals vis-a-vis those paid in the wider community. (paragraph 5.33)

10. The Government regularly monitor the universities' needs for capital funding and, using a formalised priority-setting process, plan to meet these needs. (paragraph 5.40)

11. The Government monitor the level of funding per Effective Full Time Student Unit such that the increase in the number of university places is matched by appropriate improvements to university infrastructure, bearing in mind the greater funding needs of science and science-related university places. (paragraph 5.40)

12. The number of science research fellowships and postgraduate research awards be progressively increased to a level where supply equates more closely with evolving demand in Australia and overseas. (paragraph 5.44)

13. The Government evaluate the contribution of the 1% training levy to improving the skills needed by Australian firms for the successful performance of R & D and its commercialisation. (paragraph 5.52)

14. Appropriation funding for research organisations be responsive to shifts in the level of industry demand for short term research support from these organisations, but continue to maintain sufficient resources to support core research programs at all times. (paragraph 5.68)

15. As a general principle, the full cost of carrying out research should be recovered from the user or from research grants obtained from funding bodies. (paragraph 6.17)

16. The Government provide sufficient funds to research agencies through Appropriation Acts No. 1 and No. 3 to cover the costs of smaller equipment and maintenance purchases and the direct costs of core research programs. (paragraph 6.21)

17 The Department of Industry, Technology and Commerce further investigate means of regularly collecting and publishing information on the involvement of Australian research agencies, higher education institutions and private sector organisations in research collaboration and exchange with overseas organisations. (paragraph 6.29)

18. The Australian Science and Technology Council continue to use and refine its approach to prioritising national needs for large scale research facilities. (paragraph 6.35)

19. A regular review of such facilities be undertaken, as proposed by the Australian Science and Technology Council (paragraph 6.35).

Performance and Funding of R & D by the Private and Public Sectors

20. The Government ensure that funding levels and mechanisms do not compromise the capacity of Commonwealth research agencies to conduct the core research which is necessary to the achievement of their respective missions. (paragraph 7.34)

21. Research agencies be required to continually monitor private sector capabilities in relevant research areas, and actively explore the possibilities of subcontracting work to private sector agencies. (paragraph 7.39)

22. Research agencies be provided with sufficient resources to enable them to carry out these functions. (paragraph 7.39)

23. The Australian Bureau of Statistics collect and regularly publish sufficient information on research contracts let to private industries by government agencies to allow regular monitoring of the extent of this practice. (paragraph 7.41)

24. The Government review the effects of commercial pricing by research agencies on the capacity of users to access and apply that research. (paragraph 7.47)

25. Sufficient appropriation funding be provided to government departments and agencies to enable them to meet the cost of contracting good quality research. (paragraph 7.47)

26. The Government carefully monitor the level of economic, commercial and scientific representation within research funding agencies to ensure that an appropriate balance between these different forms of expertise is maintained. (paragraph 7.57)

27. The Government consider extending the use of the attractiveness/feasibility model developed by CSIRO in the development of national research priorities. (paragraph 7.61)

28. Other Commonwealth research agencies evaluate the appropriateness of the attractiveness/feasibility model for use in the internal assessment of priorities for the expenditure of untied research funds. (paragraph 7.61)

High Priority Public Interest Research: the Environment, Industrial Needs and Social Research

29. Further steps be taken by the Government to finance and coordinate sufficient long term baseline research and monitoring to enable the assessment of environmental change. (paragraph 8.23)

30. The Government take action to redress the reduction in funding for long term basic research in taxonomy, entomology and soil science. (paragraph 8.27)

31. The Government provide further support for the development and coordination of Commonwealth and national environmental research priorities. (paragraph 8.40)

32. The Government support a research training program to ensure an adequate supply of highly qualified environmental researchers, in accordance with Recommendation 2 of ASTEC's report, Environmental Research in Australia: the Issues. (paragraph 8.44)

33. The Australian Bureau of Statistics regularly collect data on the nature and extent of private sector environmental research, and publish detailed breakdowns of publicly and privately performed environmental research. (paragraph 8.59)

34. The Government address the potential of user pays mechanisms in the area of environmental management in order to achieve a better allocation of public and private resources in the field of environmental research. (paragraph 8 62)

35. The Government urgently review the effects of the 30% external funding requirement on the capacity of those organisations affected to best serve the needs of Australian industry and to maintain relevant basic research expertise. (paragraph 8.83)

36. The Government review:

- which particular rural industries should receive public R & D funding support on the basis of public good grounds; and

- whether or not the levy mechanism is the most rational means of providing support where support is deemed necessary. (paragraph 8.91)

37. The efficiency and effectiveness of the organisational, administrative and funding arrangements of the R & D Corporations be reviewed on a regular basis. (paragraph 8.100)

38. The Government take action:

- to identify the national needs for social science research, including humanities research and research into the social impact of technology;

- to improve the coordination of social research; and

- to ensure the adequacy of funding for social research. (paragraph 8.111)

Research Management

39. The recent organisational and funding changes to Commonwealth research agencies be allowed to stabilise before any further major changes are considered by the Government. (paragraph 9.13)

40. The Minister for Employment, Education and Training urgently consult with the Australian Education Council, the Centre for Research Policy and other relevant bodies as to the most appropriate means of increasing the supply of dedicated research management training in Australia. (paragraph 9.21)

41. The Bureau of Industry Economics, the Bureau of Rural Resources and the Australian Bureau of Agricultural and Resource Economics receive increased funding for any additional research work required of them by the Government. (paragraph 9.36)

Commercialisation

42. The Government foster the acceptance of an agreed definition of commercialisation. (paragraph 10.12)

43. The goals and objectives of major research organisations, which have received a government directive to generate a portion of their funding from non-appropriation sources, include reference to commercialisation within their goals and objectives. (paragraph 10.26)

44. The commercialisation objectives of research organisations performing R & D be included in their management plans. (paragraph 10.28)

45. Research organisations involved in commercialising their research:

   . consider the optimal profile of skill sets required in carrying the results of research from the laboratory to the market place; and

   . recruit and retain such skill sets. (paragraph 10.31)

46. Research organisations involve commercial partners with resources to successfully commercialise the results of R & D at an early stage of the R & D. (paragraph 10.39)

47. In the context of establishing national research priorities, the Government:

   . define the appropriate balance between the support provided for R & D by the private sector and that given by the Government for the applied, strategic and basic research necessary to advance the knowledge base of the nation and its long term economic welfare; and

   . ensure that this balance is reached and maintained. (paragraph 10.42)

48. The performance of the Australian Technology Group be monitored and consideration be given to utilising more effectively the expertise of the Industrial Research Development Board.

49. Research organisations assess the full costs of commercialisation and, when commercialising their research, ensure that a reasonable rate of return is obtained on the Government's investment. (paragraph 10.62)

50. Research organisations regularly review the systems and practices used to commercialise their research and give priority to introducing any improvements suggested by these reviews. (paragraph 10.66)

CSIRO

51. The research costs of government-funded R & D organisations, such as CSIRO, be exempt from the application of the efficiency dividend. (paragraph 11.40)

52. The Government give high priority to increasing the funding for CSIRO's longer term strategic research. (paragraph 11.46)

53. The funding period for decision making be extended beyond the present three-year funding mechanism. (paragraph 11.46)

54. In conjunction with other research institutions, the universities, the private sector and the Cooperative Research Centres, CSIRO develop a 10-year master plan to identify high priority strategic research which is essential to the national interest. (paragraph 11.46)

55. The Auditor-General follow up the audit of CSIRO's generation of funds from external sources. (paragraph 11.50)

56. Budget-funded research agencies obtain some contribution to overhead costs when performing research financed by other government organisations. (paragraph 11.54)

57. CSIRO assess the need to rationalise its location at 108 sites and 150 laboratories in terms of the economical, efficient and effective utilisation of its resources. (paragraph 11.65)

58. CSIRO develop a longer term capital replacement program in the light of the assessment. (paragraph 11.65)

59. Future annual reports of CSIRO provide information regarding rationalisation studies and the implementation of the 10 to 20-year building and refurbishment program. (paragraph 11.65)

Defence Science and Technology Organisation

60. The Defence Science and Technology Organisation review and update the policies and procedures which define the strategic and corporate planning process and the fit between its own plans and the Defence Five Year Plan. (paragraph 12.17)

61. The plans be updated on a yearly basis in the light of both performance against timed targets within those plans and factors external and internal to the organisation. (paragraph 12.17)

62. Adequate capital funding be provided for the accommodation and equipment needs of the Defence Science and Technology Organisation. (paragraph 12.28)

63. The Defence Science and Technology Organisation establish a mechanism whereby it can effectively establish its funding needs and attach priorities to these needs. (paragraph 12.33)

64. The Department of Defence monitor the adequacy of the funds allocated to the Defence Science and Technology Organisation in relation to its capacity to maintain its technological base and provide additional funds when they are needed. (paragraph 12.33)

65. The level of funding provided for the commercialisation of the Defence Science and Technology Organisation's research be monitored. (paragraph 12.46)

66. This funding be adjusted, in the light of cost-benefit analyses, to maximise the income from the Defence Science and Technology Organisation's commercial activities. (paragraph 12.46)

67. The Department of Defence, the Department of Finance and any other organisations, that are identified as delaying the commercialisation of the Defence Science and Technology Organisation's research, review their procedures with a view to streamlining them. (paragraph 12.50)

68. An independent review be carried out of the adequacy of the funds available to employ individuals with the best available skills for negotiating, establishing and managing the commercialisation arrangements of the Defence Science and Technology Organisation. (paragraph 12.54)

69. The Defence Science and Technology Organisation identify those areas where its expertise coincides with Australian industrial capability and defence requirements, and concentrate on these areas by:

- setting up an industry advisory group to devise industry development strategies for the Organisation's expertise; and
- forming long term alliances with companies. (paragraph 12.57)

70. Priority be given to making funds available for the establishment of the Industry Support Office at the Aeronautical Research Laboratory. (paragraph 12.64)

71. Publicly available reports of the work of the Defence Science and Technology Organisation be produced annually. (paragraph 12.67)

Australian Nuclear Science and Technology Organisation

72. Increased funding be provided to the Australian Nuclear Science and Technology Organisation to enable it to upgrade its facilities and purchase new equipment, particularly a new reactor. (paragraph 13.27)

73. The nuclear reactors and associated plant belonging to the Australian Nuclear Science and Technology Organisation be reviewed regularly by an appropriate, independent, overseas organisation. (paragraph 13.36)

74. The Government ensure that sufficient resources are provided for R & D on radioactive waste management and its commercialisation. (paragraph 13 44)

75. The Commonwealth take urgent action to select a site for and construct a safe and secure nuclear waste repository. (paragraph 13.48)

76. The Government coordinate arrangements with State and Territory Governments for improved annual reporting of radioactive waste holdings to a central authority. (paragraph 13.53)

Australian Institute of Marine Science

77. The Department of Industry, Technology and Commerce scrutinise the effectiveness of the existing mechanisms for providing advice on funding and research priorities for marine R & D. (paragraph 14.25)

78. Bearing in mind the recommendation of the McKinnon Review that an Australian Marine Industries and Sciences Council be established, the Department of Industry, Technology and Commerce consider whether new mechanisms are required to provide advice on funding and research priorities. (paragraph 14.25)

79. The Department of Industry, Technology and Commerce and the Heads of Marine Agencies develop effective processes to identify ways in which Australia's research capability in marine sciences and technology can be used, disseminated and marketed overseas, especially among semi-tropical nations. (paragraph 14.30)

80. Funds be provided to the Department of the Arts, Sport, the Environment and Territories to enable it to make grants to government organisations, which have responsibilities for environmental management and wish to commission research from the Australian Institute of Marine Science. (paragraph 14.43)

81. The Department of Industry, Technology and Commerce consider other ways, such as levies on the tourist industry, to finance research relating to environmental management and protection. (paragraph 14.43)

82. Additional funds be provided to the Australian Institute of Marine Science for research staff salaries and the purchase and maintenance of equipment to ensure that it remains a research centre of world class. (paragraph 14.49)

Office of the Supervising Scientist

83. The *Environment Protection (Alligator Rivers Region) Act 1987* be amended to allow the Minister to request advice from the Office of the Supervising Scientist about any mining operation in Australia. (paragraph 15.28)

84. Commonwealth and State Ministers discuss the best use of the expertise of the Office of the Supervising Scientist in relation to Australian mining operations. (paragraph 15.28)

85 The *Environment Protection (Alligator Rivers Region) Act 1987* be amended to allow the Office of the Supervising Scientist to undertake research in the general field of environmental monitoring and management, including contracting to carry out research or provide advice for other bodies. (paragraph 15.32)

86. All mining companies operating in the Alligator Rivers Region that benefit from the work of the Office of the Supervising Scientist be levied to help support that work. (paragraph 15.38)

87. Where substantial information is made available to other mining concerns, a charge should be made. (paragraph 15.38)

88. Funds be provided for the construction of permanent laboratory accommodation at Jabiru. (paragraph 15.43)

Bureau of Mineral Resources

89. The Department of Primary Industries and Energy allocate additional resources to the National Geoscience Database Program as a matter of high priority. (paragraph 16.21)

90. The Bureau of Mineral Resources review the 40-year timeframe for the completion of the Minerals and Petroleum Programs and identify the measures to be taken to decrease the long lead time. (paragraph 16.23)

91. The Government allocate additional resources to the Bureau of Mineral Resources to enable it to accelerate the collection and analysis of data needed for the Minerals and Petroleum Programs. (paragraph 16.23)

92. The Government accelerate the design and construction of the new building for the Bureau of Mineral Resources. (paragraph 16.25)

93. The Bureau of Mineral Resources restructure the form of its estimates so that the costs of research programs are separately appropriated in the annual Appropriation Acts and will not be aggregated as running costs. (paragraph 16.34)

94. The research costs of the Bureau of Mineral Resources' programs be exempt from the application of the efficiency dividend. (paragraph 16.34)

95. The Bureau of Mineral Resources' funding be based on the triennium principle similar to that approved for other government-funded research agencies. (paragraph 16.34)

ABBREVIATIONS

AAHL	Australian Animal Health Laboratories
ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
AGAL	Australian Government Analytical Laboratories
AIMS	Australian Institute of Marine Science
AIRDIS	Australian Industrial Research and Development Incentives Scheme
AIRG	Australian Industrial Research Group
AITC	Australian Industry and Technology Council
ANAO	Australian National Audit Office
ANSTO	Australian Nuclear Science and Technology Organisation
ANU	Australian National University
ARC	Australian Research Council
ARR	Alligator Rivers Region
ARRI	Alligator Rivers Research Institute
ASTEC	Australian Science and Technology Council
ASTIS	Australian Science and Technology Information Service
ATG	Australian Technology Group
AVCC	Australian Vice Chancellors' Committee
BHP	Broken Hill Proprietary Limited
BIE	Bureau of Industry Economics
BMR	Bureau of Mineral Resources, Geology and Geophysics
BRR	Bureau of Rural Resources
CCARR	Coordinating Committee for the Alligator Rivers Region
CEPA	Commonwealth Environment Protection Agency
CMIST	Committee for Marine Industry, Science and Technology
CRA	CRA
CRC	Cooperative Research Centre
CRDC	Commercial Research and Development Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DASET	Department of the Arts, Sport, the Environment and Territories
DASETT	Department of the Arts, Sport, the Environment, Tourism and Territories
DEET	Department of Employment, Education and Training
DITAC	Department of Industry, Technology and Commerce
DPIE	Department of Primary Industries and Energy
DSTO	Defence Science and Technology Organisation
EFSTU	Effective Full Time Student Unit
GBRMPA	Great Barrier Reef Marine Park Authority
GDP	Gross Domestic Product
GVP	Gross Value of Production
HOMA	Heads of Marine Agencies
IGAE	Intergovernmental Agreement on the Environment
IRDB	Industry Research and Development Board
JCPA	Joint Committee of Public Accounts
LWRRDC	Land and Water Resources Research and Development Corporation

MIC	Management and Investment Companies
NBEET	National Board of Employment, Education and Training
NPDP	National Procurement Development Program
NRIC	National Resource Information Centre
NSB	Nuclear Safety Bureau
NT	Northern Territory
NTCS	National Teaching Company Scheme
OECD	Organisation for Economic Cooperation and Development
OSS	Office of Supervising Scientist (for the Alligator Rivers Region)
R & D	Research and Development
RAAF	Royal Australian Air Force
TDP	Technology Development Program
UNESCO	United Nations Educational Scientific and Cultural Organisation

Chapter 1

INTRODUCTION

Australia has a record of failing to recognise the significance of discoveries in Australian laboratories. Witness our rejection of the "black box" flight recorder, computing and transistors in the 1950s which set us back 30 years in electronics.[1]

These are some well known horror stories of Australia's failure to grasp opportunities.

. *Computing - CSIRAC Mark 1 was the fourth or fifth largest stored memory in the world and the first outside the USA and Britain. We threw our advantage away: computers, it was decided, would have no economic importance for Australia.*

. ***Second-generation transistor*** *- CSIRO's work in the early 1950s was ahead of the Bell Laboratories. A Canberra inter-departmental committee decided that transistors would never replace the valve industry. But it did!*

. *Dr David Warren's* ***Black-box flight recorder*** *was contemptuously rejected by the Department of Civil Aviation and the RAAF.*[2]

Origins of the Inquiry

1.1 Although Australians have never been renowned for their entrepreneurial spirit, they should be proud of the talent for discovery and invention displayed through the years by many of their scientists and backyard inventors. To Australia's cost, however, the full potential contribution of our research capabilities to the nation's development has remained largely unappreciated and untapped.

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1. The Hon R J L Hawke, Prime Minister and the Hon B O Jones, Minister for Science, Customs, Small Business and Minister Assisting the Prime Minister on Science and Technology. Science and Technology for Australia, AGPS, Canberra, May 1989, p. 8.
2. B Jones. 'Becoming the Clever Country - Essential First Steps', Search, Vol. 22, No. 1, 1991, p. 3.

1.2 Nevertheless, since the mid 1980s, a number of developments have aroused an unprecedented level of political and public interest in the funding and conduct of research and development (R & D) in this country. The search for solutions to our current account deficit and public demands for better environmental management have both underlined the real urgency of many science and technology policy issues.

1.3 Although it is only recently that research has entered the mainstream of political debate, R & D has not, in the past, been totally ignored by policy makers. Successive Australian governments have attempted to increase the level of private sector investment in R & D - generally with little or no success. Marked increases since 1985, which have been tempered by the current recession, followed a decrease of 40% in real terms between 1973-74 and 1981-82.

1.4 From Federation, the Australian economy has been heavily dependent on the export of basic resources and agricultural commodities. Investment in R & D has always been low in comparison with the OECD nations, as has the adoption of innovative technology by Australian firms.

1.5 The cost of these investment patterns and the policies which have helped to shape them has become increasingly clear in the past two decades. The level and nature of competition, and patterns of international economic activity have been transformed by an explosion of technological advances. Relatively few Australian firms have managed to ride the wave: too few have been able to keep up with the rising levels of productivity and innovation that are setting the standard of competition in international markets. Furthermore, many of the fledgling Australian companies that had attempted to break into high technology markets were decimated by the October 1987 stock market crash.

1.6 Meanwhile, in the public sector, fiscal restraint necessitated by mounting national debt has focused greater attention on the savings which can be achieved through a more systematic evaluation of cost-effectiveness and efficiency in public expenditure. As a significant, if not major, component of Commonwealth budget outlays, Australia's public sector research effort has deservedly come under increasing scrutiny during this period.

1.7 A large number of reviews of various aspects of the national research effort were conducted by the Australian Science and Technology Council (ASTEC) and other bodies during the 1980s. In line with the thrust of government policy, these reviews considered, amongst other things, how to make public research institutions 'more conscious of and responsive to society's needs and aspirations' and increase the relevance of publicly performed research to national needs and aspirations.[3]

1.8 In its 1989 report The Core Capacity of Australian Science and Technology, ASTEC identified a number of scientific and technological factors which it considered to be 'necessary components of Australia's ability to achieve sustained economic growth'[4]:

- basic scientific research;
- strategic R & D;
- industrial research and experimental development;
- technological innovations;
- informed management of national responsibilities (such as health, national security, the environment and quality of life); and
- science as part of our culture.

1.9 The report went on to suggest that maximising the potential of these factors to contribute to economic growth and to the well-being of our society would require not only 'the production of a highly skilled workforce', but also the 'effective integration of scientific results and technology with economic developments and other natural responsibilities'.[5]

1.10 The findings of ASTEC's review were salutary: 'worrying deficiencies' in Australia's capacity to reap maximum benefits from science and technology endeavours were identified. Major areas of concern were funding levels and sources, the state of the national research infrastructure, and a number of other factors which were adversely affecting research productivity. The latter included a 'paucity of good research management practices' and a lack of focus in research priorities and organisation.[6]

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3. The Hon R J L Hawke and the Hon B O Jones, op. cit., p. 3.
4 ASTEC. The Core Capacity of Australian Science and Technology, AGPS, Canberra, April 1989, p. 1.
5. ASTEC, loc. cit.
6. ASTEC, loc. cit.

1.11 Two key themes which re-appeared in these reviews were that:

- the achievement of greater value for money would require an increased integration and concentration of the Australian public sector research effort; and

- although Australia can be proud of the achievements of its public sector researchers, there remains a need to harness the full potential contribution of publicly funded research towards the development of Australian industry.

1.12 These studies brought home the significance of the fact that in international terms, publicly funded research is being conducted in relative isolation from Australian industry. ASTEC, among others, advised that mechanisms were required to increase researcher/industry interaction and to encourage a greater transfer of technology to Australian industry. In response, the Government introduced major changes to research funding provisions.

1.13 The new measures included 'a carrot and stick' approach to funding. Positive and negative financial incentives were applied to those undertaking research with the aim of increasing the proportion of research funded through user pays mechanisms. The wider application of user pays principles was seen as one means of effecting a re-orientation of the activities of the universities and public sector research organisations towards 'the national goals of industrial development and economic restructuring'.[7]

1.14 The new funding arrangements were characterised by incentives to research organisations to attract more funds directly from industry, and by a greater emphasis on direct funding of research activities through a system of grants allocated on a competitive basis. They also involved cuts to untied recurrent appropriations for many tertiary institutions and research organisations - in particular, for the Commonwealth Scientific and Industrial Research Organisation (CSIRO). The new arrangements and the abolition of the Department of Science in 1987 were greeted with considerable hostility by sections of the science and tertiary education communities.

1.15 In response to an unprecedented level of debate on science, technology and industry policy, the Government issued a Science and Technology Policy Statement in May 1989. The May 1989 Statement was the first consolidation of science policy and conceded that research infrastructure was strained It identified

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7. ibid., p. 37.

a number of issues requiring prompt action, including the development of improved career and training structures for researchers and the building of industry and community awareness of science and technology issues.

1.16 Several new measures designed to improve advisory mechanisms for science and technology policy and to coordinate planning and practice were announced in the Statement. Among other things, the Government also announced extra funds for priority research, equipment upgrading and university research infrastructure.

1.17 Whilst the science community generally welcomed the new measures, significant areas of public debate remained, including:

- the impact of the new funding arrangements on the level of resources available for the conduct of various categories of research;

- the capacity of the public research institutions to fulfil the new, more commercial role required of them by the Commonwealth;

- the efficiency and cost-effectiveness of public sector research organisations; and

- the efficacy of the current organisation of the national research effort.

1.18 In response to these concerns, this Committee announced in September 1989 that it was commencing an Inquiry into Public Sector Research and Development. The aims of the Inquiry were twofold:

- to provide a non-partisan contribution to the debate over the value for money obtained from expenditure on public sector research organisations in recent years; and

- to follow up progress made by a number of major research organisations in the implementation of the recommendations of various external reviews of their operations, including several reports of the Auditor-General.

Conduct of the Inquiry

1.19 The Committee recognised that the funding and activities of the major research organisations must be assessed in the overall context of the national research effort. Nevertheless, it opted to focus its attention on the major research organisations and to exclude a detailed analysis of research performed within the tertiary education sector. The Committee also initially decided to exclude private sector investment in R & D from the terms of reference.

1.20 In response to advertisements in the national press and invitations to relevant government and non-government organisations, the Committee received 50 submissions to the Inquiry. Submissions were made by:

- individuals;
- all major research organisations;
- all relevant government departments and authorities; and
- industry, consumer and research associations.

1.21 Soon after submissions were received, the March 1990 federal election was announced. Consequently, the Committee was dissolved, in accordance with the *Public Accounts Committee Act 1951*. Following the reconstitution of the Committee after the election, a new Committee membership resolved to extend the terms of reference for the Inquiry.

1.22 In addition to public sector research, the Committee resolved that it would also review Commonwealth support for private sector investment in R & D and its commercialisation. The extension of the terms of reference for the Inquiry was prompted by a number of considerations.

1.23 First, the initial round of submissions to the Inquiry raised a number of important questions about the relationship between public sector research organisations and industry. As the preponderance of submissions was from government departments, scientists and public sector organisations, the Committee felt it necessary, in the interests of achieving a balanced assessment, to seek further input to the Inquiry from organisations and individuals with experience in relevant business areas.

1.24 More importantly, evidence provided in the first round of submissions highlighted the fact that, given current funding arrangements, the willingness and capacity of the private sector to invest in and successfully commercialise R & D now has a far greater influence on:

- the adequacy of research funding in general; and
- the return to the taxpayer from major research organisations.

The Committee therefore welcomed the recognition of the need 'to move away from too narrow a focus on public sector research' which appeared in the 1991-92 Science and Technology Budget Statement.[8]

1.25 The Committee re-advertised the Inquiry in the national press on 1 September 1990 and invited some 50 individuals, firms and organisations to provide submissions. Those individuals and organisations who had lodged a submission in response to the earlier advertisement of the Inquiry were specifically invited to take the opportunity to provide a second submission in order to update evidence already provided, or to comment on issues pertaining to the new terms of reference.

1.26 Following the re-advertisement of the Inquiry, many additional submissions were received from Commonwealth departments and research agencies which had lodged earlier submissions. However, the main body of evidence was received from a much broader range of organisations and individuals, including the following:

- individuals who were, or had been, involved in the management of venture capital companies;
- individuals with experience in the management of small, innovative start-up companies;
- representatives of Australia's few large private sector R & D performers, such as Broken Hill Proprietary Ltd (BHP) and CRA;
- firms and organisations providing commercialisation services to small companies;

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8. Science and Technology Budget Statement 1991-92, 1991-92 Budget Related Paper No. 6, AGPS, Canberra, p. 2.

- councils and boards involved in the administration of grant schemes and the selection of projects for assistance, such as the Industry Research and Development Board (IRDB) and the Australian Research Council (ARC);
- industry associations; and
- academics with teaching or research expertise in relevant areas, such as research management and business administration.

1.27 Eleven public hearings and inspections were conducted in various Australian capitals between August 1990 and May 1991. Appendix A lists the submissions to the Inquiry. Details of the dates and locations of public hearings, inspections, and informal discussions, along with the identity of the 84 witnesses to the Inquiry are at Appendix B. [A selected bibliography is at Appendix C].

Comments on Method

1.28 In the interests of facilitating international comparisons, and in line with the practice of the Australian Bureau of Statistics (ABS), the Committee has adopted the internationally accepted Organisation for Economic Cooperation and Development (OECD) definition of R & D for the Inquiry. That is:

> ... creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of new knowledge to devise new applications.[9]

According to this definition, the hallmark of R & D is that it seeks new knowledge, whether or not the aim is an immediate and specific practical application of that knowledge.

9. Evidence, p. S647.

1.29 Scientific advances and the complexity of modern research problems increasingly blur the dividing lines between different fields or types of research. It has been conventional to divide R & D activities into two broad categories of endeavour:

- applied research; and
- basic research (pure or strategic).

1.30 The ABS follows the OECD in using the term 'applied' research to refer to investigative work which 'is original work undertaken in order to acquire new knowledge with a specific application in mind ... either to determine possible uses for the findings of basic research or ... new methods or ways of achieving some specific and predetermined objective'.[10]

1.31 Basic research is also directed at the acquisition of new knowledge, but in this case the researcher sets out to investigate phenomena without a specific application in mind. Pure basic research is directed primarily at the advancement of knowledge. Strategic basic research 'is directed into specified broad areas in the expectation of useful discoveries' and 'provides the broad base of knowledge necessary for the solution of recognised practical problems'.[11] This Report does make some use of these semantic divisions, mainly because they form the basis of most statistics available on the domestic and international funding and performance of R & D.

1.32 Research can also be usefully considered in relation to the beneficiaries of its results. The distinction is made between research outputs which constitute 'public' as opposed to 'private goods'. Research outputs which constitute 'public goods' differ from these that are 'private goods' in so far as they benefit a much wider range of people than those who fund the research or buy the resulting products.

1.33 In conducting its Inquiry the Committee recognised that it did not have the resources to conduct a full and detailed evaluation of all issues relevant to public and private sector R & D in Australia. Selectivity was required if the review was to be practical and the results timely. Accordingly, this Report considers a

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10 I Castles. Research and Experimental Development All Sector Summary Australia 1988-89, ABS, Catalogue No. 8112.0, 1990, p. 25.

11. I Castles, loc. cit.

number of general issues relevant to the funding of publicly performed research, but does not make specific comment on all of the research organisations or all programs which directly or indirectly affect the innovation process.

1.34 Despite the need for selectivity, the Committee made a deliberate decision to cast the new terms of reference for the Inquiry in broad and general terms. Rather than making an ex-ante evaluation of which issues merited detailed consideration, the Committee first solicited general comment on the adequacy, cost-effectiveness and efficiency of Commonwealth support for private sector R & D investment. Issues of public concern raised in submissions then provided a starting point for more detailed examination.

1.35 Whilst submissions covered a very wide range of issues, the bulk of them dealt with similar areas of government policy. The Committee's decisions as to which programs to review were influenced by evidence received in submissions and at public hearings. However, throughout the Inquiry, the Committee has sought to keep a watching brief on the literature pertaining to a wide range of related issues in order to obtain a broader perspective on the evidence before it.

The Complexity of Variables Affecting Returns from Publicly Funded R & D

1.36 In recent years, the trend in public administration has been to use more regular and systematic evaluation of efficiency at an operational level and of cost-effectiveness at the program level. The Committee, which has long been an advocate of improved mechanisms of accountability, applauds this development.

1.37 Nevertheless, the Committee was surprised and concerned at the paucity of relevant data collected by Commonwealth departments with R & D-related policy responsibilities. The Research Committee of the IRDB has expressed similar concerns:

> There is very little detailed information available concerning R & D in Australia, especially with regard to the benefits of R & D to Australian companies and factors which determine its success. This is in spite of a great deal of broad, or anecdotal evidence, which is often either conflicting in nature or misleading in that its generality masks critical issues.[12]

12. Research Committee, IRDB, Industrial Research in Australia, Vol. 1, October 1990, p. 1.

1.38 The Committee views with concern the relatively small amount of attention that has been given by policy makers and evaluators to the analysis of the interactive effects of programs and policies. This applies in particular to the analysis of industry policy issues. There is some evidence that greater efforts in this direction might yield considerable savings to the taxpayer and greater success in achieving a number of policy objectives, including maximising the returns on research funding.

1.39 The 1991-92 Science and Technology Budget Statement stated that recent investigations commissioned by the Government into science and technology matters point to 'the need to understand how the science and technology system operates as whole in order to identify the real impediments to obtaining a more effective return on the nations investments in these areas.[13] The findings of this Inquiry certainly add support to this view but they also highlight the need for a widening of this focus. Specifically, broad policies in the area of microeconomic reform may be as crucial to maximising returns from investments in science and technology as modifications to the science and technology system itself.

1.40 It is axiomatic that one measure of the contribution being made to Australian development by public sector research organisations is the efficiency and cost-effectiveness of their performance against their broad corporate objectives. However, the extent of that contribution is also ultimately dependent on factors external to the organisations themselves, such as the effectiveness of the research training system, the efficacy of the national research priority setting process and the level of coordination between the various arms of the national research effort.

1.41 Likewise, the contribution made by these organisations to the development of industry cannot simply be measured by the level of profits or savings which have accrued to companies employing the results of public sector research. On the contrary, the contribution that can and has been made by public sector research to industry development is dependent on a wide range of variables affecting industry decision making and performance.

1.42 The Committee has not attempted to pronounce upon the relative importance of various fields of research, or on the precise levels of funding

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13. Science and Technology Budget Statement 1991-92, 1991-92 Budget Related Paper No. 6, AGPS, Canberra, p. 2.

appropriate to each research organisation or field of endeavour. This is a task better undertaken in other forums. Instead, the Committee has focussed its review on two more basic questions:

- how have recent changes to funding arrangements for Commonwealth research organisations affected their capacity to fulfil their missions; and

- what is the relationship between levels and forms of Commonwealth R & D and overall returns on the national R & D effort?

Structure of the Report

1.43 The Committee has organised this Report into two volumes. This volume reports on issues relevant to the first part of the Committee's reference for this Inquiry: public sector R & D. The second volume of this Report, which is to be presented to the Parliament later in 1992, will cover issues relevant to the second component of the Committee's reference: Commonwealth support for private sector R & D and its commercialisation.

1.44 The question of how to achieve value for money from research-related expenditure requires analysis at two levels. First, it is necessary to consider the research system itself - both its component parts and the way they operate as a whole. Secondly, there is the problem of applying research outputs in order to achieve maximum returns.

1.45 Chapters 2 and 3 of this Volume provide an outline of R & D activities in Australia and an introduction to some of the major issues which are explored in later chapters and in Volume 2.

1.46 Chapters 4 to 10 consider a number of broad issues which are of general relevance to:

- the adequacy of funding for public research and the national research infrastructure - skills, equipment and facilities; and

- the cost-effectiveness and efficiency of the Commonwealth research system.

1.47 The quality of the research system depends on many different variables. First, there is the effectiveness of the research policy-making process, an issue which has recently been the subject of a major review by ASTEC. Chapter 4 raises a number of pertinent issues which were addressed in submissions to the Inquiry, and comments on a number of recommendations made in ASTEC's recent report, Research and Technology: Future Directions.

1.48 Secondly, the research system must be underpinned by an adequate research infrastructure, comprising sufficient human resources, equipment and facilities. Chapters 5 and 6 raise a number of concerns about the state of the research infrastructure in Australia. Here the Committee pays particular attention to the need to maintain an adequate supply of trained researchers and to provide them with incentives to establish their careers in Australia. This issue is relevant not only to the future of the Commonwealth research system but to the capacity of the private sector to undertake more (and more profitable) research.

1.49 Chapters 7 and 8 consider a number of issues relevant to the funding of basic research and public good research. How do current funding arrangements affect the performance of these types of research? Will restricting public funds for basic and public good research save the taxpayer money in the long term?

1.50 Chapters 7 and 8 also address the crucial issue of accountability in the expenditure of Commonwealth funds on research. Here the Committee makes a number of recommendations regarding the collection and reporting of relevant information by Commonwealth research agencies. Accountability issues relevant to agencies responsible for policy administration and dispensing research moneys are further considered in Volume 2 of this Report.

1.51 Chapter 9 presents a number of general findings relating to the quality of research and resource management by Commonwealth research organisations. Chapter 10 considers the more specific question of how effectively the research organisations have responded to the Government's requirement that they become more commercially oriented. Some relevant questions are:

- what is the purpose of commercialisation?
- what can the research organisations themselves do to improve the rate of technology transfer?
- should the research organisations themselves act as brokers in the technology transfer process?

1.52 Finally, Chapters 11 to 16 of this Report build on the general findings reported in earlier chapters by identifying strengths and areas of concern specific to a number of the major research organisations selected for review in this Inquiry.

Chapter 2

R & D IN AUSTRALIA: FUNDING, PERFORMANCE AND ORGANISATION

Introduction

2.1 This chapter provides a summary of some of the essential characteristics of Australian R & D, and of recent trends in the funding, performance and organisation of the national research effort.

2.2 Specifically, this chapter sets out some basic data in relation to the following key variables:

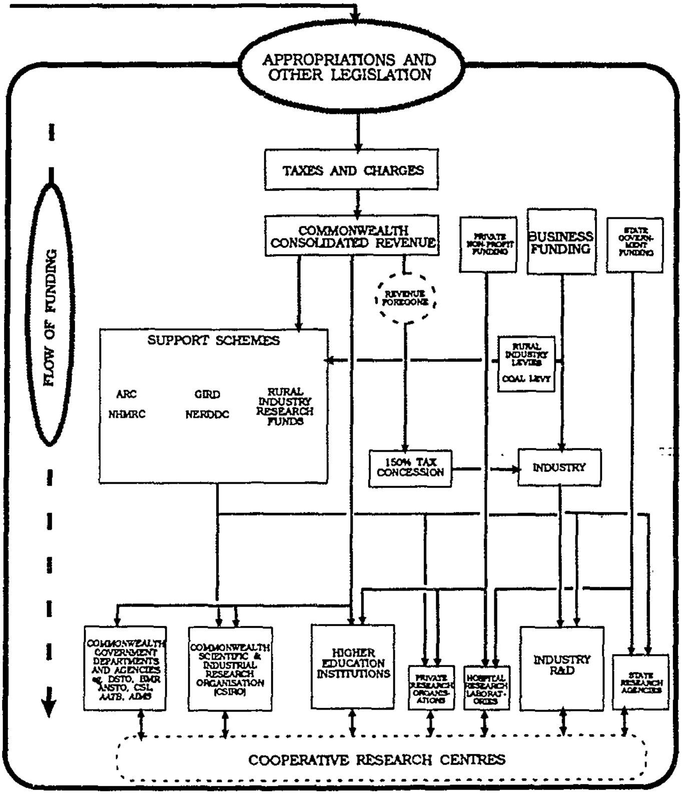
- aggregate expenditure on R & D;
- the funding and performance of various types and fields of research activity;
- Commonwealth R & D expenditure;
- State funding of R & D;
- private sector investment in R & D; and
- Commonwealth support for R & D.

Aggregate Expenditure on R & D

2.3 The major flows of funding support for R & D in Australia are shown in Figure 2.1. The funds originate largely from the taxpayer and private business, with the Commonwealth Government being the primary source Minor funding flows are not shown.

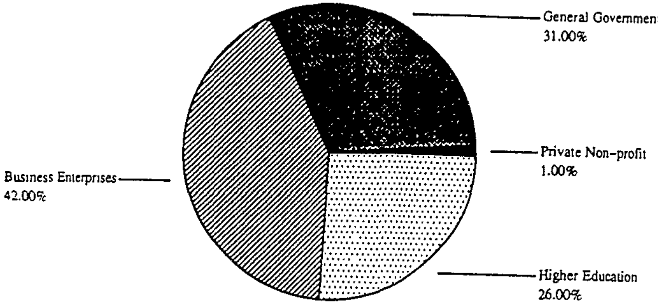
2.4 The latest published statistics on aggregate gross expenditure on R & D carried out in Australia reveal an estimated expenditure of $4,187m in 1988-89. This figure represents an increase of 34% since 1984-85, calculated at average 1984-85 prices. Figure 2.2 shows the percentage of the total $4,187m

Figure 2.1. Flow of Funding Support for R & D.



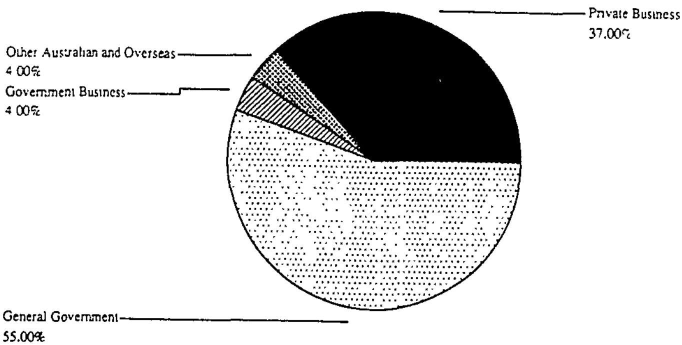
Source: DITAC Science and Technology Policy Branch. Australian Science and Innovation Resources Brief 1992, Measures of Science and Innovation 3, a Report in a Series on Australia's Research and Technology, and their Utilisation, AGPS, Canberra, 1992, p.31.

Figure 2.2. Gross Expenditure on R & D by Institutional Sector, 1988-89.



Source: I Castles <u>Research and Experimental Development All-Sector Summary Australia 1988-89</u>, Catalogue No. 8112.0, ABS, 1990.

Figure 2.3. Sources of R & D Funds, 1988-89.



Source: I Castles, loc. cit.

expended by each sector, which gives some indication of R & D performance by sector in that year. The percentage of total funds provided by major sources in 1988-89 is indicated in Figure 2.3.

2.5 The utility of international comparisons as a guide to desirable levels and patterns of R & D expenditure is open to question. The fact that Australia compares unfavourably with high R & D performers, such as Japan, tells very little about whether the level of funds and distribution of research is optimal for a nation with Australia's particular sources of competitive advantage and at Australia's stage of industrial and social development.

2.6 Comparisons of Australian R & D expenditure with that of wealthier nations do, however, lead to one general conclusion. Australia has relatively low levels of R & D investment by the private sector. In fact, the total spending of all Australian businesses on R & D approximates that of a medium-sized international company, such as Volvo. Therefore, as ASTEC has pointed out, 'the total level of performance of research and development in Australia as a proportion of gross domestic product is unusually low and there is a substantial dominance of government, both in funding and performance'.[1]

Funding and Performance by Type of Research Activity

2.7 Figures 2.4 and 2.5 illustrate the expenditure devoted to each type of research by main funding sources in 1986-87 and 1988-89. Details of R & D funding by major purpose and respective fields of science for the 1988-89 financial year are included as Figures 2.6 and 2.7. In 1985, ASTEC reported that 'Australia has a higher ratio of basic to applied research than most other OECD countries'.[2] Nevertheless, ASTEC did not advocate any reduction in the amount of basic research conducted; rather, it advocated policies to increase the performance of applied research for and by the private sector.

2.8 More recent trends have been largely in line with this recommendation. The private sector has substantially lifted its R & D investment and the bulk of that increase has been in applied research. Although it is not possible to estimate whether there are currently more basic research projects being conducted in the public sector than in previous years, there would not appear to have been any overall reduction in the level of funds provided. In the business sector, the percentage of total expenditure devoted to basic research has apparently

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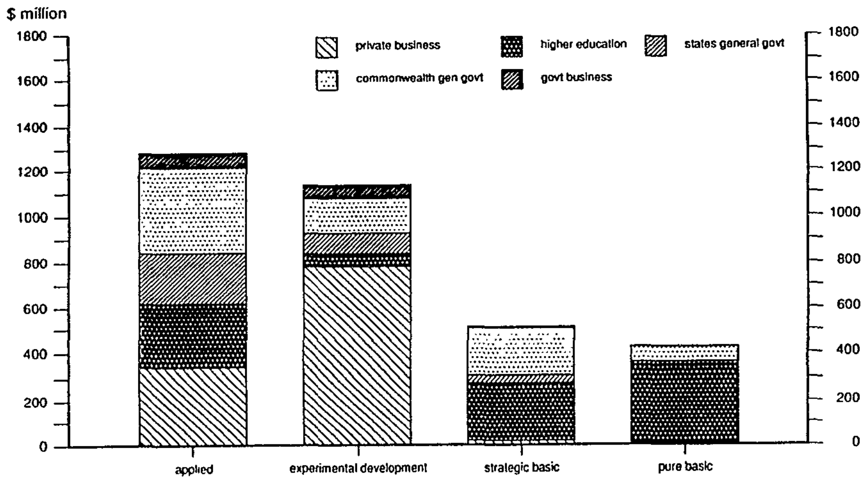
1. ASTEC. Public Investment in Research and Development in Australia, AGPS, Canberra, November 1985, p. 1.
2. ibid., p. 12.

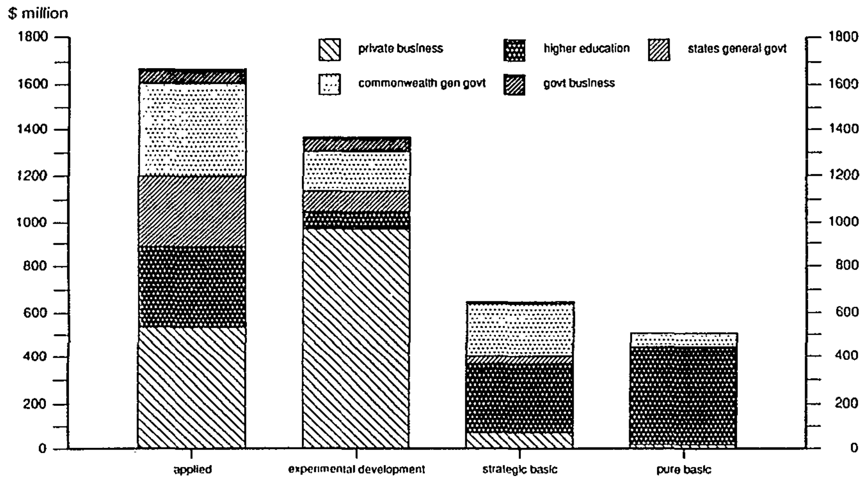
Figure 2.4. Gross Expenditure on Research by Sector, 1986-87.



For basic research, private business and government business expenditures are combined under private business.

Source: I Castles. <u>Research and Experimental Development All-Sector Summary Australia 1988-89</u>, Catalogue No. 8112.0, ABS, Canberra, 1990.

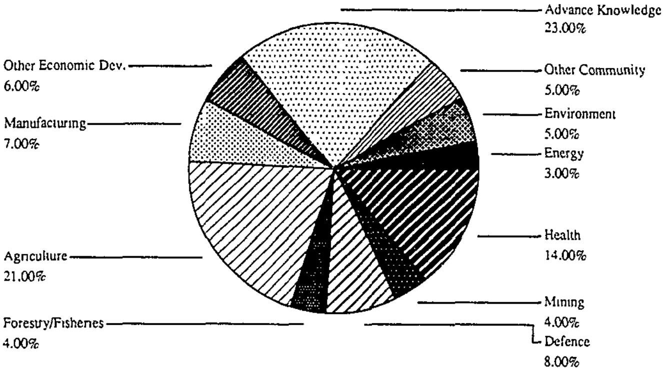
Figure 2.5. Gross Expenditure on Research by Sector, 1988-89.



For basic research, private business and government business expenditures are combined under private business.

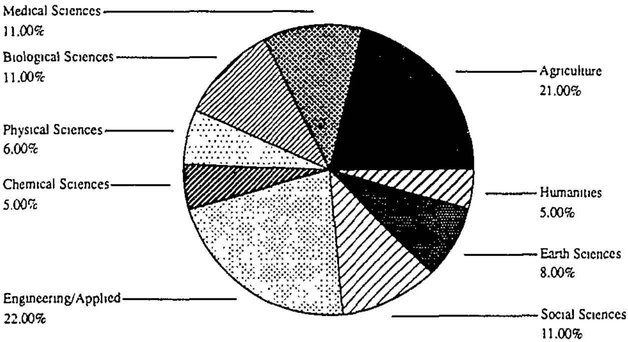
Source: I Castles. <u>Research and Experimental Development All-Sector Summary Australia 1988-89</u>, Catalogue No. 8112.0, ABS, Canberra, 1990.

Figure 2.6. Australian R & D Expenditure by Major Purpose, 1988-89, from a Total Expenditure of $2448.6m (excluding business enterprises)



Source· DITAC Science and Technology Resource Analysis Section, November 1990

Figure 2.7 R & D Expenditure by Major Field of Science, 1988-89, from a Total Expenditure of $2448.6m (excluding business enterprises)



Source: DITAC, loc.cit.

increased from 2% in 1986-87 to around 6% in 1989-90. In addition, the percentage of expenditure directed towards strategic basic research by Commonwealth research organisations research rose from 26% to 27% between 1986-87 and 1988-89. However, the States are directing a higher percentage of their R & D expenditure towards applied research, with a 6% increase to 69% recorded between 1986-87 and 1988-89.

Commonwealth Funding of R & D

2.9 The following section introduces some important features of Commonwealth R & D funding; it covers:

- aggregate trends in expenditure;
- the structure of the Commonwealth-funded R & D effort;
- trends in support for the various arms of the Commonwealth R & D effort; and
- the major fields of science and purposes for which funds are provided.

2.10 Table 2.1 provides a breakdown of Commonwealth expenditure on R & D (at constant prices) for the years 1980-81 to 1991-92. It should be noted at the outset that the analysis of figures provided by the ABS and the Department of Finance on R & D expenditures is complicated by a number of factors. To provide any clear indication of changes in the level of support for R & D activities, figures detailing trends in expenditures must be set against trends in the costs of conducting research. Although labour remains the major cost in research activities in both the public and private sectors, Australian scientists are still paid relatively poorly in international terms, despite recent award increases. However, fluctuations in non-labour costs must also be taken into account.

2.11 As has been pointed out elsewhere, the continuing evolution of scientific knowledge and methods of investigation has led to the use of ever more sophisticated techniques and expensive equipment.[3] Not only are the costs of scientific activity in most fields rising rapidly, but Australia currently imports most of its scientific equipment and materials. The general downward trend in the value

3. T Wicken and D Widdup. 'Five Years down the FASTS Track', Search Vol.21, No. 7, 1990, pp. 227-9.

Table 2.1. Summary of Major Commonwealth Support for Science and Innovation, Through the Budget and Other Measures ($m at constant 1984-85 prices)

	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	(est.) 1991-92
MAJOR SCIENTIFIC RESEARCH AGENCIES												
• Defence	133.4	158.5	157.0	155.2	158.4	155.1	159.5	151.5	155.9	157.5	152.2	143.5
• Civil	469.3	489.8	501.6	479.6	467.4	472.7	471.1	432.9	400.8	406.1	423.8	435.1
SUB-TOTAL	602.7	648.2	658.6	634.8	625.8	627.8	630.6	584.4	556.7	563.5	576.0	578.6
SCIENCE AND INNOVATION GRANTS												
• Health and Medical	28.6	36.0	39.2	47.9	52.0	51.9	55.3	55.3	56.8	61.7	71.2	79.2
• Industry and space	74.4	34.5	63.7	74.2	67.6	91.0	86.0	64.5	60.2	62.2	63.2	72.5
• Cooperative Research Centres	-	-	-	-	-	-	-	-	-	-	-	12.7
• Rural	29.7	30.8	31.1	36.9	41.4	44.8	55.5	44.0	54.2	57.4	55.1	68.0
• Energy and environment	10.6	14.5	17.0	18.5	16.7	13.5	12.4	9.1	8.7	12.9	16.1	15.4
• Transport	9.2	3.4	2.8	3.6	2.8	2.4	1.7	1.6	1.5	1.4	1.5	1.5
SUB-TOTAL	152.6	119.2	153.9	181.1	180.6	203.6	211.0	174.5	181.4	195.6	207.0	249.2
COSTS OF IR&D & RELATED INCENTIVES	-	-	-	-	20.0	155.1	176.5	196.1	167.2	176.2	178.2	162.2
HIGHER EDUCATION RESEARCH												
• ARC and related grant schemes	38.5	39.9	45.6	49.0	52.8	54.4	56.6	58.4	62.8	87.0	115.5	156.9
• Specific R&D support	107.7	106.8	106.3	110.1	112.0	110.3	109.6	108.6	105.5	104.9	103.8	103.8
• Est. general research support	349.7	356.8	350.7	349.2	418.0	443.9	487.0	494.3	475.5	458.0	442.1	441.3
SUB-TOTAL	495.9	503.5	502.6	508.3	582.8	608.6	653.1	661.3	643.8	649.9	661.4	702.0
TOTAL COMMONWEALTH SUPPORT AT ESTIMATED 84-85 PRICES	1251	1271	1315	1324	1409	1595	1671	1616	1549	1585	1623	1692
EST. REAL % INCREASE/DECREASE		1.6	3.5	0.7	6.4	13.2	4.8	-3.3	-4.2	2.3	2.4	4.3

Source: Science and Technology Budget Statement 1991-92, 1991-92 Budget Related Papers No. 6, AGPS, Canberra, p. 88.

of the Australian dollar over the past two decades has substantially increased the cost of purchasing scientific inputs.

2.12 Keeping these considerations in mind, aggregate figures for total Commonwealth support show a significant constant dollar increase of 32 4% between 1979-80 and 1989-90. The major component of that growth has been expenditure on R & D grant programs and incentives for private sector R & D, which increased in real terms by 64.1% during the period.

2.13 In 1990-91 and 1991-92, total Commonwealth support for R & D rose in constant dollar terms by 2.4% and 4.3% respectively. In each of these years, the major growth areas have been higher education research and special purpose research grant schemes. In 1991-92, rural and health R & D received funding boosts, but the largest increase, of 12%, was for environmental research. Figure 2.8 shows the trends in funding for various components of Commonwealth support for R & D.

2.14 In international terms, an unusual feature of the organisation of the Australian research system has been the prominence of large Commonwealth research agencies which have received little or no funding from the private sector. These agencies conduct about a third of Australia's R & D effort, a large proportion of which is accounted for by the activities of CSIRO and the Defence Science and Technology Organisation (DSTO).

2.15 ASTEC has noted that Australia is particularly 'unusual in having one agency, CSIRO, performing so much of the country's total research and development'.[4] Nevertheless, the dominant trend in the organisation of publicly funded research in Australia is its increasing decentralisation. Public sector research is conducted in:

- 11 universities;
- other higher education institutions, such as Special Research Centres and Key Centres for Teaching and Research;
- 11 major research organisations; and
- within government departments.

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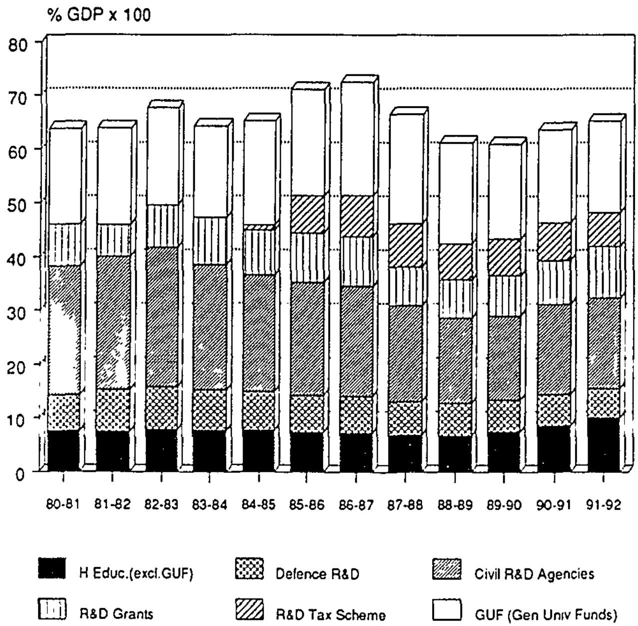
4 ASTEC Public Investment in Research and Development in Australia, AGPS, Canberra, November 1985, p. 12.

Figure 2.8. Major Commonwealth Support for Science and Innovation as a Percentage of GDP.



Source: Science and Technology Budget Statement 1991-92, 1991-92 Budget Related Paper No. 6, AGPS, Canberra, p. 93.

Furthermore, research in broad fields, such as agriculture or geophysics, is not concentrated in the one institution or organisation.

2.16 Research is funded through budget appropriations and through grant schemes, which are dispensed and administered by a broad spectrum of government departments and a large number of boards, councils and corporations. University research alone is funded by some 30 different bodies at the federal level.

2.17 These agencies are generally composed of members selected on the basis of their expertise and experience in relevant industries and fields of research, and some have representation from relevant Commonwealth departments. Appendix D lists major research grant schemes and funding bodies.

2.18 *Funding for R & D performed within higher education institutions*, excluding support from special purpose grant schemes, was estimated to increase to $1,005.5m in 1990-91, or a 1.6% real increase over the previous year. For 1991-92, total funds for university research have been estimated to rise by about 6%. Although overall support for research within this sector has increased significantly since 1979-80, until the late 1980s the number of university researchers had increased at a rate faster than the growth in funding.

2.19 Funding for university research is divided into several allocations:

- specific R & D support;
- an estimated research component of general university funds; and
- ARC and other grant schemes.

2.20 Australia has traditionally allocated a much greater proportion of university research funds via general appropriations than most OECD nations This has meant that the universities have had a relatively large say in the direction of their research endeavours.

2.21 However, the balance of funding for university research has changed radically in the past few years. The shift to funding a greater proportion of research by competitive mechanisms, as recommended by ASTEC, reflects overseas trends. One consequence of this new policy direction has been an enormous increase in funds controlled by the ARC since 1989-90. Funds provided to the ARC in 1990-91 were double those provided in 1989-90 and a further real increase of 37% to $241 8m was estimated for 1991-92.

2.22 The 11 member Council, which forms part of the National Board of Employment, Education and Training (NBEET), has numerous responsibilities which include dispensing research grant moneys, postgraduate awards, and funds for the Special Research Centres and Key Centres for Teaching and Research. These Centres were established in 1988, in line with recommendations made by ASTEC concerning the need to concentrate scarce resources on the development of excellence in a reduced number of fields. They were initially funded with some $5m which was redirected from general recurrent grants to universities for teaching and research in that year.

2.23 Table 2.2 lists the major research agencies, the portfolios to which they report and recent budget outlays. It shows the relative size of appropriations directed towards Commonwealth research agencies between 1980-81 and 1991-92 Although in real terms overall funding for the major agencies has stayed at the same level for the past three years, there has been a shift in the balance between funds for civil and defence R & D. In the last two financial years, for which figures are available, funding for defence R & D has fallen by 10% in real terms.

2.24 Current government policy has been directed towards providing incentives to both the business community and the research organisations to collaborate more closely. A major plank of this approach has been the wider application of the user pays principle to research funding, a change which is designed to give potential users a greater opportunity to determine research directions within these organisations.

2.25 Direct budget funding of major Commonwealth research agencies has declined accordingly - by 1.4% in real terms since 1979-80. Cuts to appropriations provided to the major research agencies have not been even. CSIRO, as the largest of the research agencies, has been particularly hard hit with decreases of some $27m, in real terms, to funds provided through Appropriation Acts No. 1 and No 3 between 1983-84 and 1989-90.

2.26 At the same time, research agencies have been encouraged to compete more actively for a share of the expanded pool of grant moneys controlled by a plethora of granting bodies. It should be noted, for example, that since the initial cuts to CSIRO's appropriations, there has been a fairly steady increase in its external sources of income.

Table 2.2. Budget Outlays on Major Commonwealth Research Agencies ($m).

						Outlays						(est.)
	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
ARTS, SPORT, THE ENVIRONMENT, TOURISM & TERRITORIES												
Antarctic Division	22.8	21.6	32.0	35.2	37.4	42.2	47.4	49.2	46.3	57.7	62.8	68.2
Bureau of Meteorology Research Centre (BMRC)[1]	0.9	1.2	1.7	1.7	1.8	1.8	2.3	2.5	2.2	2.4	2.8	2.9
Supervising Scientist Alligator Rivers Research Inst	3.1	4.1	6.1	4.6	4.8	5.5	6.1	6.0	6.6	7.5	6.7	7.2
DEFENCE												
Defence Science and Technology Organisation	95.4	126.1	138.8	146.6	158.4	165.9	183.4	187.0	209.8	225.2	227.2	221.1
EMPLOYMENT, EDUCATION & TRAINING												
Anglo-Aust Telescope	1.5	1.7	1.9	1.8	1.8	1.9	2.0	2.4	2.5	2.7	2.9	3.0
HEALTH, HOUSING & COMMUNITY SERVICES												
Australian Inst. of Health (excl. grants)	2.8	3.0	3.4	4.0	4.6	5.1	5.2	3.4	4.2	4.4	4.2	4.9
Commonwealth Serum Labs (Budget component)	3.7	4.9	6.3	6.6	8.8	12.8	15.8	17.3	16.6	9.4	3.0	2.9
INDUSTRY, TECHNOLOGY & COMMERCE												
Aust Nuclear Science & Technology Organisation[2]	33.0	37.8	36.4	38.8	41.9	45.4	45.2	50.8	54.3	57.5	62.6	64.9
Australian Institute of Marine Science	5.2	5.7	6.4	6.9	7.4	7.6	8.2	9.5	11.0	11.4	13.6	14.2
CSIRO[2]	247.1	290.9	328.2	331.6	324.9	344.3	367.8	347.8	348.1	375.2	414.4	440.7
Kraft Pulp Mill study (CSIRO)	-	-	-	-	-	-	-	-	-	0.5	1.4	1.9
PRIMARY INDUSTRIES & ENERGY												
Contribution to CSIRO for Aust Animal Health Labs	-	-	-	-	3.9	4.1	4.4	4.7	4.7	4.9	5.3	5.5
Bureau of Mineral Resources[3]	15.4	18.9	21.1	22.0	30.1	35.2	37.4	40.6	42.9	47.0	52.9	54.2
TOTAL	430.9	516.0	582.2	599.9	625.8	671.7	725.2	721.2	749.3	805.8	859.9	891.7

(1) BMRC was established on 1 January 1985. Prior data are estimated R&D expenditures by the Bureau of Meteorology.
(2) CSIRO and ANSTO figures for 1980-81 were adjusted to include superannuation on the same basis as in subsequent years.
(3) From 1989-90, property operating expenses (principally rent) of about $3m per annum are deducted to reflect expenditure on the same basis over the series.

Source: Science and Technology Budget Statement 1991-92, 1991-92 Budget Related Paper No. 6, AGPS, Canberra, p. 94.

2.27 CSIRO, ANSTO and the Australian Institute of Marine Science (AIMS) have been set the target of obtaining 30% of their annual budgets from external sources. ANSTO achieved this target in 1990-91, and CSIRO expects to meet it during the 1991-92 financial year. AIMS has until 1995-96 to reach this level of external funding.

2.28 In addition to these 'big ticket' agencies and numerous smaller ones which conduct experimental field research, the Commonwealth also funds a host of small agencies to conduct social science research in a wide variety of policy areas.

2.29 Three independent social science research bureaux make a particularly important contribution to government R & D policy and industry decision making. They are:

- the Bureau of Rural Resources (BRR);
- the Australian Bureau of Agricultural and Resource Economics (ABARE); and
- the Bureau of Industry Economics (BIE).

The BRR collects and analyses scientific and technical information across the whole spectrum of rural industries, whilst the ABARE and BIE provide economic analyses of a wide range of issues of relevance to the development of Australian industry.

State Funding of R & D

2.30 In 1988-89, State Government agencies spent some $453m on R & D, which represents almost 11% of the national research effort and a real increase, in dollar terms, of 9% over 1987-88. Some 60% of all State Government funding for R & D is directed towards agriculture, and the bulk of this amount is spent on applied research of relevance to the needs of specific businesses. Health, forestry and fisheries are other major areas of expenditure. ASTEC has also noted that the States fund a larger share of medical and social science research than the Commonwealth.[5]

2.31 In recent decades, State Governments of all political complexions have made attempts to fortify their regional science and technology bases as a means to

5. ASTEC. Research and Technology: Future Directions, AGPS, Canberra, September, 1991, p. 103.

strengthening their industrial bases.[6] However, these activities have not, for the most part, been closely integrated with federal government programs. Although there is some funding provided by the Commonwealth to the States for R & D, most Commonwealth and State research activities are managed separately, forming distinct spheres of activity.

2.32 The major exception is in the provision of extension services to manufacturing and service firms, an activity which is the joint responsibility of the States and the Commonwealth through the National Industry Extension Service.

Private Sector Investment in R & D

2.33 Currently, almost half of all private sector R & D spending is accounted for by 62 of our larger business enterprises, most of which are members of the Australian Industrial Research Group (AIRG). Figure 2.9, provided by AIRG, gives an indication of trends in R & D expenditure by these companies in recent years.

2.34 In 1987, ASTEC estimated that some two-thirds of all industrial R & D in OECD countries was conducted by companies employing more than 10,000 staff[7]. The major performers of industrial R & D in Australia are, however, small by international standards. Whilst a small number of companies amount for the majority of R & D investment, the vast majority of firms conducting R & D still have under 500 staff.

2.35 In 1989-90, 52% of R & D was performed by the manufacturing sector. The largest and fastest growing area of business R & D expenditure is computer software, which currently accounts for about 21% of total business R & D expenditure. Other leading areas are motor vehicles and parts, at around 9% of the total, telecommunications and radio, at around 8.5%, and metal products, chemicals, petroleum and coal products.

2.36 From its nadir in 1981-82, business expenditure on R & D had risen by 140% in constant dollar terms by 1987-88. The overall level of growth slowed significantly to 5% in constant dollar terms in that year, but rose again by 16% in

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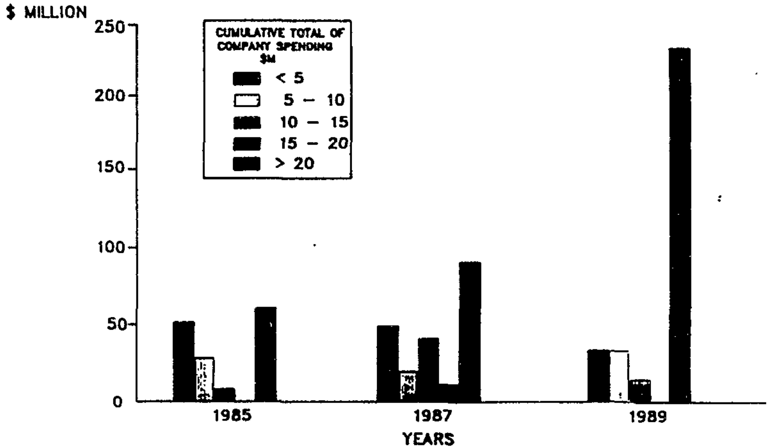
6 ASTEC. The Core Capacity of Australian Science and Technology, AGPS, Canberra, April 1989, p. 17.

7 ASTEC Improving Australia's Competitiveness Through Industrial Research and Development, AGPS, Canberra, September 1987, p. 33.

Figure 2.9. Distribution of R & D Expenditure by AIRG Members, 1985-89.



Source: AIRG, evidence, p. 566.

1988-89.[8] The average annual growth rate for business funding of R & D was 15.2% between 1981 and 1989, and 14% for business performance over the same period.[9] However, the latest recession has had a major impact on R & D investment; 1989-90 showed a marked slowing, with a slight fall from $1,218m in 1988-89 to $1,204m.[10]

2.37 Nevertheless, the increases of the past decade must be placed in perspective. The increases in business expenditure on R & D shown in Figure 2.10 have only restored the level of private sector investment in R & D to the level of the late 1960s.

2.38 Furthermore, some small percentage of the increases shown in the figures for the years immediately following the introduction of the 150% tax concession in July 1985 may have reflected changes in the way firms classified staff and activities, rather than real increases in R & D activity[11]. Finally, the figures will in part reflect increases in the cost of R & D - including the increased cost of buying the services of public sector researchers following the introduction of more commercial practices in major research organisations.

2.39 During the 1970s, firms in many OECD countries responded to the general downturn in the investment climate by increasing R & D expenditures In Australia, however, there was a dramatic decline in private sector R & D investment. Private sector expenditure on R & D as a percentage of Gross Domestic Product (GDP) and as a proportion of aggregate R & D expenditure remains low in international terms. This is partly a reflection of an industrial structure which is skewed towards low to medium technology industries and characterised by high levels of foreign ownership in R & D intensive industries.

2.40 There are, however, strong disparities between levels of spending in different enterprise sectors, and some sectors now compare reasonably well in international terms. For example, in recent years, R & D investment in the low and medium R & D intensive sectors of manufacturing has been comparable with that of a number of small and medium OECD economies. On the other hand, investment in the high R & D intensive manufacturing sector is still relatively low.

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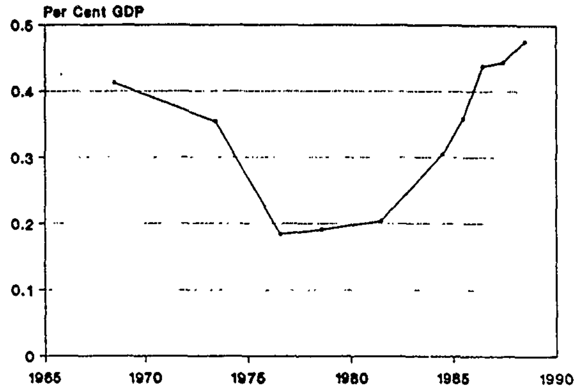
8 I Castles Research and Experimental Development Business Enterprises (Inter Year Survey) Australia, 1989-90, Catalogue No. 8114.0, ABS, Canberra, 1991.

9 DITAC. Australian Science and Innovation Resources Brief 1992, AGPS, Canberra, 1992, p. 12.

10. Castles, loc. cit.

11 ASTEC. Improving Australia's Competitiveness Through Industrial Research and Development, AGPS, Canberra, September 1987, p. 52.

Figure 2.10. **Business Expenditure on R & D by the Private Sector in Australia as a percentage of GDP, 1965-90.**



Source: IRDB. 1989-90 Annual Report, p.13, based on ABS data.

2.41 Overall, however, the total level of expenditure on R & D by the private sector has apparently increased spectacularly in the past decade DITAC has claimed that during the 1980s, the rate of increase in R & D expenditure by Australian business was one of the highest in the whole OECD area.

2.42 As noted by AIRG, a study commissioned by DITAC in 1985 showed that business R & D in Australia is concentrated in industries which, like most sectors of manufacturing, have historically had high or moderate tariff protection.[12] Recent commitments by the Government to further reductions in tariff protection may, therefore, have the short term effect of reducing or slowing the growth of the private sector R & D effort.

2.43 As a consequence of the increasing costs of R & D, the current international trend is towards increasing collaboration in pre-competitive R & D by separate corporations. Yet another feature of the Australian business sector R & D

12. Evidence, p. S553.

effort is the relatively small percentage of total R & D investment that is made in such collaborative ventures. AIRG suggests that this is a consequence of the relatively small size of most Australian companies and the relatively high interest rates which have prevailed in this country in recent times.[13]

2.44 Furthermore, data collected since 1981-82 by the BIE and the ABS would suggest that the proportion of business-funded R & D performed under contract by public sector research organisations has increased faster than the level of business R & D spending as a whole.[14] However, there are variations; figures supplied by AIRG suggest that its members expanded the level of R & D activity contracted to non-government organisations between 1989 and 1990.

Support for Private Sector R & D

2.45 There are a great many policies which can be seen to affect the levels and direction of private sector R & D. More importantly, perhaps, there is an even greater range of policies and factors which can affect the level of returns accruing from that investment.

2.46 Prior to 1985, Australia provided minimal support for industrial R & D in comparison with most OECD nations. Support for manufacturing R & D has been particularly low. The increased support now directed at private sector investment in R & D is presented by the Department of Industry, Technology and Commerce (DITAC) as part of a wider package of measures designed to increase the level of innovation and international competitiveness in Australian firms. Innovation is seen as encapsulating both:

- the performance of R & D that results in inventions; and
- the successful commercialisation of these innovative products and services.

Primary and Energy Industries

2.47 Until recently, the Commonwealth has had no funding scheme for private sector R & D in the minerals industry. The industry has its own association -

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13. Evidence, p. S554.
14 ASTEC. The Core Capacity of Australian Science and Technology, AGPS, Canberra, April 1989, p. 71.

the Australian Minerals Industries Research Association - which coordinates the considerable R & D expenditure of private companies in this sector. However, the Government has provided support to this research effort through the 150% tax concession and through the minerals-related research conducted by higher education institutions and Commonwealth research agencies, such as the Bureau of Mineral Resources, Geology and Geophysics (BMR) and CSIRO. In a new initiative announced in November 1991, the Commonwealth and Queensland Governments are providing a repayable grant to CSIRO to enter a consortium with three companies to develop low-cost technology for magnesium production.

2.48 To encourage R & D in the various rural and energy industries, the Government combines a system of industry levies with the provision of funds on a matching basis. Until recently, these funds have been administered by various R & D Councils. A joint statement by the then Minister for Primary Industries, the Hon J C Kerin, MP, and the then Minister for Resources, the Hon P F S Cook, MP, in May 1989, entitled Research, Innovation and Competitiveness, announced, among other things, the establishment of a series of R & D Corporations to replace Councils covering industries relevant to portfolio interests. The new Corporations have been charged with increasing the efficiency and effectiveness of R & D efforts in their industries and encouraging greater industry contributions.

2.49 The Department of Finance suggested in its second submission to the Inquiry that the real value of Commonwealth expenditure on rural research increased by 41.3% between 1987-88 and 1990-91.[15] This increase reflects a corresponding rise in private sector funding of R & D in these industries. Information on recent and projected funding for rural R & D Corporations, which was provided by the Department of Finance, is shown in Table 2.3.

Manufacturing and Service Industries

2.50 Within the broad range of policies of relevance to the innovation process, the major programs which are directed specifically towards the performance of R & D itself are the responsibility of the Minister for Industry, Technology and Commerce Day-to-day responsibility for the coordination and administration of these programs lies with the IRDB which is serviced by a secretariat located within DITAC.

2.51 DITAC's submissions to the Inquiry indicated that the package of programs relevant to the goal of increasing innovation and competitiveness include a range of grant and non-grant support programs. Some of these programs are

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15. Evidence, p. S1283.

Table 2.3. a. Commonwealth Funding for Rural R & D Corporations ($m at constant 1984-85 prices)

Corporation	1987-88	1988-89	1989-90	1990-91(Est.)
Meat and Livestock	6.95	8.85	9.66	9.64
Wheat	6.84	5.51	6.62	8.03
Wool	9.80	16.10	14.53	11.43
Others (includes Fishing)	14.53	17.52	20.81	24.64
Total	38.12	47.97	51.62	53.75

b. Future Projected Commonwealth Funding for Rural Research and Development Corporations ($m at constant prices)

Corporation	1991-92	1992-93	1993-94
Meat and Livestock	9.62	9.67	9.67
Wheat	7.92	9.20	9.20
Wool	9.60	13.14	12.51
Others (includes fishing)	27.59	30.46	31.26
Total	54.73	62.45	62.64

Source: Evidence, pp. S1282-3.

targeted at specific industries or specific types of R & D, and many of them are administered by the IRDB, which was established under the *Industry Research and Development Board Act 1986.* As defined in section 3 of the Act, the object of the Board is to promote the development of Australian industry and to improve its efficiency and international competitiveness by encouraging R & D activities.

2.52 The Board administers an Innovation Support Program which has the following elements:

- the 150% tax concession for R & D;
- the National Procurement Development Program (NPDP), which is designed to promote business growth through government purchasing;
- the National Teaching Company Scheme, which is intended to increase cooperation in research projects between public sector research bodies and industry;
- the Discretionary Grants Scheme, which assists companies that are unable to benefit adequately from the tax concession;
- the Advanced Manufacturing Technology Development Program, which funds collaboration between R & D companies and companies carrying R & D to the market place; and
- the Generic Technology Grants Scheme, which targets commercially driven R & D in fields that have been identified by the Board as having strategic importance to Australia's industrial involvement in biotechnology and technologies relating to the environment, communications, information systems, and manufacturing and materials.

2.53 The Government considers the tax concession, which was introduced in July 1985, to be the cornerstone of its commitment to increase private sector R & D.[16] The tax concession assists only those established companies that are making taxable profits. The Government's May 1989 Science and Technology Statement announced the continuation of the tax concession at a rate of 150% until 1993 and a phased reduction from that rate to 125% by 1995. Following intense lobbying, the March 1991 Industry Policy Statement, Building a Competitive Australia, announced that the concession would be retained as a permanent feature of the taxation system

16. Evidence, p. S1372.

at a level of 125% after 1993. The retention of the 125% deduction for the costs of research and development was confirmed in the Prime Minister's February 1992 One Nation Statement.

2.54 There are also a number of schemes administered by DITAC, which have been discontinued or continue in a modified form, namely:

- the Management and Investment Companies (MIC) Program, which aimed to 'kickstart' the venture capital industry in Australia and ran from 1984-91;
- the Australian Civil Offsets Programs, which included an R & D component and which ceased to undertake new activities after June 1991;
- the Partnerships for Development Program, which requires overseas companies doing business with the Commonwealth to increase their R & D expenditure in Australia; and
- the Science Innovation Program, a collection of sub-programs which provide grants to promote national competence in emerging areas of science and technology considered to be of strategic importance but finished in June 1991.

2.55 An additional funding mechanism is the repayable grant, such as that announced in November 1991 for CSIRO. Under the terms of this grant from the Commonwealth and Queensland Governments, CSIRO will form a research consortium with three companies to develop a low cost technology for the production of magnesium metal.

2.56 Table 2.4 shows the total expenditure in recent years on the range of programs designed to support R & D in manufacturing and service industries. The cost of administering these programs is significant, with DITAC alone spending some $4.6m in 1989-90 on the administration of three of the major programs - the 150% tax concession, the NPDP and Grants for Industrial Research and Development which include the Discretionary and Generic Technology Grants Scheme.

2.57 The estimated costs to revenue of the 150% tax concession and the MIC Program since their introduction are set out in Table 2.5.

2.58 Bearing in mind that estimates of revenue likely to be forgone in future years must be approached with some caution, DITAC estimated a cost to revenue for the tax concession in 1991-92 and 1992-93 in the order of $225m and $238m respectively. The cost of the extension beyond 1993 will be some $160m in 1996-97, rising to $280m by 2000-01.[17]

2.59 Support for private sector R & D is discussed further in Chapter 3 of this Volume and Volume 2 of the Report.

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17. B Hawke, Prime Minister, P Keating, Treasurer and J Button, Industry Minister. Building a Competitive Australia, AGPS, Canberra, March 1991, p. 4.4.

Table 2.4. **Commonwealth Outlays to Support Private Sector Investment in R & D ($m at constant 1984-85 prices)**

	R&D [a] GRANTS	BOUNTIES [b]	SIPS [c]	NPDP [c]	MJV [c]	TDP [c]
1980-81	71.0	19.0	-	-	-	-
1981-82	30.4	18.2	-	-	-	-
1982-83	59.7	16.0	-	-	-	-
1983-84	70.5	11.0	-	-	-	-
1984-85	66.4	14.7	0.2	-	-	-
1985-86	77.7	25.4	0.3	-	0.3	0.7
1986-87	62.6	26.2	0.3	-	0.3	1.0
1987-88	39.0	29.8	0.5	0.6	0.6	1.1
1988-89	32.4	34.6	0.4	2.9	0.9	0.8
1989-90	28.6	40.1	0.4	3.9	0.6	1.3
1990-91(est)	26.1	39.6	0.4	4.9	1.7	2.0

(a) Includes payments under the *Industrial Research and Development Incentives Act 1976*, the *Industrial Research and Development Act 1986* (Grants for Industrial Research and Development), the Motor Vehicle and Components Development Grants Scheme and the Australian Building Research Grants Scheme.

(b) Includes payments under the Computer Bounty and the Metal Working Machine Tools and Robots Bounty.

(c) SIPS - Science Innovation Program; NPDP - National Procurement Development Program; MJV - Malaria Joint Venture ; TDP - Technology Development Program.

Source: Evidence, p S1278, based on Science and Technology Budget Statement 1990-91, 1990-91 Budget Related Paper No. 7, AGPS, Canberra; Minister for Finance. 1990-91, Financial Statements, AGPS, Canberra, various years.

Table 2.5. **Revenue Forgone under the 50% Tax Concession and the Management and Investment Companies (MIC) Program ($m at constant 1984-85 prices)**

	150% Tax Concession	MIC Program
1984-85	-	20
1985-86	136	19
1986-87	148	17
1987-88	162	16
1988-89	122	5
1989-90	126	13
1990-91 (est)	232	22

Source: Evidence, p. S1277, based on Science and Technology Budget Statement 1990-91, 1991-92 Budget Related Paper No. 7, AGPS, Canberra.

Chapter 3

RETURNS TO AUSTRALIAN R & D INVESTMENTS

The Role of R & D in the Development of Australian Industry

3.1 The Government has stated that the development of Australian industry is a major objective of its research-related programs. In order to make even the most general assessments of the adequacy of funding for research to meet the Government's stated objective of developing Australian industry, two things must be clearly understood:

- some salient characteristics of the Australian economy; and
- the nature of the contribution R & D itself can make to the achievement of the goal of industrial development.

3.2 Numerous recent studies into the economic ramifications of technological change have considered specific aspects of this relationship in more detail than is possible in this Report. There are significant areas of convergence in the findings of these studies, many of which form the basis of an emerging consensus on the general conditions which will need to obtain if Australia's economic performance is to improve.

3.3 It is generally accepted that Australia's chronic foreign debt must be reduced if Australians are to retain control of their quality of life. Reducing debt will require not only judicious public expenditure decisions but a marked improvement in the capacity of Australian industry to increase national income. The bottom line is that more Australian firms must acquire the capacity to compete effectively against global competition in domestic and international markets.

Some Pertinent Characteristics of Australia's Economy

3.4 The achievement of this objective will require considerable change at the level of the firm and in the wider economic infrastructure. Australian industry has tended to specialise in the production of high volume, undifferentiated bulk commodities. It is clear that Australian industry must continue to build upon the advantage bestowed by the nation's rich natural resource base. Nevertheless, the development of an economy which is sufficiently robust to weather international economic trends into the 21st century will also require building on and extending to create other advantages.

3.5 In world terms, demand and trade in commodities markets is growing at a relatively slow rate. Opportunities for Australian firms to further increase their market shares for these goods and services certainly exist, and productivity levels in many sectors of agriculture and mining are comparable with world standards. However, the overall trend in the past few decades has been for commodity prices to fall relative to prices of the goods and services imported into Australia.

3.6 The high import bill has in large part been a consequence of the decline in the competitiveness of the Australian manufacturing sector during the same period. Despite improvements in the performance of some sectors of the manufacturing and service industries during the 1980s, Australian firms have been unable to take full advantage of opportunities to expand their industrial base into higher value, higher growth markets.

3.7 The decline in the competitiveness of many sectors of manufacturing has had negative multiplier effects throughout the economy. Established firms in a variety of industries which are reliant on manufactured inputs or machinery cannot source them at competitive prices from domestic suppliers and are therefore particularly vulnerable to shifts in the exchange rate.

3.8 Amongst the many reasons that can be cited for the generally poor performance of Australian manufacturing are structural impediments to competitiveness. These include factors such as:

- the distance from world markets;
- a lack of strong domestic demand;
- complaisant attitudes born of tariff protection and a lack of competitive pressures;
- low financial dynamism; and
- low productivity at the level of the economic infrastructure.

3.9 Low rates of productivity at the level of the firm, poor quality and undifferentiated products and an inward, short-term orientation on the part of management have also been contributing factors. Despite marked improvements by some firms, average productivity levels in service and manufacturing industries are still lagging behind those being achieved by overseas competitors.

3.10 Low productivity rates can be linked to labour market characteristics, such as high rates of absenteeism and labour turnover, but they also reflect the relatively low utilisation of new production and management technologies by Australian businesses. Although the last five years or so have seen an unusually high rate of adoption of technology strategies by Australian firms, recent increases in the use of such strategies have occurred mainly in large enterprises and in industries which are by their nature technology intensive.[1]

R & D in Australian Industries

3.11 At the level of the firm, successive studies have found strong correlations between rates of investment in R & D and productivity, penetration of new markets and rate of growth of turnover.[2] There is also considerable evidence to show that the adoption of appropriate 'technology strategies' confer considerable sources of competitive advantage on business enterprises.

3.12 However, the important message that appears again and again in the literature - including the IRDB's study of Australian firms - is that investment in R & D only improves profitability where it is complemented by high employee productivity and sound management of production, distribution and marketing. Likewise, the successful implementation of a technology strategy involves not simply the adoption of new technologies in production, but also complementary innovation at the managerial and organisational level.

3.13 Michael Porter's influential work, The Competitive Advantage of Nations provides a particularly compelling analysis of the role of innovation in increasing national wealth.[3] Porter's theories are based on a study of the determinants of competitive advantage in some 10 countries at different stages of economic development.

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1. The Centre for Technology and Social Change for DITAC, Technology Strategies in Australian Industry, AGPS, Canberra, 1990, p. 48.
2. The Centre for Technology and Social Change for DITAC, loc.cit.
3. M E Porter. The Competitive Advantage of Nations, Macmillan, London, 1990.

3.14 In terms of Porter's analysis, Australia is as yet a 'factor driven' economy, meaning that it still relies heavily on the advantages that its natural resources provide in the production of basic commodities. Furthermore, the technology used has been imported. The industrial structure is concentrated towards price and cost-sensitive market segments, with the result that national income remains very sensitive to world economic cycles and wage and other domestic factor costs.

3.15 Porter's theory suggests that sustainable increases in national income and living standards are most likely to be achieved if Australian firms can be encouraged to see survival in terms of continually upgrading their sources of competitive advantage. This means constantly seeking to improve productivity and to produce higher quality, higher value-added, or more innovative products. It means placing flexibility and cooperation at a premium, such that there is a will, at each level of the enterprise, to work together to overcome obstacles.

3.16 As DITAC suggests, the type of innovation necessary to increase competitiveness in various markets may be a matter of 'finding more effective ways of doing things' at the level of production. But as has been pointed out by the OECD the capacity to produce more efficiently - through the use of new technology, or as a result of microeconomic reform - will not guarantee international competitiveness. Increasingly, success relies on 'design capability, systems engineering and marketing networks ... and management information and control systems'.[4] Equally, and in order to take advantage of continually changing demand and supply conditions, competing successfully may require the capacity to produce new or different goods and services.

3.17 As a source of new or improved products or processes, R & D is clearly a crucial aspect of innovation. However, successful innovation requires more than a competitive mind-set and a willingness to invest in R & D or new technologies. Maximum returns from these investments only accrue if they are made in the light of full information as to market needs and trends, and if firms have access to the financial and human resources required to produce, distribute and market - that is commercialise - their innovative goods and services effectively.

Returns on R & D Investments

3.18 Research consistently has shown that the performance of R & D has a multiplier effect through the economy. Although the benefit accruing to the nation

4. D Ernst and D O'Connor. Technology and Global Competition: the Challenge for Newly Industrialising Economies, OECD, Paris, 1989, p. 23.

is not necessarily a function of the benefit accruing to the individual firm, the 'social return' on R & D, or return to the firm plus return to the economy, is generally of the order of 50%-100%.[5] However, the process of calculating likely returns on research, in order to make sensible investment decisions, and the business of maximising returns to research investments are complicated by a variety of factors. Two of these factors merit particular attention. The first is related to the nature of the research process itself. The second factor relates less to the intrinsic characteristics of the research process and more to the influence that external factors may have on the level of returns accruing from the research.

Opportunity Cost and the Budget Cycle

3.19 The level of risk involved in R & D projects is highly variable and risk and returns are difficult to calculate in advance. R & D is an intrinsically unpredictable process which can meet unforeseeable obstacles or produce serendipitous discoveries. Furthermore, the full commercial returns from successful projects may not become evident for decades after the initial investment is made. Therefore, Government decisions about research funding are often made in the absence of any reliable indication of the overall effects of decisions taken in previous years.

3.20 It is generally accepted that private firms tend to underinvest in certain types of research because they cannot appropriate all the benefits that accrue from the costs they incur. Furthermore, the opportunity cost of waiting for large investments to generate returns are often too high for firms that do not have an established stream of income from other business activities.

3.21 The same considerations can be expected to influence funding decisions at the level of government in times where there is considerable political and public pressure to employ fiscal restraint. This is particularly the case where, as in Australia, there are still relatively few votes to be gained from support for science. There is not a well-developed public awareness of the potential of science nor a cultural environment which promotes long term thinking. Under these circumstances, the budget cycle will to some extent inevitably favour the funding of research which will provide a visible and reasonable short term payoff, at the expense of research which may afford considerable savings to the taxpayer in later decades.

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5. The Centre for Technology and Social Change. 'The return on investment in R & D', in <u>Industrial Research in Australia, Volume 2</u>, (ed. Research Committee, IRDB), 1990, p. 5.

External Factors Affecting Returns

3.22 One basic message which recurs in the evidence before the Inquiry is that the level of returns on investments in R & D and returns on revenue forgone in the form of incentives to R & D are a function of a complex system of factors. The achievement of maximum value for money from Commonwealth R & D-related expenditures is certainly dependent on the adequacy of those expenditures and the efficiency or cost-effectiveness of R & D-related programs. But these are necessary rather than sufficient conditions.

3.23 The rate of return from these expenditures will depend on the extent to which the whole system of relevant factors - and policies - work in harmony. A weak link at any point in the system or lack of 'fit' between related policies will reduce potential returns.

3.24 In broad terms, some of the variables which may influence the ultimate level of returns from R & D-related expenditures are as follows:

- the domestic economic environment - factors affecting patterns of demand, supply and investment;
- the research infrastructure - factors affecting the quality and supply of researchers, equipment and facilities;
- information and communication - factors affecting the flow of information to decision makers in policy and research agencies, private firms and other organisations which are potential research users;
- the quality of management and organisation of the research effort; and
- the capacity of users to apply or commercialise research results to achieve maximum returns - in the form of profits, savings, or the realisation of social, environmental or other objectives.

3.25 Submissions to the Inquiry emphasised the roles of different parts of the system. There was, however, overwhelming agreement that weak links remain and that these weaknesses are reducing the potential returns from Australian research.

Major Impediments to Maximising Returns to R & D in Australia

3.26 There is no simple and direct relation between the quality of research and the level of returns to research investments. A great many mediocre inventions have been enormously profitable for overseas companies, in large part because they have been commercialised with great skill. On the other hand, the most ingenious of inventions will not achieve commercial success if there is no market for them, or if they are not produced efficiently and marketed well. This has been the fate of much intellectual property produced by Australian research.

3.27 Most of the available evidence suggests there is no lack of inventive talent in Australia. Although calls for particular research organisations to pay greater attention to market needs in selecting research projects may be justified, they are not a remedy for a more fundamental problem. This problem is that the supply of potentially profitable ideas or knowledge outstrips the supply of entrepreneurs ready to turn them into profits. In fact, the fundamental impediment to achieving maximum returns on Commonwealth research expenditures has been located at the level of turning good ideas into commercial successes. The social, commercial and marketing structures required to turn science into sales are not in place.

3.28 The vast majority of Australian firms are small. However, the size of an industrial enterprise does not necessarily hinder its success at innovation. Although larger, established firms frequently have a higher capacity to attract required finance and to spread the risks of R & D investment, small start-up firms can and do flourish in markets for innovative goods and services. Despite the world dominance of larger firms which compete fiercely for the leading edge in core technology and product areas, the process of technological change has, in practice, meant an increasing role for small firms in world trade and innovation.[6]

3.29 Nevertheless, Australian industry faces a number of structural barriers to success, some of which have been noted above. Clearly they have all played a part in reducing our competitiveness. However, this Report will focus on three broad classes of impediments:

- a hostile domestic economic environment, including high interest rates, a low supply of patient capital and expensive inputs;

6. The Centre for Technology and Social Change, Strategic Alliances in the Internationalisation of Australian Industry, AGPS, Canberra, 1990, p. 11.

- a lack of awareness of the changing needs and cultural characteristics of relevant markets, both on the part of researchers and business management; and

- relatively poor skills and experience in business, marketing and financial planning and management, and a lack of established international distribution networks.

3.30 From its analysis of the relative lack of success achieved by Australian firms in R & D-based ventures, the IRDB concluded that:

> ... many companies have looked at R & D as a stand alone activity, not requiring any consideration of the management, marketing and money issues that other investments would automatically involve. This is the fatal flaw ... [7]

Ingredients of Success

3.31 As a corollary, the characteristics of commercial success generally include a market-driven R & D process which is tailored to meet the specific needs of target markets. Therefore, research planners, be they within the private or the public sectors, must have access to full and continually up-dated information on market needs and scientific and technological developments. They must also establish early and effective means of communication with those who are likely to commercialise the research. In turn, research users must understand the ways and wants of those who are likely to purchase resulting goods and services.

3.32 The same considerations apply to those making decisions at other levels of the research system - that is, to those responsible for setting broad national research priorities and to those who are responsible for the quality and supply of trained researchers in various fields. Information, communication and forward planning are of paramount importance at all levels of the research system and innovation chain.

3.33 Access to sufficient finance and sound financial management are also crucial to commercial success. If development costs may be an order of magnitude

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7. Research Committee, IRDB. Industrial Research in Australia, Vol. 1, 1990, p. 6.

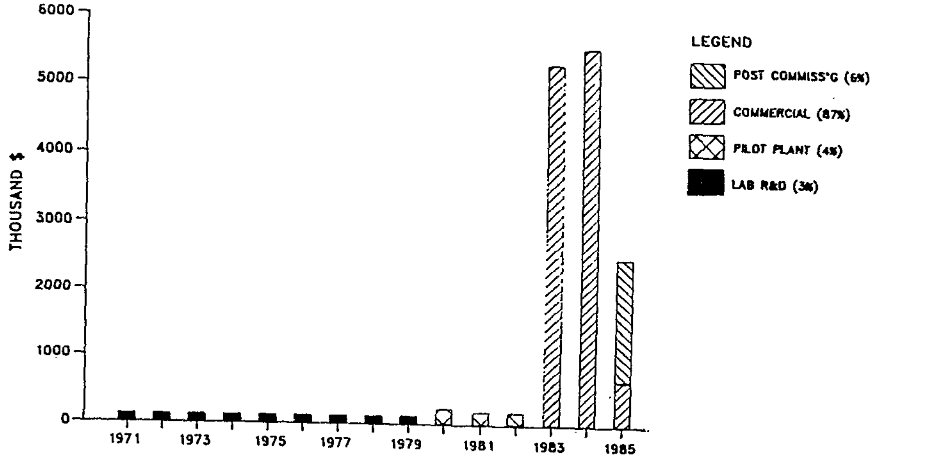
higher than research costs, the commercialisation phase of the innovation process is in turn vastly more expensive than the R & D phase. This ratio of research costs to commercialisation costs may be as high as 100:1, as illustrated in Figure 3.1.

3.34 Finally, commercial success relies on a strong 'product champion' and access to in-house or external expertise in business planning and management, commercial law, financial management and in marketing. A recent analysis of companies funded under the Australian Industrial Research and Development Incentives Scheme (AIRDIS) scheme also shows that experience in all aspects of innovation confers a considerable advantage on a small firm.[8] Likewise, at the level of the research organisation, it is only possible to manage resources so as to achieve the maximum returns from research activities if the organisational profile includes staff with relevant business-related skill-sets.

3.35 Therefore, the Committee considers that the adequacy of funds for R & D-related programs which are directed towards the objective of developing Australian industry must be assessed in the light of the availability of the market information, capital and skill-sets required to translate research results into commercial returns.

8. Research Committee, IRDB. Industrial Research in Australia, Vol. 1, 1990, p. 3.

Figure 3.1. *Figure showing the Cost of, and Time to, Commercialise a Recent Research Development, and illustrating the '1:10:100 Rule' - Research:Development:Commercialisation.*



Source: AIRG, evidence, p. 664.

Chapter 4

SETTING NATIONAL RESEARCH PRIORITIES

Introduction

4.1 On what basis, and by what means, should governments set priorities for the funding of research? This question has recently received considerable attention in Australia and a number of OECD nations.

4.2 The very act of funding one type of research in preference to another involves at least an implicit notion of priorities. In times of severe budgetary constraints and with an increasing awareness of research requirements and opportunities, the need to make hard choices about which types of research to fund necessitates a rigorous approach to making these choices. As has been argued by ASTEC, setting national research priorities is a question of approaching public research funding decisions in a systematic fashion.

4.3 Japan provides an example of a nation whose strong record of success at innovation appears to have been supported, rather than hindered, by its structured, long term, industry-led approach to R & D policy making. ASTEC's recent review of future research needs, which is discussed further in this Chapter, revealed that there is now widespread support for the institutionalisation of a similar type of approach to national research priority-setting in Australia. Although the particulars of the approaches favoured by those consulted by ASTEC differed in some respects, the Council found that in general terms, 'there is strong private and public sector support for developing more formal procedures for setting directions and priorities at the national level'.[1]

4.4 The Committee believes that three major facets of the national priority setting process deserve particular attention:

- the necessary pre-conditions for an effective, regular national priority-setting exercise;

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1. ASTEC. Research and Technology: Future Directions, AGPS, Canberra, September 1991, p. 35.

- the appropriate structural mechanisms for such an exercise; and

- the particular techniques needed to assess the relative merits of the multitude of research possibilities.

4.5 This Chapter focuses on the first two of these issues. In particular, the Committee adds its support to the view that the availability of sufficient information on which to make these choices is crucial to the efficacy of whatever national priority-setting mechanisms are employed. Furthermore, it will be argued in this Chapter that:

- the accessibility of information relevant to this process is also of great importance to private companies setting their own research agendas;

- government agencies have an essential function in the provision of this information to industry; and

- the collection and dissemination of information relevant to the priority-setting process has been inadequate and piecemeal in Australia to date, and must itself be accorded a very high priority if future public expenditure on research is to be more cost-effective and efficient.

4.6 Chapter 7 considers several aspects of the issue of techniques appropriate to the priority-setting process. Specifically, it examines the concept of market failure as it applies to R & D and particularly to basic or longer-term research. The Committee also comments in Chapter 7 on the use of cost-benefit analysis as a means of identifying the relative merit of particular types of research as candidates for public funding.

The Development of Science and Technology Policy in Australia

4.7 Until the late 1980s science funding and policy occupied a disturbingly low position on the Australian political agenda. In 1986, the OECD observed that science and technology appeared to be seen by Australians as 'in some sense external to national life'.[2] Funding for science, which accelerated with the establishment of many major science institutions in the post-Second World War period, has been

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2 OECD. Reviews of National Science and Technology Policy: Australia, OECD, Paris, 1986, p. 13.

conducted largely in the absence of a considered science and technology policy framework.

4.8 There can be no doubt that major research institutes, such as CSIRO, have made invaluable contributions to many aspects of national life. At the same time, there can be no question that, at the level of national policy, lack of vision and the ad hoc nature of decision making in the area of science and technology have been at great cost to Australia.

4.9 For much of the post-war period, the dominant stance of influential sections of the science community has been against political interference in the direction of research endeavours. This stance was backed in 1975 by a Science Task Force commissioned to conduct the first administrative review of science undertaken in Australia. The Task Force report called for the preservation of 'the CSIRO culture of unfettered science' and a pluralistic approach to decision making on science issues.[3]

4.10 Whilst the concept of 'unfettered science' was not strongly challenged in political circles until the 1980s, the need to strengthen mechanisms for the provision of advice on science-related decision making had gained some political recognition by the early 1970s. In 1972, the McMahon Government established the first Advisory Council on Science and Technology, the role of which was the provision to the Prime Minister of coordinated advice on relevant issues. The Whitlam Government, perceiving a need to connect science matters to a broad range of policy matters, set up a Department of Science and an Australian Science and Technology Council. But it was not until 1979 that ASTEC was established, as a statutory body with a broad mandate to provide independent advice to government on a wide range of policies and programs relevant to science and technology.

4.11 As noted in Chapter 1, a number of developments have combined to prompt greater political input into the research funding process in the past five years or so. The changes sparked a politicisation of the science community, many of whom have protested against cuts to untied research funds and a reduction of the influence of research practitioners in the allocation of resources to research.

4.12 In the context of increasing public debate on science and technology issues, the Government commissioned ASTEC to review the core capacity of

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3 A Moyal. <u>Science Policy and Technology Assessment: New Directions in Australia</u>, Policy Research Paper No. 3, Centre for International Research on Communication and Information Technologies, Policy Research Paper No. 3, 1990, p. 8.

Australian science and technology. The findings of the review, which was published in April 1989, noted that administrative changes following the July 1987 election had resulted in 'an increasing sectoralisation of science and technology functions across the larger mega-departments'.[4] The report argued that, despite an increasing focus within the Government and the bureaucracy on the need for coordination between departments, there remained a need for stronger mechanisms for coordinating policy and for setting research priorities.

4.13 In response, the Government's Science and Technology Statement of May 1989 announced new mechanisms for coordination designed to integrate sources of policy advice more closely to each other and to the wider policy-making framework. The new mechanisms were:

- the Prime Minister's Science Council;
- the Coordination Committee on Science and Technology; and
- the Office of the Chief Scientist.

The Statement also made it clear that one of the Government's major priorities was to redirect the attention of Commonwealth-funded researchers towards the achievement of a number of economic and environmental objectives.

4.14 The current flow of advice and responsibility for action in science and technology policy making is illustrated in Figure 4.1. The Figure indicates the major bodies and principal channels for the flow of policy advice that lead to Parliamentary and Cabinet decisions. There are also many other influential forces that are not shown, such as professional organisations and other non-government groups.

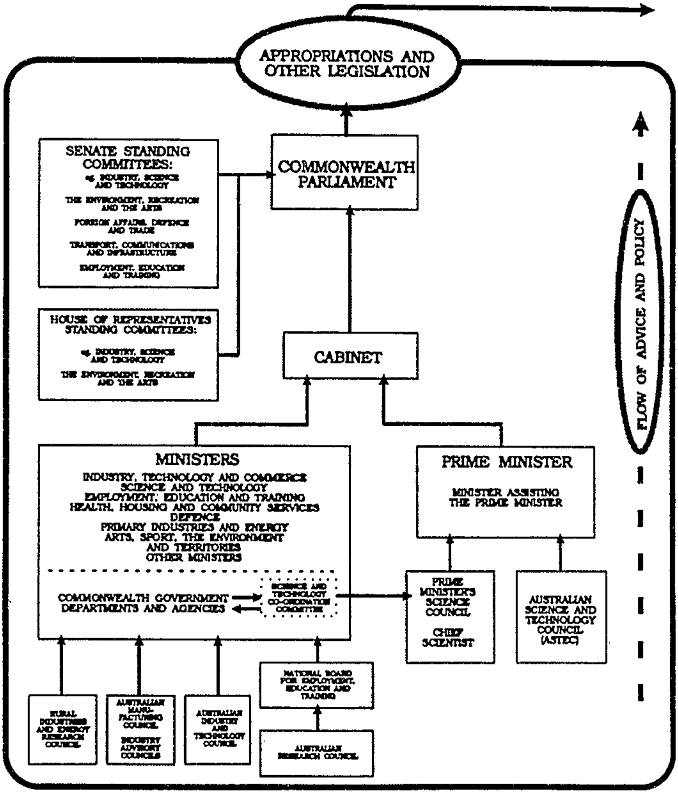
Advisory and Coordination Mechanisms

4.15 The Prime Minister's Science Council provides a conduit of information and advice to Cabinet. It comprises:

- the four departments which carry the bulk of responsibility for science and technology matters:

4. ASTEC. The Core Capacity of Australian Science and Technology, AGPS, Canberra, April 1989, p. 31.

Figure 4.1. Main Channels of Advice for Policy Formulation in Science and Technology.



Source: DITAC Science and Technology Policy Branch. Australian Science and Innovation Resources Brief 1992, Measures of Science and Innovation 3, a Report in a Series on Australia's Research and Technology, and their Utilisation, AGPS, Canberra, 1992, p. 30.

- Industry, Technology and Commerce (DITAC)
- Employment, Education and Training (DEET)
- Primary Industries and Energy (DPIE); and
- Health (through the participation of the structural adjustment ministerial group, which includes the present Minister for Health);

. other ministerial portfolios by invitation;

. the Chief Scientist, the Chairman of ASTEC and the Chairman of CSIRO;

. eight individual members with relevant industry, research or academic experience in science and technology matters; and

. a trade union representative.

4.16 The position of Chief Scientist is directly responsible to the Prime Minister. The Chief Scientist is a key member of the Science Council and chairs the Coordination Committee on Science and Technology. His role is to contribute to the planning process and to promote discussion of new ideas by ministers and the bureaucracy.

4.17 The direct link to Cabinet-level decision-making provided by the position of Chief Scientist and the Science Council is mirrored by the role of the permanent Coordination Committee on Science and Technology, which provides the link between the Science Council, the bureaucracy and the research agencies.

4.18 The Coordination Committee reports to the Science Council and feeds information back to relevant ministers. It plays a supporting role to the Science Council through the coordination of science and technology initiatives from relevant ministerial portfolios. Membership of the Committee includes senior officers of the operating departments, agencies and boards currently responsible for spending 95% of the total $2 billion allocated to science and technology by the Commonwealth Government.

4.19 There are many organisations which feed information and advice to the Science Council, the Coordination Committee and relevant ministers. At the departmental level, DITAC has the major responsibility for the provision of policy advice to the Minister for Science and Technology.

4.20 In addition, other Commonwealth departments with responsibility for the administration of various aspects of science and technology, such as DEET and DPIE, respond to regular requests from relevant Ministers to commission research into policy options and issues which are fed into the policy-making process. Furthermore, in line with the program evaluation policies introduced by the current Government, the research-related programs of all Commonwealth departments and agencies are now subject to major evaluations at least every five years.

4.21 In recent years a number of councils and committees have been set up to provide consultative interfaces between various science and technology bodies and facilitate coordination of policies for particular groups of industries. These include the Primary Industries and Energy Research Council, which was established in May 1989 to provide advice to the Minister on broad priorities, strategies and structures for R & D. This Council also represents the interests of the primary and energy industries in national forums on science and technology policies. Another such Council is the Consultative Group on Marine Industry Science and Technology. It meets twice a year and is designed to bring representatives of Australia's marine industries closer together with those research agencies conducting different types of marine research.

4.22 The principal interface between the Commonwealth and the States on science and technology matters is the Australian Industry and Technology Council (AITC), which was established in 1984. The Council meets once a year and provides a forum at which State and Commonwealth policies and responsibilities can be coordinated. It is supported by a Standing Committee comprising the chief executives of Commonwealth, State and Territory industry or technology departments and a secretariat located within DITAC. It also sets up ad hoc working groups to examine particular issues.

4.23 The objectives of the AITC are:

- to promote a national, consistent and coordinated approach to industry and technology policy and development; and

- to promote the restructuring and greater international competitiveness of Australian industry.

4.24 The focus of the AITC has been industry policy rather than science and technology; ASTEC is the body that currently has the major responsibility for conducting independent, longer-term analyses of science and technology policy issues.[5] Since 1978, ASTEC has produced over 60 reports which cover a broad range of specific and more general issues. ASTEC meets twice a year with State science and technology advisory bodies and responds to specific requests from the Prime Minister's Science Council to conduct research or to provide advice on particular issues. A review is currently being conducted into ASTEC's objectives, performance and outcomes, and can be expected to recommend improvements to its role.

4.25 However, beyond ASTEC, there are few independent centres of science policy research. The Centre for Technology and Social Change (TASC) was set up at Wollongong University and provided consultancy research to government and to some industry organisations. It conducted some important research, but had relatively few resources at its disposal. Much of its work has been taken over and expanded by the Australian Centre for Innovation and International Competitiveness (ACIIC) at Sydney University, where it is closely linked with the University's engineering and business centres.

4.26 The Committee notes, however, that the need for further research into science and technology policy has been recognised in recent times by the ARC, which awarded Special Research Centre funding for the establishment of a Centre for Research Policy at Wollongong University in 1991.

The 'White Paper' Process

4.27 In 1988, and in response to concern on the part of many of those who fund, perform and use research, the then Prime Minister, the Hon R J L Hawke, MP, commissioned a joint ASTEC/ARC review with the following terms of reference:

- to define the R & D environment in Australia, within which it may be desirable to set priorities for federal government expenditure;
- to assess the need for, and extent of, priority setting in Australian research and development;
- to review the theory and practice of priority setting for R & D in Australia and internationally; and

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5. J Stewart. 'Australia: Mapping the System', in National Purposes, Federal Government: Science and Technology in Australia, Canada and the Federal Republic of Germany, ASTEC, Canberra, November 1990, p. 25.

- to recommend means which will allow research priorities to be set, assessed, implemented and evaluated.[6]

4.28 Setting Directions for Australia, the report of the ASTEC/ARC review, recommended that a national direction-setting exercise should be conducted every four years. It suggested that ASTEC be given responsibility for a wide process of consultation with industry and government agencies and the production of an issues and options paper, based on the results of these consultations. Using this issues and options paper, the Coordination Committee on Science and Technology would prepare a White Paper setting national directions for research.

4.29 ASTEC conceived of 'national directions' as 'broad and coordinated government guidelines within which research and technology policies can be developed'[7] It suggested that new structures for decision making announced in the Government's 1989 Science and Technology Statement could provide the mechanism for implementation of the White Paper process and resulting policy guidelines.

4 30 Research and Technology: Future Directions, which was presented by ASTEC to the Prime Minister in September 1991, sets out a series of major issues and options which had emerged from ASTEC's consultations with government agencies and industry. Specifically, the report identified what were considered by parties to the consultation process as 'key structural weaknesses in the research and technology system, and areas of significant national need'.[8]

4.31 The next White Paper is due for release in August 1992 in conjunction with the Budget Research and Technology: Future Directions forms an important input to the White Paper, as does advice from the Coordination Committee on Science and Technology and the Prime Minister's Science Council. These bodies have identified four themes for the White Paper:

- innovation;
- awareness of the role and importance of science and technology;

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6. ASTEC. Setting Directions for Australian Research, AGPS, Canberra, June 1990, pp. xiv-xvi.
7. ASTEC. Research and Technology: Future Directions, AGPS, Canberra, September 1991 p. 32.
8. ibid., p. 33.

- skills; and
- infrastructure for research.[9]

4.32 The Committee believes that, in general terms, the process for priority setting suggested by ASTEC represents a significant improvement on former science and technology policy-making process. The Committee notes, however, that criticism has been levelled at Research and Technology: Future Directions for its failure to provide a comprehensive vision for Australia's R & D and well-evaluated options to guide policy and decision making. ASTEC's most recent report, Major National Research Facilities: A National Program, adopts a more definitive approach in assessing and recommending options, which the Committee applauds.[10]

4.33 The Committee believes that greater scrutiny of research opportunities and better coordination of the policies necessary to encourage their exploitation should help to increase the cost-effectiveness of the national research effort. Nevertheless, the priority-setting mechanisms and four-year time-frame proposed by ASTEC should be subject to regular review to assess whether they remain appropriate to changing Australian conditions. The review of ASTEC's objectives, performance and outcomes can be expected to consider this matter in some detail.

4.34 **The Committee recommends that:**

- **the Government review on a regular basis the effectiveness of the mechanisms for establishing national research directions for Science and Technology White Papers.**

4.35 In the remainder of this Chapter, the Committee draws on the evidence presented to it in the course of its Inquiry to identify issues related to the priority-setting process, and reports its conclusions.

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9. Evidence, p. S1840.
10. ASTEC. Major National Research Facilities: A National Program, AGPS, Canberra, March 1992.

The Need for Improved Commonwealth-State Coordination

4.36 A number of submissions to the Inquiry commented on the need for better coordination of State and Commonwealth policies of relevance to science and technology. ASTEC's recent review also highlighted this point: consultation with industry and state advisory bodies revealed that they were in favour of an increased role for the States and Territories in developing national research policies and in the administration of relevant programs.[11]

4.37 ASTEC concluded that:

> The States are where the bulk of the public sector research is performed ... but insufficient cooperation and policy coordination between the Commonwealth Government and the State Governments is leading to national policies and programs which commonly do not adequately reflect important regional dimensions.[12]

4.38 Two options were put forward by ASTEC as means of rectifying this situation. The first was that the Commonwealth Government could convene a Special Premiers' Conference to assist in the development of improved coordination of program administration and policy development. The second option was for the States to develop, and provide adequate resources for, state coordination arrangements compatible with those of the Commonwealth. Such arrangements would facilitate the development of a national approach to research and technology policy developments.

4.39 This Committee supports both of these options. However, it also takes the view that there would be merit in including high-level state and territory representation on the Coordination Committee on Science and Technology, perhaps at sub-committee level.

4.40 **The Committee recommends that:**

- **the Commonwealth and State Governments take action to implement the options for improving**

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11. ASTEC. Research and Technology: Future Directions AGPS, Canberra, September 1991, p. 35.
12. ibid., p. 104.

intergovernmental coordination suggested by the Australian Science and Technology Council in its report, Research and Technology: Future Directions; and

- **the Government give consideration to extending the membership of the Coordination Committee on Science and Technology to include high-level state and territory representation.**

Industry Input to the Priority-Setting Process

4.41 Several submissions to this Inquiry put forward the view that it is crucial that national research policy makers pay greater attention to the views and needs of private firms than has hitherto been the case. The majority of industry submissions to ASTEC's review of national research directions put forward similar arguments.

4.42 *The Committee is fully supportive of this view. As discussed in* Chapter 3 of this Report, the Committee believes that it is crucial that all the policies which directly or indirectly affect the level of returns from public research investments are clearly identified and harmonised. The Committee believes that the process of consultation with industry and other groups preceding the development of the White Paper should assist in this process.

4.43 There are several key bodies on which industry views are represented, for example:

- the IRDB is composed of people with recognised industry skills and experience;
- the Science Council and all of the councils and corporations funding research have members with strong industry experience;
- the AIRG is active in the promotion of its members' views;
- research agencies such as CSIRO are increasing their consultations with relevant business enterprises; and
- industry can now affect public sector research priorities more directly by providing funds directly for research projects or collaborative ventures.

4.44 Other means of influencing research priorities are now open to industry. An example of one of these is the Task Force on the Commercialisation of Research. The Task Force, which was established following the March 1991 Industry Policy Statement and reported in November, has provided an avenue for industry input to the White Paper process.

4.45 The Japanese research and technology priority-setting process, which is structured and has a long term focus, is heavily influenced by the long term priorities of major corporations. The Committee believes that this process is a desirable model for Australia to aim for in the future. However, its efficacy is in part a function of the maturity of Japanese corporations, their knowledge of innovation opportunities and their long term focus.

4.46 Australian firms are becoming increasingly aware of the need for long term strategic planning and the opportunities for market success through R & D However, some of the consultative mechanisms for the discussion of research directions and opportunities have not yet been fully utilised by certain sectors of Australian industry. As mentioned in Chapter 14, lack of interest by the private sector in the Committee for Marine Industry, Science and Technology (CMIST), provides one example.

4.47 The Committee believes that the Government should encourage more Australian firms to make an important contribution to the national research and technology priority-setting process by improving the level and accessibility of relevant information to such firms. With access to appropriate information on national and international science and technology developments and market opportunities, industry can provide valuable input to the processes of national priority setting and other disbursement of research funds by bodies such as R & D Corporations and the IRDB. Naturally, the accessibility of such information is also crucially important to firms in making their own investment decisions.

4.48 The debate over the appropriate focus for Commonwealth support for innovation, and for industry policy generally, has been polarised into arguments between two notional camps. In simplified terms, it would seem that one camp believes that the only legitimate role for government is to remove impediments to the operations of the 'market'. The other believes that removing such impediments is well and good but not enough: government must also recognise that freely operating 'markets' will not always produce results that are in the national interest

4.49 For the purposes of this Chapter, however, it is important to note that both camps have generally recognised that there is a legitimate role for government in reducing search costs to industry - particularly when, as in current Australian conditions, most of our companies are small and have difficulties obtaining sufficient start-up capital.

4.50 This issue will be treated in more depth in Volume 2 of this Report. Although the major focus of this volume is the funding, cost-effectiveness and efficiency of publicly performed R & D, the Committee considers that many of the steps that need to be taken by the Government to maximise returns from public investments in R & D are also relevant to the issue of improving the competitiveness of Australian firms.

4.51 In the following sections, the Committee sets out, in general terms, the types of information that it believes are required both to improve the quality of the priority-setting process and to increase the cost-effectiveness of publicly funded research. It also makes several suggestions as to the bodies which might be accorded responsibility for the collection and dissemination of that information.

The Need for Comprehensive, Accessible Information

4.52 During an informal discussion with several Committee members, Mr Bill Kricker, former Chairman of the IRDB, suggested that the little that was currently known in Australia about R & D and innovation generally amounted to 'motherhood statements'. The truth of this claim became increasingly apparent to the Committee as it went about collecting and analysing evidence before the Inquiry

4.53 The Committee believes that, in the short term at least, investments in mechanisms for the collection, analysis and dissemination of information on various aspects of the national research effort and on science and technology generally should be accorded top priority by the Government.

4.54 Evidence to this Inquiry suggests that what is most needed at present to improve the research priority-setting process is the availability of sufficient information to all relevant players, public and private, in order to enhance the effectiveness of those mechanisms which already exist. The Committee notes that both the House of Representatives Standing Committee for Long Term Strategies and ASTEC have recently reached similar conclusions.[13]

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13. House of Representatives Standing Committee for Long Term Strategies. Australia as an Information Society: Grasping New Paradigms, AGPS, Canberra, May 1991.

4.55 In Research and Technology: Future Directions, ASTEC noted that:

> There is increasing acceptance of the importance for direction-setting exercises based on the predominantly qualitative information derived from consultative processes like those conducted by ASTEC. However, such qualitative information has to be supported by sound quantitative information on the national research and technology effort and on economic and social activity.[14]
>
> *Quantitative information for government policy making falls* into two categories: information about existing Australian conditions or circumstances ... for portfolio-based policy development, and information about the performance and funding of research for policy development in relation to the research effort as a whole. There are significant gaps in both areas.[15]

Further:

> There is no central or coordinated mechanism in Australia for the systematic capture of local and global information about research and technology although databases are available through libraries and research agencies such as CSIRO.[16]

4.56 The Committee shares ASTEC's concerns regarding the need for more information about national and international research directions and capabilities, and about the relationship of national and international science and technology developments to the future of Australian firms and the Australian economy. Of equal importance, however, is the synthesis of this information and mechanisms to ensure its availability in user friendly forms.

14. ASTEC, Research and Technology: Future Directions, AGPS, Canberra, September 1991, p. 37.
15. ibid., p. 98.
16. ibid., p. 96.

What Sort of Information is Needed?

4.57 The Committee identified a number of areas in which it would be valuable to have information available. This information includes:

- detailed, consolidated data on publicly performed research;
- information on trends in the Australian private sector, with particular reference to innovation and the effects of government policies;
- forecasts of international science and technology developments and their likely effects on trade, competition and the likely returns from the national research effort;
- indications of areas of commercial opportunity both here and overseas, coupled with analysis of the social and other factors crucial to success in those markets which appear to hold the most opportunity;
- information on opportunities for innovation that is tailored to the needs of specific Australian firms; and
- information on Australian and overseas science and technology which is tailored to suit the needs of the schools and the media.

Publicly Performed Research

4.58 As was pointed out by a Working Party appointed by the Australian Academy of Science, there is currently no ready-made system for learning about what is going on in public sector research:

> ... even individual organisations have difficulty in knowing exactly what research is being conducted within their walls.[17]

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17. Australian Academy of Science. Australian Science and Technology Information Service: Feasibility Study Report, October 1989, p. 37.

4.59 The Committee commends the ABS for its recent initiatives in the development of an improved system for the classification of Australian research across fields of research and socio-economic objective. However, the Committee believes that there remains a pressing need for the collection and consolidation of more detailed information concerning Australian public sector research.

4.60 Required information includes details of the following :

- research that is planned, completed or in progress within the universities and research agencies;
- public sector research expertise that is available to industry or other organisations interested in collaboration;
- publicly produced knowledge that that could be, but has not yet been exploited for commercial gain;
- the level of contracting out of public sector research requirements to industry; and
- publicly performed research that has, or is being, funded by industry.

4.61 The Committee acknowledges that some agencies have made more progress than others in consolidating information on what they are doing and in disseminating that information to potential users. For example, CSIRO puts out a monthly research list on microfiche and, on the initiative of Chief Executive, Dr John Stocker, has commenced 'Operation Ambassador'. This is a program which involves seeking out and consulting with potential users of CSIRO's work. Likewise, as discussed in Chapter 14, AIMS has taken proactive steps to ensure that details of its work and capabilities are made available to potential users.

4.62 Evidence before the Committee would suggest that, at least in the immediate future, research organisations will need to take the lead in identifying and 'doorknocking' potential industry users. Of course, such strategies involve the expenditure of considerable resources, both in terms of travel costs and the time of senior research and management staff. The Committee believes that additional resources must be provided to research organisations which are being encouraged to forge closer links with the private sector for marketing functions such as this.

4.63 However, the Committee also believes that there is a further requirement for up-to-date, consolidated databases of research across socio-economic objective. Admittedly, some progress in this direction has already occurred, for example:

- Australian Marine Research in progress is jointly produced by AIMS, CSIRO, Great Barrier Reef Marine Park Authority (GBRMPA) and the Victorian Institute of Marine Science;

- the BRR already collects and synthesises information on Australian and overseas research into rural industries;

- the Academy of Science has just published a Directory of Climate and Atmospheric Research conducted across Australia which provides program details and contact names and addresses; and

- gradual improvements are being made in the development of environmental management databases.

4.64 **The Committee recommends that:**

- **the Government take immediate action to facilitate the development of comprehensive, consolidated databases on various aspects of the Commonwealth-funded public sector R & D effort, including:**

  - **research that is planned, completed or in progress within the universities and research agencies;**

  - **public sector research expertise that is available to industry or other organisations interested in collaboration;**

  - **publicly produced knowledge that could be, but has not yet been exploited for commercial gain;**

  - **the level of contracting out of public sector research requirements to industry; and**

  - **publicly performed research that has, or is being, funded by industry.**

Private Sector Innovation in Australia

4.65 In his evidence to the Committee, Mr Denis Hanley, a former member, and Chairman, of the IRDB had this to say about the current level of understanding of private sector innovation in Australia:

> One of the things that I find unusual - and I do not say this as a criticism of DITAC - is that there is not this comprehensive study or analysis of its bailiwick. I would expect that up on every wall there would be some sort of chart about what Australia's industry is, so that everybody knows what it is and knows who the players are. I would have thought that that was fundamental to setting goals and objectives and feedback loops ...[18]

> ... I would like to suggest that DITAC lay out what Australian industry is. Who are the players? What is the structure? Let them make it very clear and understandable to all of us. The first place is to define where you are and once you do that, you can think about where you are going to go.[19]

4.66 The Committee strongly supports this suggestion. It notes that a number of public sector research organisations such as CSIRO, which have been encouraged to direct their attention to industry needs, have had to try to gather this type of information in respect of relevant industries themselves. Furthermore, they have had to do so at a time when the resources available to them for policy development and administrative work have been severely stretched to facilitate significant organisational change.

4.67 Certainly, numerous analyses of Australian firms have been conducted or commissioned by public sector agencies in recent times. The economic difficulties faced by this country over the past decade have prompted government departments and relevant Ministers to conduct or commission studies detailing the nature of particular Australian industries or segments of those industries. Bodies such as the BIE, ABARE and the Industry Commission have conducted analyses of the effects of a wide range of micro- and macroeconomic policies on particular industries and industry sectors. Two recent reports, commissioned by the IRDB, entitled Industrial Research in Australia and Innovation in Australia, have made significant

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18. Evidence, pp. 1274-5.
19. Evidence, p. 1283.

contributions to understanding the characteristics of private sector R & D and successful innovative companies.

4.68 The Committee considers the work of such bodies to be extremely valuable. However, it notes with concern that coverage has been far from comprehensive, and that there is a pressing need for a concerted mechanism to ensure the systematic collection and regular updating of detailed information on Australian industry. The Committee takes the view that many organisations could play an important role in the collection and analysis of the many components of the required information. For example, private consulting firms could be commissioned to conduct much of the required 'mapping' work.

4.69 The key point, however, is that there is a need for one organisation to play a central role in the identification and synthesis of information and its dissemination to potential users. Furthermore, those bodies which are given responsibility for the collection and analysis of such information must be provided with sufficient resources to do so by the Government.

4.70 **The Committee recommends that:**

- **the Department of Industry, Technology and Commerce and the Department of Primary Industries and Energy consider means of coordinating the regular and systematic collection, synthesis and dissemination of detailed and comprehensive information on:**
  - **the characteristics of all sectors of Australian industry;**
  - **the nature and extent of private sector innovation and R & D investment; and**
  - **the barriers to innovation faced by Australian firms.**

International Science and Technology Developments

4.71 In 1985, the ARC pointed out that Australia was behind its overseas trading partners, who 'maintain elaborate information gathering services to ensure that international developments are communicated both to research establishments and to individual users of research results.'[20]

4.72 The need for improved mechanisms for the collection and dissemination of information on international science and technology developments was commented upon by several witnesses to this Inquiry. In September 1991, ASTEC reiterated the earlier comments made by the ARC with respect to such information. Its consultations with government agencies, industry associations and private firms confirmed that:

> Internationally available research and technical information which is important to competitiveness is not readily available throughout Australian industry.[21]

4.73 This Committee supports ASTEC's view that there is a need for the establishment of a system of information brokerage which can perform the function of a clearing house for the vast flow of technical information generated in Australia and overseas. ASTEC's suggestions that the National Industry Extension Service and Austrade could play a greater role in this regard deserve further consideration by the Government.

4.74 There may also be merit in another option put forward by ASTEC: the establishment of a Technical Attache System along the lines of the Swedish model. Sweden's Technical Attaches, most of whom are drawn from industry, follow up on technical and scientific developments overseas and play a major role in disseminating that information to Swedish industry.

4.75 **The Committee recommends that:**

- **the Department of Industry, Technology and Commerce act immediately to establish a mechanism for the dissemination of information on international science and technology developments to Australian industry.**

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20. ARC. <u>On the Public Funding of Research: a Report</u>, AGPS, Canberra, November 1989, p. 33.
21. ASTEC. <u>Research and Technology: Future Directions</u>, AGPS, Canberra, September, 1991, p. 49.

4.76 However, the Committee also believes that it may be worth considering the establishment of an agency with a wider mandate, which might include:

- the synthesis of information contained in databases on Australian research with information on international science and technology developments; and
- the identification of long range market opportunities for Australian firms here and overseas, on the basis of a thorough understanding of the nature of Australian industry and its overseas competitors.

Analysis of Long Range Market Opportunities

4.77 The Committee notes that Austrade conducts and commissions small scale market analysis work for certain sectors of Australian industry. However, according to the McKinsey review of the organisation, Austrade's strengths are in the role it can play in providing in-market support to Australian exporters and in promoting Australian firms in those markets.[22] The organisation does not have the knowledge or resources required to conduct long term, strategic analyses of market opportunities.

4.78 Unfortunately, neither do the vast majority of Australian firms, given their current stage of development. Yet if investments in R & D, or the contracting of research to Commonwealth research agencies or the universities, are to form the basis for significant returns, prior analysis of long range trends and opportunities in relevant markets here and overseas is vital.

4.79 At this stage of the development of Australian industry, the Government could play a useful role in reducing the search costs involved in the collection and analysis of relevant information by supporting an agency with the necessary skills and experience. DITAC has commissioned some important research in this area, for example, a study on advanced manufacturing technology and two others on developments in waste management technology and related opportunities

4.80 However, the Committee considers that there may be merit in a more systematic approach to analysing long range market opportunities and matching

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22. McKinsey & Company. Organising to Deliver Export Impact: Australian Trade Commission, 1990, p. 10.

information on those opportunities with information about the R & D capabilities of the universities and public sector research agencies.

Information Tailored to the Specific Needs of Australian Firms

4.81 The Committee considered the types of information that would be most useful to private sector firms that wish to draw on the results of Australian research. The Committee was told of the experience of the Director of the Science and Technology Policy Section of DITAC in selling patent information and products:

> ... when we tried to sell patent information, very few firms seemed interested. ... They already had too much information ... and did not have the capacity to make use of what they were already receiving. ... most firms did not really want answers to questions - they wanted to be told what significance those answers had for their current operations - they wanted advice.[23]

4.82 The Committee takes the view that there is merit in the establishment of an agency which acts as a one stop shop for firms which want information about the state of the art in relevant research fields, the resources available in the public sector for contract research and the commercial opportunities relevant to such research. Research completed or currently being conducted in Australia could be combined with information from the Patents Office and overseas science and technology databases in response to specific queries from private companies, and packaged in such a way that it clearly addresses the specific needs of those companies.

4.83 The agency might, for example, be able to help firms answer questions such as:

- have any other firms done this before?
- are there existing technical solutions to this problem?
- is anyone currently researching this problem?

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23. L Rymer, 'Research and Innovation', paper given to an Australian Tertiary Institutions Commercial Companies Association Conference on Marketing Academic Services, Canberra, July 1991, p. 2.

- who in Australia would be capable of investigating this problem?

4.84 The availability of this consolidated resource could:

- improve the quality and quantity of information available to ASTEC in the preparation of its four-yearly issues and options paper, and assist in the formulation of the Science and Technology White Paper;
- assist small, innovative businesses make profitable investment decisions by reducing search costs;
- increase the utilisation of public sector research expertise by Australian firms;
- assist Commonwealth research agencies to plan their own research programs and cooperate more closely with each other; and
- provide a resource for Austrade which could improve decision-making regarding the provision of finance to Austrade's customers.

4.85 The Committee believes that ideally, provision of these services should be the province of private sector consulting agencies. It notes that Australian firms have reacted positively to the joint Commonwealth/State-run National Industry Extension Service, which provides advice and referral on marketing and other issues relevant to innovation. Their response suggests that there is a potentially profitable market for the provision of such services. If Commonwealth-funded databases on public sector research, international science and technology developments and the nature of the Australian private sector were readily accessible, a private sector market might develop around the provision of such services.

4.86 Nevertheless, the Committee believes that at the current time there *is strong justification for the public provision of such services.* The following considerations have led the Committee to this view:

- the critical lack of finance available to prospective entrepreneurs and small and medium sized innovative firms for the purchase of advice;

- the urgent need to act quickly to encourage more Australian firms to improve their competitiveness in domestic and international markets; and

- the possibility that such a service would maximise the use of the skills of Commonwealth-funded researchers and generate increased national income from the results of publicly performed research.

4.87 The Committee welcomes the Government's commitment to establish the Australian Technology Group (ATG), which was announced in February 1992 in the Prime Minister's One Nation Statement. The ATG will provide a link between research institutions and the market place and assist the translation of ideas, research results and breakthroughs into commercial reality.[24] The dissemination of information will depend on the ATG identifying research with commercial potential, particularly from public sector research organisations, and marketing research to Australian and overseas companies.

4.88 The Committee considers, however, that the ATG should have a wider role. In addition to identifying and marketing suitable research, the ATG should respond to requests for information from the private sector, as envisaged in paragraphs 4.82.

4.89 *The Committee recommends that:*

- **the Australian Technology Group synthesise and provide information on an ongoing basis on:**

  - **publicly performed Australian research;**

  - **international science and technology developments; and**

  - **commercial opportunities within domestic and international markets.**

4.90 The ATG will be funded by the Government but will aim in the longer term to be self-financing from fee and investment income. The Committee believes that this is an appropriate approach to launching the ATG and urges that the need for public support for the ATG be monitored.

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24. The Prime Minister. One Nation, February 1992, p. 78.

Information on Science and Technology Tailored to the Needs of the Schools and the Media

4.91 The level of the general public's interest in, and understanding of, important science and technology issues will be an important determinant of the effectiveness of the research priority-setting process. The whole priority-setting and funding process is likely to be improved significantly if government decisions are scrutinised by an informed electorate that understands the importance of expenditure on research and support for private sector innovation, to Australia's immediate and long term future.

4.92 The Government has acknowledged this issue in successive Science and Technology Budget Statements, but the Committee considers that still more emphasis must be placed on improving public understanding of the importance of science and technology to the nation.

4.93 A submission to this Inquiry from the Academy of Science's Working Party on the Australian Science and Technology Information Service (ASTIS) suggests that there is a disturbingly low level of knowledge of simple scientific facts and concepts in the wider Australian community.[25]

4.94 At the same time, many sections of the community exhibit an apparent thirst for science information which is insufficiently satisfied by the media. The media has a major role in setting the political agenda and in influencing levels of public concern about specific political, economic and social issues. The quality of its reporting on science and technology issues needs to be improved.

4.95 The ASTIS Working Party submission notes that, in comparison with the USA and the UK, there is very little in the way of science information and communication services offered in Australia. It also notes that ASTIS could play a major role in the promotion of Australian science and technology overseas, and possibly increase the level of Australian research collaboration with international agencies, through the provision of information services to the international media and R & D institutions.

4.96 ASTIS is an initiative of the Australian science community. It has received wide support from international science associations and science information services, which have offered reciprocal access to information and advice

25. Evidence, p. S620.

The ASTIS concept was inspired by the success of media resource services which provide information and referral services in the UK and the USA. The Service is conceived as a resource which will provide information tailored to the needs of the media, teachers and public office holders, rather than those of industry. Nevertheless, as the establishment of ASTIS is likely to encourage more and better quality media reports of science and technology issues, the Service may well increase industry interest in innovation, if only indirectly.

4.97 Just as there is a need for the provision of advice on science and technology matters tailored to the needs of specific firms, the ASTIS Working Party has found that international on-line databases of science and technology information 'are only of occasional benefit for the run-of-the-mill requirements on behalf of the media and the schools'.[26] The provision of summaries of information on specific areas of specialisation in R & D prepared by ASTIS staff could fill gaps in the information now offered by research institutions.

4.98 In its feasibility study, the ASTIS Working Party proposed that the Service be established with the following objectives:

- improving the scientific, educational, economic and cultural bases of Australia by promoting public understanding of science and technology:
- assisting all sections of the media to report and analyse scientific and technological matters by providing ready access to experts for comment and authoritative information on science and technology and related issues;
- enhancing the quality of science education by direct involvement of working scientists and technologists;
- generating awareness among community leaders, including public office-holders, of the implications of advances in research and development; and
- providing avenues for the scientific and technological community to express accountability to the nation and to be linked to the international media.

26. Australian Academy of Science, Australian Science and Technology Information Service: Feasibility Study Report, October 1989, p. 38.

4.99 The Working Party reported to the Committee that the feasibility study had received financial support from 42 institutions involved in R & D and the media had registered great interest in the establishment of the Service. Files of information were provided by 55 institutions and the required computer software and hardware tested. Working links were established with the international media. The Service could have been fully operational in a matter of months, had a commitment to supplement funds promised by the private sector been made by the Commonwealth.

4.100 After the core ASTIS operation had been funded and established it was proposed to extend provision of ASTIS's services to subscribing organisations on a share-cost basis. The Working Party ascertained that ASTIS was likely to be cheaper and more cost-effective than other means of raising public awareness, such as advertising campaigns. Estimated total operating costs for the first three years of the Service are in the order of only $400,000 per annum, at 1989 prices.

4.101 The Committee takes the view that the establishment of ASTIS could significantly improve the quality of media reporting of scientific issues and the level of public understanding of science and technology issues, and so play an important role in the promotion of Australian science overseas. It believes that the Government should act now to provide core funding for the Service, as such an investment is likely to generate indirect returns to the nation which far outweigh the required Commonwealth outlays.

4.102 **The Committee recommends that:**

- **funding for an initial three-year period be provided to the Academy of Science to enable the establishment of the Australian Science and Technology Information Service.**

Chapter 5

THE RESEARCH INFRASTRUCTURE 1: HUMAN RESOURCES

Introduction

5.1 In previous chapters of this Report, it was argued that the achievement of maximum value for money in Commonwealth expenditures on research activities is contingent not only on effective research priority setting, but also on the capacity of the science infrastructure to support top quality research in fields accorded priority by governments and private enterprise. The quality of this infrastructure - human resources, equipment and facilities - is itself determined by both government policies and the management policies adopted by research organisations.

5.2 ASTEC's Profile of Australian Science, published in 1989, found that Australia was struggling to maintain its place in world science in a number of areas due to:

- restricted access to expensive facilities;
- an insufficient number of postgraduate students; and
- the imminent retirement of gifted individuals who could not be replaced.[1]

5.3 A full assessment of the range of issues of relevance to the science infrastructure is not possible here. However, in this Chapter, the Committee addresses a number of issues which it considers are currently of great importance

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1. ASTEC. Profile of Australian Science: a Study of the Current State and Potential of Basic Scientific Research, AGPS, Canberra, 1989.

to the long term health of the research infrastructure. This Chapter focuses on the human resources component of the research infrastructure. In particular, it addresses the need for measures:

- to ensure an adequate future supply of quality research staff; and
- to improve the quality of research training.

Can We Arrest the Brain Drain?

5.4 The Committee found that most of the research organisations considered in the context of the Inquiry shared the following characteristics:

- research staff exhibit high levels of commitment to their work, but morale in some areas has suffered in recent years in the face of deteriorating working conditions, uncertainty and major organisational and funding changes; and
- despite variations in particular organisations and particular fields of research, the age distribution in the major research organisations is skewed heavily towards older staff - the average research scientist in non-tertiary institutions being around 48 years of age.[2]

5.5 From the mid-1960s to the early 1970s, there was a phase of relatively high growth in the number of research staff employed by the public sector. However, staff ceilings led to widespread stagnation of recruitment rates from that time through to the early 1980s and staff recruited in the boom years will start to retire in the mid to late 1990s. For example, DSTO has estimated that, given a retirement age of 60, it would lose 20% of its research and engineering staff over the next nine years and 50%, or 600 staff, in 19 years. Similarly, a report by CSIRO tabled at a meeting of the Science Council in May 1990, stated that some 50% of the organisation's research staff would reach retirement age in 10 years time.

5.6 CSIRO, like AIMS and several other research organisations, has expressed concern about its capacity to fill these vacancies with top quality new blood. Although DSTO has been able to improve its age profile by recruiting some 200 young scientists in the past five years, there are indications that it may become

2. Evidence, p. 44.

increasingly difficult for DSTO, along with other research organisations, to continue to recruit sufficient numbers of highly qualified, competent graduates.

5.7 A combination of factors may lead to dramatic quantitative and qualitative losses in the skills and experience base of some of these organisations during the coming decade. During the 1980s there was a shift away from enrolments in graduate and postgraduate courses in science, mathematics, technology and engineering at Australian universities. Brighter students increasingly opted for training in professions offering higher status or remuneration, such as law and commerce.

5.8 Both the public and private sectors in most OECD countries are offering researchers better pay, career opportunities, working conditions, facilities and equipment than Australian research organisations are able to provide. A predicted shortage of graduates in countries such as the USA and the UK will stiffen competition for the best researchers, meaning that more Australian graduates may take up offers overseas and it may not be possible to recruit from overseas to make up the shortfall.

5.9 At a Workshop on the 'Future of Australian Science and the Direction of Australian Society', Professor Barry Rolfe made the following observations:

> ... in North America alone, the National Science Foundation predicts a shortfall of 675,000 scientists and engineers by the year 2000 ... the European Community has just announced its plans to invest an extra 3.5 billion ecus, [European Currency Units] equivalent to about $4.6 billion US dollars over the next few years into science and technology. Some of the money will be used to fully support the employment of 5000 new young scientists.[3]

5.10 What will public research organisations have to offer in the future to attract and hold on to the best of Australian research talent? What will they have to offer to attract international expertise in specific fields in which Australia lacks research experience? Opportunities and rewards available to researchers overseas continue to escalate. At the same time, many Australian public sector scientists are being asked to make do with insufficient supplies of outdated equipment, and to

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3. B G Rolfe. 'A Scientist's View of our Ability to Compete in the 21st Century', paper given to a Workshop on the Future of Science and the Direction of Australian Society by the Australian National University and the Parliamentary Research Service, Canberra, October 1990.

divert their attention from their particular research interests in order to concentrate on the more immediate demands of applying and commercialising their research.

5.11 The following extract from a recent edition of Fortune encapsulates the major elements of the problem:

> Of the estimated $108 billion the US will spend this year on civilian R & D, industry will shell out roughly $74 billion to pay for everything from next year's products to pure cogitation at universities and corporate brainpower palaces like Bell Labs.
>
> ... America continues to act as a magnet for brilliant intellects. ... They come for the advanced labs and the stimulation of each other's company: The US scientific and engineering community is nearly a million strong ... They come ... because America ... offers an environment where scientists can make names for themselves at a tender age. R & D spending keeps rising year after year ... .[4]

5.12 The recruitment of experienced researchers from outside the research organisations to fill gaps in expertise as they arise would appear to present a particular problem to Australian research organisations. Certainly, a number of the research organisations have international reputations for excellence in certain fields However, in the words of the then Acting Chief Defence Scientist, 'we simply do not offer the level of money to get people at the middle grade professional and above level'.[5]

5.13 The Director of AIMS, Dr Joe Baker, summed up the problem when he spoke about a recent recruitment exercise in his evidence to the Committee:

> We attracted an application from an excellent lady scientist in Bermuda. Her current salary is $US60,000 tax free. She has all the equipment she wants. She said she would like to come and work with us. She wanted an equivalent salary ... she wanted certain equipment which would have cost $700,000. I could not meet either side of that ...

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4. G Bylinsky, 'America's Hot Young Scientists', Fortune, October 8 1990, p. 28.
5. Evidence, p. 648.

> The United States has the freedom to offer a package to a really good person ... If you want a professor you go out and buy that professor at the top price.[6]

5.14 It must be noted that the managers of many Australian research organisations have been working to achieve improved remuneration, career opportunities and working conditions for their research staff. CSIRO, under the inspiration and direction of Dr John Stocker, has taken the lead. Amongst recent improvements instituted by CSIRO management are the following :

- increased and improved staff training opportunities in a variety of skills;
- increased staff rotation and the establishment of a number of career development positions; and
- a merit reward and promotion scheme which is tailored to provide appropriate rewards for those with management talent, for those who attain outstanding excellence in scientific achievement, and for those who directly contribute to research projects which lead to major commercial successes.

5.15 In 1990, CSIRO mounted a sufficiently compelling case before the Industrial Relations Commission to win a claim for pay increases of between 11% and 19% for its various grades of research scientist. Following this outcome, the Professional Officers Association, which covers public sector research scientists, was successful in achieving parity with CSIRO salaries for all research staff employed by research organisations under the *Australian Public Service Act 1922*.

The Supply of Quality Research Staff

Teaching Staff, Student Places and Resources Available in Schools and Universities

5.16 Improved salaries and career development opportunities may help public sector research organisations retain top quality staff. These developments may also reduce, to some extent, disincentives for Australian students to enrol in science courses. Nevertheless, many other factors will influence the future demand for places in relevant courses and the quality of the graduates who take up research positions in government research organisations and the higher education system.

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6. Evidence, pp. 1177-8.

5.17 These factors will include the following:

- the status accorded to science in the wider community;
- the quality of science teaching and resources available to science teachers in secondary schools;
- the quality of graduate and postgraduate teaching in relevant disciplines within the universities; and
- the capacity of the higher education system to deal with an increased student load.

5.18 Science enrolments in many universities received a significant boost in 1991, with major Sydney and Melbourne institutions recording first year science quotas that are higher than they have been for some years. These increases have occurred in the context of a massive 39% increase in the rate of participation in tertiary education courses between 1983 and 1990. Nevertheless, the rate of growth in enrolments in science and mathematics courses would not appear to have matched that for enrolments in many other disciplines.

5.19 The Committee shares ASTEC's view that efforts to promote science and technology as exciting, rewarding fields of endeavour must be intensified if we are to inspire more bright students to take on science careers.[7] Both State and Federal Governments have in recent years taken a number of initiatives in this area which are applauded by the Committee.

5.20 At the federal level, these initiatives include the following:

- the allocation of some $700,000 in 1990-91 to the Science and Technology Awareness Program, which supports a number of activities including the $250,000 Australia Prize and several other new awards for scientific excellence;
- continued support for the National Science and Technology Centre in Canberra, which incorporates 'Questacon' - a fun, hands-on science awareness-raising program;

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7. ASTEC. Research and Technology: Future Directions, AGPS, Canberra, September 1991, pp. 90-1.

- the sponsorship of new prizes for scientific excellence by the ABC;
- joint industry-government sponsorship of a National Science Festival in 1993, which aims to provide a forum for exchanges between scientists and industry and encourage young people to take on science careers; and
- plans developed by the federally funded Centre for Advanced Engineering for the establishment of a Technology Awareness Institute, with the help of financial contributions from the business community.

5.21 At state level, some recent developments have included the establishment of a Science Park in Adelaide, which is to incorporate a Science School of the Future established by the SA Education Department.

5.22 CSIRO is also playing an important role in raising the attractiveness of science as a career. Its Double Helix Club now has a membership of over 13,000 young Australians. In his evidence to the Committee, CSIRO's Chief Executive, Dr John Stocker, explained that the Club:

> ... involves children in the excitement of hands-on science enterprises as well as looking through our magazine at some of the organisation's forefront activities, explained in simple terms. We have in each major city in Australia a science education centre where children can do the sorts of experiments that they do not get to do at school, which are booked out for ages in advance.[8]

5.23 Developments such as these serve to increase the awareness of school children of science career opportunities. They also increase science and technology awareness in the wider community and provide primary and secondary teachers with more and better teaching resources and opportunities.

5.24 The Australian Academy of Science's proposal for ASTIS was discussed in Chapter 4. The establishment of the service, as recommended by this Committee at paragraph 4.102 would be another way of improving the information and resources available to science teachers and raising the interest of young students in science as a career.

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8. Evidence, p. 97.

5.25 In addition to providing teachers with a point of contact to find sources of information on recent discoveries and developments in science and technology, the educational services envisaged for ASTIS include the following:

- the facilitation of personal contact between schools and practising scientists and technologies; and

- a toll-free telephone service to assist teachers to arrange visits by scientists to schools, and by schools to research laboratories.

5.26 The Science Council has considered a number of means to increase the quality of science and mathematics teaching in primary and secondary schools, including the establishment of a National Standing Committee on Science and Mathematics Education. In the meantime, the Curriculum Corporation was established in 1990 to promote national collaborative curriculum development and provide advice to the Australian Education Council on national curriculum issues. This development follows an agreement reached by relevant Commonwealth, State and Territory Ministers in April 1989.

5.27 The Committee supports moves to improve curricula and teaching resources in relevant subjects. However, if Australian schools are to provide sufficient, high quality science and mathematics teachers in the future, the question of salary relativities and working conditions must be satisfactorily addressed. This issue applies equally to ensuring an adequate future supply of high quality teaching and postgraduate supervision within stralian universities.

5.28 The Government is clearly aware of the consequences of allowing remuneration for researchers with scientific, mathematical and engineering qualifications to fall behind that available to graduates of other disciplines both here and overseas. The Department of Finance takes the view that underpricing of research distorts resource allocation; the same economic principle must apply to the pricing of research skills.

5.29 In his 1990 Australia Day address, the then Minister for Employment, Education and Training, the Hon J S Dawkins, MP, made the following comments:

> Why is it that salaries place a greater worth on a graduate accountant than an engineer or scientist? Why is it that a public affairs manager receives 10% more than a research and development engineer or 20% more than a senior design draftsman or an industrial chemist?

> .... the current overhaul of the wages system is a golden opportunity to sensibly rebalance public and private salaries.[9]

5.30 Although the Commonwealth research organisations have been successful in raising the level of remuneration for scientists to more acceptable levels, researchers in the higher education sector, the secondary school teachers and academics responsible for teaching the next generation of researchers continue to receive disturbingly low salaries.

5.31 An announcement of pay rises of up to 20% for academics in July 1991 has gone some way towards rectifying the situation. However, it has been calculated that, against international levels, Australian academic salaries have declined by at least 30% in recent decades. A report by the National Institute of Labour Studies pointed to the implications of these academic salary relativities of this kind in the light of the expected shortage of academic staff in the developed, English speaking countries:

> Given the continuation of Australia's relative pay position compared with the US, UK, Canada and NZ, the prospects are not promising of attracting sufficient academic staff of the required calibre from these countries, to meet the projected requirements. Indeed, Australia may face the possibility of losing large numbers of highly qualified academic staff to these countries as international competition intensifies. If academic pay relativities remain at current levels, Australian higher education institutions may face the prospect of having to recruit more and more from non-traditional sources, largely non-English speaking countries, in order to meet the projected annual requirements of academic staff.[10]

5.32 A number of recent reports have suggested that Australia will face a shortage of between 12,000 and 20,000 academics by the turn of the century. Computer science and engineering have been mentioned along with economics, law, accounting and medicine as areas of predicted shortage. A supply gap of a similar

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9. The Hon J S Dawkins, Minister for Employment, Education and Training, Can Australia Become the Clever Country?, 26 January 1989.
10. J Sloan, M Baker et al. Study of Labour Market for Academics, AGPS, Canberra, December 1990, p. 113.

order has been estimated for Canadian universities by the end of the 1990s and the pattern of academic retirements is apparently similar throughout the developed world.

5.33 **The Committee recommends that:**

- **the Government review on an ongoing basis the salaries paid to public sector researchers, teaching academics and school teachers working in science and science-related areas, with a view to establishing more appropriate relativities for the salaries paid to these professionals vis-a-vis those paid in the wider community.**

5.34 In its submission to the ASTEC review on Research Directions for Australia's Future, DEET suggests that the supply of academic staff should be improved by the following current initiatives:

- faster rates of growth of higher degree places than that for lower degree places;
- an increase in the number and value of Australian Postgraduate Research Awards;
- the removal of restrictions on the payment of above award rates to academic staff by the universities;
- moves to facilitate the immigration process for overseas researchers and academics; and
- the establishment of a Staff Development Fund for higher education involving expenditure of $5m in 1990 and a planned expenditure of a further $5m per annum for another five years.[11]

5.35 The Committee is concerned that these initiatives will not be sufficient to entice more, higher quality graduates to take up careers as teaching academics or pursue further research qualifications. Available evidence would

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11. DEET. 'The Role of Higher Education in Australia's Research Effort', submission to ASTEC's Review of Research Directions for Australia's Future, pp. 6-7.

certainly suggest that there must be a further expansion in the number of undergraduate and postgraduate places within the universities. But increasing student places will have negative consequences if aggregate funding for the higher education sector is not increased. If the quality of teaching in the universities is to improve and if the current high growth of enrolments is to be sustained, there must be greater government expenditure on the infrastructure of the universities. Numerous recent reports by government and independent agencies have argued that, if we are to ensure a sufficient supply of well-trained graduates, the universities must receive adequate funding, both to provide more graduate and undergraduate places and to upgrade the teaching infrastructure.

5.36 Since 1988, the Government has created some 85,000 new university places. Nevertheless, government funding per Effective Full Time Student Unit (EFTSU) fell by 12% between 1983 and 1991. Furthermore, the Australian Vice Chancellors' Committee (AVCC) has pointed out that the Government's desired increase in enrolments in science and engineering courses creates additional difficulties because places in these disciplines are particularly costly to provide.

5.37 Staff and facilities in many universities are currently under enormous strain, and students face overcrowding in lectures and shortages in books and equipment. In part, these difficulties appear to stem from the inadequacy of current enrolment funding mechanisms to adjust to fluctuations in the demand for student places One example of the difficulties faced by university administrators is provided in NBEET's 1990 report, Library Provisions in Higher Education Institutions. The report noted that, during a period in which funding available to the universities for infrastructure decreased in real terms, the real average costs of periodicals increased by some 38%.[12]

5.38 In May 1989, the Government announced an extra $211m specifically targeted at upgrading university infrastructure. However, the AVCC argued that there are extremely urgent infrastructure needs which will require further funding of $100m for 1992 and 1993. In response to the overcrowding experienced by universities in 1991, an additional $53m was provided in the 1991 Budget to fund the refurbishment of existing university buildings and accelerate new building projects. A further boost to the universities' capital program was announced by the Minister for Higher Education and Employment Services, the Hon P J Baldwin, MP, in October 1991. An additional $270m, to be provided in 1994, represents a 27% real increase in expenditure over the level of funding planned for 1993 and will, in the

12. NBEET. Library Provision in Higher Education Institutions, Commissioned Report No. 7, AGPS, Canberra, 1990.

AVCC's view, 'go a long way to addressing the critical capital backlog'.[13] In addition, $20m for urgent renovation and refurbishment was provided in the Prime Minister's One Nation Statement in February 1992. Nonetheless, as the AVCC pointed out in its report for the 1993-95 triennium, there is still 'an urgent need for an immediate injection of further funding into capital and renovations funding'.[14]

5.39 The Committee welcomes the Government's recognition of the need for increased funding for the universities. It believes that the universities' needs in this respect should be monitored on a regular basis in the context of a rigorous analysis of nation-wide needs.

5.40 **The Committee recommends that:**

- **the Government regularly monitor the universities' needs for capital funding and, using a formalised priority-setting process, plan to meet these needs; and**

- **the Government monitor the level of funding per Effective Full Time Student Unit such that the increase in the number of university places is matched by appropriate improvements to university infrastructure, bearing in mind the greater funding needs of science and science-related university places.**

5.41 The level of infrastructure in higher education institutions is, of course, also a determinant of the value for money that will be obtained from expenditures on research within the tertiary education sector. Research funding arrangements which have exacerbated infrastructure deficiencies are further discussed in Chapter 6.

5.42 The Government has responded to anticipated gaps in the supply of academic staff by progressively increasing the number of postgraduate awards and doubling the dollar amount of the awards. The number of research scholarships has

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13. The Hon. P Baldwin, Minister for Higher Education and Employment Services. Higher Education: Quality and Diversity in the 1990s, AGPS, Canberra, October 1991, p. 7; AVCC. Media release, 10 October 1991.
14. AVCC. Australian Universities in a Changing World: Report for the 1993-95 Triennium, Canberra, May 1992, p. 27.

increased from 745 to 1,100 in three years. In 1991, the ARC provided 1,000 new Postgraduate Research Awards and 100 Postgraduate (Industry) Awards; in 1992 the numbers are 1,200 and 108 respectively.

5.43 However, these measures would not appear to be meeting current and foreseeable demand. For example, there were 5,254 applicants for Postgraduate Research Awards in 1992, but only 1,300 received funding. The AVCC has called for a further increase in the number of postgraduate awards over the next three years, as well as more research fellowships, particularly in the areas of most acute predicted shortage. The Committee believes that the number of postgraduate awards in science subjects should be increased, the impact of the increase in places on demand should be monitored and the need for further increases reviewed on a regular basis.

5.44 **The Committee recommends that:**

- **the number of science research fellowships and postgraduate research awards be progressively increased to a level where supply equates more closely with evolving demand in Australia and overseas.**

Beyond the Universities: Increasing the Relevance of Research Training to Industry Needs

5.45 An issue which has been the focus of considerable attention within industry and the government bureaucracy in recent years has been the need to provide research students and public sector research staff with more industry-based training. In the late 20th century, training must be conceptualised as a process which continues throughout an individual's career. As will be discussed in Chapter 10, a dominant theme of submissions to the Inquiry from private companies and relevant government departments was that technology transfer from public research agencies would be improved if research organisation staff had a better understanding of industry realities. Accordingly, the question was frequently raised of how to provide public research agency staff with greater levels of industry experience.

5.46 In 1985, ASTEC recommended extra funds for research fellowships for research training in industry.[15] ASTEC raised the issue again in 1987; a survey

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15. ASTEC. Public Investment in Research and Development in Australia, AGPS, Canberra, 1985, p. 54.

conducted by the organisation that year revealed that, although private companies had few complaints about the quality of graduates, companies believed that tertiary students would benefit greatly from work experience during their degree courses.[16]

5.47 ASTEC's 1989 The Core Capacity of Australian Science and Technology expanded on the point:

> The PhD is undervalued in industry, but perhaps for valid reasons: the training involved is likely to be inappropriate for the requirements of private companies in terms of the scope of knowledge required, the ability to adapt to the directed nature and shorter time scales of industrial research, the commitment to the objectives of industry, and the ability to work as part of a team.
>
> If Australia is to take advantage of the productivity benefits which flow from the conduct of long-term research in industry, then first our whole approach to industrial R & D training needs to be reassessed.[17]

5.48 In countries such as Japan and Germany, there is a much higher level of on-the-job training in research and other skills. However, these countries have rather different industrial cultures from that which exists in Australia; their industry and trade associations have historically placed high priority on the improvement of the national skill base. Furthermore, the supply of in-house research training is a function not only of the orientation but also of the size of firms; countries such as Japan also have a greater number of highly profitable firms than Australia. Currently very few companies in Australia have large R & D budgets and this situation is unlikely to change in the immediate future.

5.49 One government response to the problem was the introduction of a compulsory 1% training levy through the *Training Guarantee (Administration) Act 1990.* At the time of the levy's introduction, most of Australia's larger companies were already spending more on training than 1% of their annual national payrolls These larger companies also tend to be the nation's major investors in R & D. The most significant effect of the levy should therefore be found among smaller companies.

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16. ASTEC. Improving Australia's Competitiveness through Industrial Research and Development, AGPS, Canberra, 1987, p. 30.
17. ASTEC. The Core Capacity of Australian Science and Technology, AGPS, Canberra, April 1989, p. 82.

5.50 As the Act has been in operation only since July 1990, it is difficult to fully assess its impact. An initial assessment of the impact of the training levy revealed an extremely low level of support for it amongst the managers of Australian companies.[18] These managers believed that the effect of the levy would be to stimulate firms to seek training primarily to comply with the Act, rather than to provide levels of training appropriate to their needs.

5.51 The Committee believes that improvement in the skills available to commercialise Australia's R & D is critical to the nation's economic well being. It also believes that any new scheme, such as the training levy, should be monitored for its success in meeting the Government's objectives.

5.52 **The Committee recommends that:**

- **the Government evaluate the contribution of the 1% training levy to improving the skills needed by Australian firms for the successful performance of R & D and its commercialisation.**

5.53 Another government initiative in response to the relative lack of in-house training in Australia has been the establishment in 1990 of a new category of postgraduate award, the Postgraduate (Industry) Award. The objectives of the new award are twofold:

- the promotion of joint industry-higher education research opportunities, especially in areas such as engineering and computing; and

- the provision of a greater supply of postgraduate students with valuable industry experience.

5.54 Each Commonwealth award must be sponsored by a company, which must agree to provide an annual commitment of at least $5,000 in cash and a further $5,000 in cash or kind to support the student's research.

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18. K Hall and S Orchard, 'Human Resource Development, Industrial Culture and the Training Levy', W.A. Labour Market Research Centre Discussion Paper No. 91/7.

5.55 According to the ARC, the original number of awards planned for 1990 was increased from 30 to 60 due to the high level of demand from industry However, the number of applications from firms has been much poorer than expected, and TASC was commissioned by the ARC to investigate the reasons why, and to consider as well a comparable scheme for senior academics to work in industry.

5.56 The major constraint on the successful operation of both award schemes was found to be a lack of awareness of them, particularly in industry. A number of other factors were identified, many of them relating to teething problems with relatively newly developed schemes. TASC also considered the ingredients of success in the scheme, among which were trust and confidence between industry and academic participants, which grew from previous contacts between the two sides. Where this did not already exist, it proved an obstacle to the schemes, with concerns by companies over the extent to which academics understand intellectual property, confidentiality, and time and cost constraints.[19]

5.57 Another possible reason for the low demand for the postgraduate awards is the existence of a similar scheme, the National Teaching Company Scheme (NTCS), which is administered by DITAC. The major difference between this scheme and the Postgraduate (Industry) Awards is that the former provides a higher level of income for graduates. However, it only allows for part-time study. A recent review of the effectiveness of the NTCS by the BIE noted the potential for overlap between the two schemes and recommended that a close watching brief be kept on this issue.[20] TASC pointed out, however, that the two schemes 'address different objectives, draw on largely distinct populations to provide participants and, therefore, do not compete with each other'.[21]

5.58 The NTCS was introduced in 1984-85 with the aim of:

- overcoming market failure with respect to limited private sector knowledge of the benefits accruing to companies that use the expertise available in research institutions;

- providing graduates with industry experience;

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19. NBEET. Productive Interaction: an Investigation of the Factors which Constrain and Promote Proposals under the APRA(I) and ARF(I) Schemes, Commissioned Report No. 13, AGPS, Canberra, February 1992.
20. BIE. The National Teaching Company Scheme, Program Evaluation Report No. 10, AGPS, Canberra, 1991.
21. NBEET, op. cit., p. 42.

- providing the research staff of institutions with the opportunity to collaborate with industry, and hence improve their understanding of industry needs and modes of operation; and

- helping to improve company performance by encouraging the adoption of new technology or the development of new products or services.

5.59 Since the Scheme's inception, the Commonwealth has funded 180 projects; 66 projects have been funded by the States. The level of Commonwealth funding for the Scheme in its first three years averaged $575,000 per year. After a favourable interim review in 1987, funding for the scheme was nearly doubled to $1.4m in 1988-89. Total commitments to 1990-91 amounted to $7.8m. But despite the increasing level of funds available under the Scheme in recent years, demand for funding has consistently exceeded grants approved by a ratio of about 4:1.

5.60 The BIE found that the success of the NTCS in increasing the awareness of companies of the benefits of collaboration with research institution staff was strongly related to company size. It was also related to the degree of interaction the company had with institutional research staff before applying for funding under the Scheme - an outcome which perhaps suggests that attitudinal barriers to interaction on the part of industry may be difficult to break down.

5.61 The BIE considered that insufficient time had elapsed to measure the full impact of the Scheme on the demand for graduates in industry. Nevertheless, data collected for the review suggested that companies with prior links to the institutions were encouraged to formalise or extend those links by their participation in the Scheme. Smaller companies with no prior links were less likely to seek formal links with research institutions as a result of their participation in the Scheme. The BIE's interpretation of this outcome and possible alternative interpretations will be considered in Volume 2 of this Report.

5.62 The success of the NTCS in achieving its secondary objective of providing research institution staff with valuable industry experience was more clear-cut. All but a few of the researchers who participated in the Scheme felt that their participation had enhanced their career prospects in industry.

5.63 The encouragement of longer-term links between companies, universities and research organisations was a primary goal behind the establishment of the new Cooperative Research Centres (CRCs), which were announced as part of the May 1989 Science and Technology Statement. However, it is too early to assess the effectiveness of the CRC Program across its many objectives, and particularly against the latter.

5.64 A number of submissions to the Inquiry suggested that the goal of more effectively harnessing our R & D effort to the development of industry will necessitate a higher degree of short term movement of public sector researchers into employment by private companies. Such movement would provide Australian industry with a greater degree of influence on the nature of research training, and update the knowledge of researchers about areas of relevance to particular industry sectors.

5.65 In 1990, AIRG approached DITAC with a request that it identify barriers to such short-term movements with a view to their removal. However, DITAC's investigations suggested that possible barriers constituted by the employment conditions of the research organisations themselves, such as lack of portability of superannuation, or negative attitudes to such movement on the part of researchers, have largely been overcome.

5.66 Rather, the major barrier seems to be a lack of demand from industry itself. Although this may indicate a need for more and better marketing of research capabilities on the part of the research organisations themselves, there are many possible causes of this low demand, some of which will be examined in Volume 2 of the Report.

5.67 Clearly, there is a need to investigate the pre-conditions for greater industry demand for the short term services of public sector researchers. Nevertheless, such investigations should not obscure the need to ensure that public sector research organisations have sufficient staff to conduct core mission-oriented research. What is not generally addressed in discussions of the need to increase short term research mobility is the corresponding requirement that research organisations receive sufficient appropriations to maintain ongoing expertise in core research program areas.

5.68 **The Committee recommends that:**

- **appropriation funding for research organisations be responsive to shifts in the level of industry demand for short term research support from these organisations, but continue to maintain sufficient resources to support core research programs at all times.**

5.69 Another important aspect of research training is the responsibility of the research institutions themselves to provide their researchers with training to enhance their understanding of the operations and needs of private companies. The extent to which these organisations have met this responsibility will be discussed in Volume 2 of the Report.

Chapter 6

THE RESEARCH INFRASTRUCTURE 2: EQUIPMENT AND FACILITIES

The Current Situation

6.1 In 1989, ASTEC's report on The Core Capacity of Australian Science and Technology stated baldly that, since the mid-1970s, Australia's public research laboratories had 'been starved of equipment funds'.[1] The higher education sector had been the hardest hit, as the decline in funds available, relative to the rising cost of maintaining and upgrading equipment, had been accompanied by a rise in the number of researchers employed in the tertiary sector.

6.2 The report also indicated that, although there is still a shortfall in the *proportion of R & D expenditure going to equipment, government research* laboratories are relatively well equipped in comparison with the universities:

> Government research laboratories have improved their research productivity and reduced overhead costs through good research management, and have therefore been able to reduce the number of research staff. As a result those who remain have better access to equipment funds.[2]

ASTEC *also noted that government laboratories had been more ready than the* universities to pool resources for the purchase of major items and to share access to those items.

6.3 Nevertheless, the adequacy of equipment and facilities has varied across organisations and divisions of those organisations. In some areas, researchers themselves have found solutions other than resource pooling to relieve pressing equipment needs. The Committee heard evidence that some scientists have gone so far as to put their own money towards the purchase of much needed equipment in order to maintain the quality of their research.

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1. ASTEC. The Core Capacity of Australian Science and Technology, AGPS, Canberra, April 1989, p. 94.
2. ibid., p. 99.

6.4 Dr Max Whitten, Chief of the CSIRO Division of Entomology, which conducts research of enormous importance to the viability of our rural industries, told the Committee that during CSIRO's leanest years in the late-1980s, some officers had used their own money to support attendance at international conferences. He also told the Committee that 'there have been one or two cases where officers have actually traded in their salary for pieces of equipment'.[3]

6.5 As mentioned in Chapter 2, the last 20 years or so have seen an ever increasing rate of sophistication in the techniques and tools available to scientists. At the same time, the cost of state of the art equipment has increased at a pace which has accelerated well ahead of the rate of inflation. According to ASTEC, if *Australia wishes to maintain standards of research excellence in international terms*, rising expenditures on such equipment are to some extent inevitable and must be seen as investments.[4]

6.6 The ARC has explained the need for increasing expenditure on equipment in the following terms:

> ... all of the things that are easy to learn about are discovered first and with advancing knowledge it becomes progressively more difficult and more costly to make additional discoveries. More and more resources ... need to be used to maintain the same level of output of new knowledge.[5]

6.7 The declining value of the Australian dollar for much of the 1970s and 1980s added considerably to the effective cost increases experienced by Australian research organisations. In 1989, CSIRO tendered evidence to ASTEC that the major devaluation that occurred during the 1984-85 financial year effectively swallowed up some 9% of the limited funds at its disposal for capital equipment maintenance.

6.8 Concerns regarding inadequate funding for the repair, maintenance and upgrade of equipment and facilities were registered by nearly all of the research organisations which tendered submissions to the Inquiry. DSTO was the only agency which seemed generally satisfied with the level of funding provided for those purposes.

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3. Evidence, p. 123.
4. ASTEC, op. cit., p. 98.
5. ARC through NBEET. On the Public Funding of Research, Minister for Employment, Education and Training, November 1989, p.11.

6.9 Following ASTEC 's April 1989 criticisms of the level of Commonwealth funding for equipment and facilities, the Government announced a commitment of $90m for the upgrading of capital stock between 1989-90 and 1993-94. Extra funds provided by the Government to the organisations which have been the hardest hit have, in the opinion of the research organisations themselves, gone some way to alleviating urgent, immediate problems.

6.10 In 1991-92, $12m of the Government's $90m commitment was allocated to the establishment of capital asset management programs for CSIRO, the Australian Nuclear Science and Technology Organisation (ANSTO) and AIMS. CSIRO received $10.7m of that amount, leaving $1.3m to be divided between ANSTO and AIMS.

The Need for Improvement

6.11 Research organisations consider that funds are not yet sufficient to meet the challenge of satisfying organisational objectives approved by their Ministers and keeping up with cost increases and international developments. ASTEC concurs with this view. Its September 1991 report, Research and Technology: Future Directions stated again that 'the infrastructure supporting the public sector research system is inadequate to maintain Australia's international research competitiveness'.[6] Specific concerns regarding capital expenditure raised by individual organisations will be further considered in later chapters of this Report.

6.12 In addition to general concerns regarding the manifest failure of appropriations to cover the rising cost of re-equipping research laboratories, submissions from the research organisations all raised specific concerns about the effect of recent changes to funding mechanisms on their capacity to maintain equipment and facilities. The most widespread concern related to the increasing proportion of research which is funded by external agencies responsible for the allocation of government grants. One consequence of this change, according to the research laboratories, is increasing pressure on research infrastructure. This is because most of the grants do not cover the full direct costs, let alone the indirect costs, of the research they support. With some exceptions - notably, the ARC - the granting bodies provide 'marginal' funding, and assume that the research organisations receive sufficient appropriations to cover overhead costs.

6. ASTEC, Research and Technology: Future Directions, AGPS, Canberra, September 1990, p. 93.

6.13 In 1989, ASTEC registered similar concerns. Although it was fully in support of the increase in external competitive funding for research, ASTEC argued that there was a need for dialogue between granting bodies and grantee organisations with a view to boosting the proportion of the total grants allocated for equipment and other infrastructure costs.[7] In the absence of any significant improvements to the situation, ASTEC went ahead and published its own review of the problem in February 1991.

6.14 ASTEC's conclusions on the issue were largely the same as those presented in many submissions to the present Inquiry, including that from DITAC. Recommendation 9 of DITAC's second submission to the Inquiry stated that:

> ... external funding mechanisms should, wherever possible, provide the full costs (including all overheads) involved in carrying out the research they commission from government research organisations to obviate the need for a subsidy from the budget appropriation ... .[8]

DITAC also recommended that budget appropriations should not be reduced in response to increased levels of external funding.

6.15 The issue of pricing research undertaken for external organisations by public sector bodies has been explored further in a paper prepared for the Coordination Committee on Science and Technology. This paper emphasises the importance of considering all the cost components of research in estimating a price for performing research. If research is underpriced, the reasons for it need to be clearly articulated. One such reason might be the recognition of the broader role of public sector research organisations in maintaining 'a strategic research base for current and future benefit of Commonwealth and other external bodies'. The pricing of research is particularly complicated in the increasing number of cases of collaborative research projects that are being undertaken.[9]

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7. ASTEC, Funding the Fabric: Should Commonwealth Government Competitive Research Granting Schemes Contribute More to Research Infrastructure Costs?, ASTEC Occasional Paper No. 14, AGPS, Canberra, February 1991, p. 2.
8. Evidence, p. S706.
9. Department of the Prime Minister and Cabinet, Office of the Chief Scientist. Costing and Pricing of Public Sector Research, AGPS, Canberra, January 1992, p. 4.

6.16 The Committee believes that priority-setting mechanisms are needed to delineate the extent to which appropriation funds should be used to subsidise the cost of research carried out for external users. The same mechanisms could be employed in relation to establishing the appropriate funding levels for research grants. It is the Committee's view that the full costs of research should be recovered wherever possible. However, it would be of concern if provision for the full costs of each research project funded through grant mechanisms necessitated further reductions in the number of research projects that were supported. It would be particularly important under these circumstance to guard against reducing funds for longer term, more expensive research.

6.17 **The Committee recommends that:**

- **as a general principle, the full cost of carrying out research should be recovered from the user or from research grants obtained from funding bodies.**

6.18 Another aspect of current funding arrangements which concerns the Committee is the mechanisms for the purchase of equipment items worth less than $250,000. Such relatively small items must now be purchased out of general funds provided under Appropriation Act No. 1. The Committee heard evidence that these arrangements have had a deleterious effect on the maintenance programs of some agencies, and CSIRO, ANSTO and AIMS have all raised their concerns with their ministers. The arrangements have been a double-edged sword for some agencies as they have had to trade off the need to repair aging buildings, and replace smaller equipment items against the desire to adequately fund core, public good research programs.

6.19 The Committee supports the recent devolution of responsibility to research agency managers in the allocation of funds. As discussed in Chapter 9, increased decentralisation of authority requires greater skills of middle managers, and there remains a clear need in some agencies to improve the process of decision making in relation to resource allocation.

6.20 Nevertheless, the need for improvements is not located wholly at the level of the organisations themselves. The Committee takes the view that the long term efficiency of the resource allocation process in meeting essential infrastructure needs is being jeopardised by the inadequacy of resources supplied through Appropriation Act No. 1.

6.21 **The Committee recommends that:**

- **the Government provide sufficient funds to research agencies through Appropriation Acts No. 1 and No. 3 to cover the costs of smaller equipment and maintenance purchases and the direct costs of core research programs.**

6.22 The thrust of ASTEC's preferred research funding strategy in the current period of budget constraint has been towards greater support of excellence and high priority research areas rather than spreading available funds thinly across a broader range of activities. The Committee supports this philosophy, and the establishment of centres of excellence such as the Key Centres for Training and Research. However, it believes that the funding of such centres must not be at the expense of the capacity of major research organisations to fulfil their missions or to pursue core public good research programs. The issue of funding for core public good research is further discussed in Chapter 7.

International Collaboration

6.23 The Committee notes that international R & D collaboration in the developed world has increased rapidly in the past few decades. In part, the growth in collaborative arrangements has been a consequence of the rising costs of equipment and facilities. It has also reflected a need to pool scarce skills and knowledge to solve increasingly complex problems. This imperative is particularly important to a country such as Australia, given that its population is too small and its industry too underdeveloped to support massive investments in state of the art equipment and facilities. Yet ASTEC recently noted that, in relative and absolute terms, Australia would appear to devote very few resources to international research collaboration.[10]

6.24 The major research organisations themselves, along with some of our major private sector companies, are currently involved in collaborative research. In addition, university staff and postgraduate students gain access to overseas facilities and expertise through exchange and fellowship programs.

6.25 In response to a perceived need to boost the level of international cooperation, the Government has introduced an International Science and Technology Program which is administered by DITAC. The Major Grants component

10. ASTEC. Research and Technology: Future Directions, AGPS, Canberra, September 1991, p. 27.

of the International Science and Technology Program has received $6.2m since its introduction in 1989. This program, which is to be reviewed in 1992, supports:

- major research collaboration projects;
- major international science and technology conferences in Australia; and
- access to major overseas research facilities.

6.26 The Committee *is in favour of greater overseas collaboration*, and supports ASTEC's suggestion that:

> ... all government departments with a responsibility for research could identify the opportunities for participation in international research programs in their area, and could ensure that such participation is funded adequately.[11]

6.27 The Committee notes, however, that in 1989 ASTEC warned against relying excessively on overseas collaboration as a means of getting around the problem of increasing equipment costs:

> Negotiated access to overseas facilities is rarely a suitable option compared with access to locally installed equipment, except in the case of very expensive items such as cyclotrons or large particle accelerators. ... It should be recognised that scientists who do all or most of their work overseas will contribute more to the host country than to Australia. An excessive reliance on access to overseas facilities may well encourage a brain drain in that area of R & D; it may also be an indication of the need to acquire similar equipment or to move out of that area altogether.[12]

6.28 The Committee was concerned to discover that DITAC does not maintain up-to-date records of the nature and extent of Australian research collaboration with overseas agencies and companies. The Committee has been informed that this situation is due, in part, to the lack of consolidated records of

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11. ibid., p. 83.
12. ASTEC. The Core Capacity of Australian Science and Technology, AGPS, Canberra, April 1989, p. 101.

such activities maintained by the universities, and the difficulty of monitoring relevant private sector activities. Nevertheless, the Committee believes that the possibility of collecting such data should be further investigated by DITAC. The availability of such information is particularly important for sound decision making in relation to the funding of future international collaborative research.

6.29 **The Committee recommends that:**

- **the Department of Industry, Technology and Commerce further investigate means of regularly collecting and publishing information on the involvement of Australian research agencies, higher education institutions and private sector organisations in research collaboration and exchange with overseas organisations.**

Acquisition of Equipment

6.30 ASTEC has produced 10 reports relating to large scale equipment and facilities, of which the last one, for the first time, assessed a range of proposals from the point of view of a long term, national, strategic plan.[13] The need for a national plan has arisen from the increasing complexity and cost of carrying out research, that were noted in Chapter 2. Faced with massive costs for large-scale equipment, a means of selecting which should be supported is essential if public funds are to be well-spent and Australia's scientific and technological base developed in a balanced manner.

6.31 Developing such a national plan entailed the selection of criteria for attaching priorities to proposed facilities in the context of Australia's science and technology needs over the next 10 years. Starting with criteria based on those developed by CSIRO for setting its own research priorities, ASTEC identified two *significant ones. A major, national research facility must bring:*

- benefits to science and technology in terms of national scientific objectives, the need for the facility, whether it is uniquely suitable for Australia and its expected impact, both nationally and internationally; and

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13. ASTEC. Major National Research Facilities: a National Program, AGPS, Canberra, March 1992.

- benefits to the nation that include its significance to industry and national social objectives, and its impact on Australia's international standing.

6.32 Using these criteria, ASTEC has identified seven proposals that merit support in the next five to 10 years, and a further nine that should be considered at a later stage. The seven high priority proposals comprise four 'single platform' facilities, which are each located at one site, two 'networked' or series of linked facilities, and one that would provide access to overseas facilities.[14] The estimated cost of these facilities is $275m over 10 years. The selection of these facilities is seen as the first step in a process that will include a rigorous evaluation of each proposal.

6.33 The Committee welcomes ASTEC's approach to planning for the national research infrastructure. It notes ASTEC's proposal that reviews such as the one just completed should:

- take place at four-yearly intervals;
- provide for the consideration of new proposals for inclusion in the national program;
- include consideration of access to major research facilities overseas where such access is an appropriate alternative to the creation of an Australia-based facility;
- provide for the phasing out of facilities that no longer satisfy national needs and priorities; and
- be closely linked with national priority-setting in research and technology.[15]

6.34 The Committee strongly supports ASTEC's recommendations as an improvement on earlier, more haphazard methods of allocating funds. It believes that the new approach should take into account changes in the capacity of the private sector to fund the purchase of large-scale equipment and facilities.

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14. The seven high priority proposals comprise an upgrade for the Australian Telescope, a high-flux research reactor at Lucas Heights, a marine geoscience research vessel, a mining materials research facility in Brisbane, a tropical marine research network, a very high speed research data network, and access to a synchrotron research facility to be built overseas.
15. ASTEC. op. cit., p. xi.

6.35 **The Committee recommends that:**

- **the Australian Science and Technology Council continue to use and refine its approach to prioritising national needs for large-scale research facilities; and**

- **a regular review of such facilities be undertaken, as proposed by the Australian Science and Technology Council.**

6.36 The Government has recently taken another measure to reduce the cost of scientific and educational materials by acceding to the Florence Agreement, which is officially known as the UNESCO (United Nations Educational, Scientific and Cultural Organisation) Agreement on the Importation of Educational, Scientific and Cultural Materials. Some 79 other nations, including the USA, Japan and New Zealand, are already parties to the agreement. As of 1 July 1991, customs duties no longer apply to imported scientific equipment, books and other educational materials.

6.37 Despite the fact that the removal of duties on imports will considerably stiffen the competition faced by existing Australian scientific equipment suppliers, there is considerable potential for Australia to reduce the proportion of scientific equipment which must be imported, particularly in research fields where future demand is likely to reach the critical mass required for viable production.

An Australian Research Industry

6.38 In this Chapter and in Chapter 5, the Committee has focused on the need to continually upgrade the foundations of Australian research - human resources, facilities and equipment - as a precondition for:

- the achievement of maximum value for money from public research programs;

- the achievement of maximum value for money from expenditures designed to support the commercialisation of research; and

- the growth of more innovative Australian businesses.

6.39 In this section, the Committee suggests that, if sufficient steps to ensure the quality of the research infrastructure are taken quickly enough, it may be possible to capitalise on a spin-off benefit: the opportunity to earn export dollars from an indigenous research and research support industry.

6.40 The AVCC has noted that at least some of the pressing need to replace worn out and obsolete equipment within the universities could be met by the manufacture, within the institutions themselves, of locally developed items at a fraction of the cost of off-the-shelf imports.[16] It cites a survey of British scientific opinion which found that academic equipment constructed in-house was also frequently more state of the art than off-the-shelf items. However, it also points out that the construction of large items of equipment within Australian universities has been limited in recent years due to the decline in general funds available for research purposes.

6.41 Australian researchers already have significant expertise in the development of scientific instruments, and a small, competitive medical equipment industry exists in Australia. At a Workshop on the 'Future of Science and the Direction of Australian Society' held during October 1990 in Canberra, ANU researchers argued that they have developed a range of new instruments which could provide an initial source of competitive advantage worth millions of dollars for an Australian scientific instruments industry. The ARC recognised the need to support research aimed at innovation in this field by naming scientific instruments and instrumentation a priority area for funding in 1990.

6.42 There are no indications that the importance of highly specialised knowledge and skills as a determinant of national income will diminish in the foreseeable future; on the contrary, the demand for research skills and more sophisticated equipment will continue to increase across the developed world. In particular, there may be a viable market for Australian research skills and equipment in a number of newly industrialising Asian countries which still have few highly qualified scientists and technologists.

6.43 However, the establishment of a research industry in Australia will require more than the exposure of research performers and equipment manufacturers to greater competition. It will also require that organisations charged with the development of Australian research talent receive adequate government financial support until domestic industry is sufficiently profitable to play a greater role in the funding of research training and activities.

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16. AVCC, Foundations for the 'Clever Country': Report for the 1992-94 Triennium, the Committee, Canberra, 1991, p. 39.

Chapter 7

MARKET FAILURE AND PUBLIC GOOD RESEARCH

Introduction

7.1 Assessments of the adequacy of public funding for various types of R & D are inevitably the product of a set of more general assumptions on the appropriate role for governments vis-a-vis the conduct and application of R & D. Furthermore, as the Department of Finance suggested in its submission to the Inquiry, the extent to which research funding should be directed by central authorities 'is in large part a political decision reflecting judgements about national needs'.[1]

7.2 ASTEC speaks of a justifiable role for government in the funding or performance of research in relation to two general categories:

- national responsibilities of government; and
- economic development.[2]

7.3 The national responsibilities of the Federal Government, as defined by ASTEC, include areas such as defence, environmental management and regulatory measures in relation to public health. Generally, this type of research is seen as relevant to the capacity of government agencies to fulfil their designated functions efficiently and effectively. The other notional category identified by ASTEC, support for science and technology directed towards economic development, has been nominated by the Government as a high priority within the overall science and technology funding context.

7.4 The precise definition of what constitutes 'national responsibilities' naturally changes in accordance with the political tide and historical developments. Furthermore, the notional separation between 'national responsibilities' and

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1. Evidence, p. S525.
2. ASTEC. The Core Capacity of Australian Science and Technology, AGPS, Canberra, April 1989, p. 1.

'economic development' has limitations as a means of classifying general fields of government intervention in the science and technology system. For example, Science and Technology Budget Statements for the past three years have suggested that a major focus of the science and technology system must be the solution of both economic and environmental problems in the pursuit of sustainable economic development. Clearly, the provision of appropriate support for science and technology directed towards economic development is as much a national responsibility as ensuring that public good environmental or social research vital to Australia's future is performed and applied.

7.5 This Chapter addresses a number of general issues pertinent to the goal of achieving maximum returns on taxpayers' funds invested in public good research. Specifically, it addresses the following issues:

- the effects of current funding mechanisms on the performance of public good research;
- mechanisms for increasing private funding of public good research;
- the capacity of users to pay for access to the results of public good research; and
- the merits and limitations of the economic technique of cost-benefit analysis as a means of optimising the allocation of public funds to different types of public good research.

Market Failure and Public Good Research

7.6 Submissions from relevant departments all offer rationales for public investment and performance of R & D which are couched in terms of the economic concept of 'market failure'. In the context of the research debate, this concept refers to a perception that the private sector will tend to invest less in certain types of research than is socially optimal.

7.7 A paper on cost-benefit analysis by Dr Brian Johnston of ABARE explains why this is the case:

> ... the firm is only going to be concerned with those benefits and costs that affect it directly - the private benefits and

costs. It will not be concerned with those benefits and costs borne by other companies, individuals or the government.[3]

7.8 DITAC suggested two other major reasons for 'market failure' or under-investment in R & D by the private sector:

- the risks involved in research mean that funds may be spent with no return; and
- the small size of many Australian enterprises means that few will have the resources and expertise to conduct research on a sufficiently large scale to produce worthwhile results.[4]

7.9 Most submissions to the Inquiry reflected an agreement that expenditure on research would be a waste of taxpayers' money if it supported research that would have otherwise been funded, conducted and made available to users by the private sector. It is considered that it is appropriate for government to intervene to ensure the performance of this type of research where the desired output is a public good.

7.10 Research outputs which constitute public goods are distinguished from outputs that are 'private goods' in so far as they have the capacity to benefit a much wider range of people than those who actually fund the research or pay for the resulting products. Benefits which accrue to those other than those who fund the research or pay for the product are termed 'spillover benefits' or 'positive externalities'.

7.11 'Market failure' is, in theory, most likely to occur at the 'basic' end of the research spectrum. Such research is much further from the marketable product stage of R & D than strategic or applied research and has significant 'spillover' benefits that cannot be captured by private firms.

7.12 In the case of some technological breakthroughs, the firm which achieves that breakthrough may not be able to control access to the knowledge which has made the breakthrough possible, even if the precise details of the technology involved are the subject of patent protection. Once a product based on

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3. B. Johnston. 'Applying Cost-Benefit Analysis to the Evaluation of Research and Development Activities', paper given to a TASC Workshop on R & D Evaluation, Leura, NSW, November 1990, p. 1.
4. Evidence, p. S670.

that breakthrough has gone to market, other firms may be able to develop similar or spin-off products, which fall outside the ambit of the original patent protection, simply by studying how the new technology works. Although the firm that makes the original discovery may reap considerable competitive advantage from that discovery in the first instance, it will not be able to appropriate all the benefits that accrue from it, and may soon face intense competition from suppliers of similar or alternative products.

7.13 In recognition of the fact that the field of basic research is particularly prone to the operation of market failure, well over 90% of Australian basic research is publicly funded and performed. About 30% of the national basic research effort is performed in government research organisations, such as the CSIRO.

7.14 Nevertheless, as has been pointed out by the Department of Finance, beyond the bottom line of agreement that governments have a major role to play in the funding of basic research, 'market failure' considerations provide 'little guidance for policy makers on the precise level or distribution of government spending that is warranted'.[5] Once it has been established that the market is indeed 'failing' in respect of certain fields of research, the application of the economic technique of cost-benefit analysis may provide much needed guidance as to which specific research projects are most deserving of public funding. The merits and limitations of this technique are discussed in the final section of this Chapter.

7.15 However, before discussing cost-benefit analysis, it is important to consider some more basic issues with respect to the identification of broad areas of 'market failure'. In general terms, disagreements about the adequacy of funding for various types of research can usually be traced back to disagreements about:

- the precise research areas where the market is 'failing'; and
- why such failure might be occurring.

7.16 Attempts to define appropriate forms of government intervention in the R & D system confront a range of contentious questions. For example:

- can it be said that 'market failure' is operating when public sector research produces knowledge with strong commercial

5. Evidence, p. S493.

potential (say, in the field of mariculture) but there are very few firms who are prepared to go out and commercialise that knowledge?

- if the Government thinks the market is 'failing', should it try to send out the appropriate signals to get it functioning, or should it step in with publicly funded research to fill the gap? Is it possible to do both simultaneously?

- how can the Government ascertain whether existing public sector research efforts are 'crowding out' private companies which might otherwise step in to fill the gap supposedly created by 'market failure'?

- where 'market failure' is identified, what is the most cost-effective and efficient way of organising a publicly funded research effort to fill the gap?

7.17 ASTEC stated in 1985 that it believed that:

> ... the present state of research and development in the private sector in Australia requires that the Government involve itself in activities to stimulate private sector capability in the short to medium term until such time as that capability approaches that of comparable countries.[6]

7.18 However, the question must be put: on what basis is a country 'comparable'? Canada is often referred to as a country comparable with Australia. Although its domestic market is only the size of that of a large American state, Canada forms part of a 250 million plus North American market. Should countries such as Australia be comparing themselves with New York State, with California or with countries with comparable populations and market conditions?

7.19 As set out in paragraph 7.8, DITAC's position on reasons for 'market failure' also suggests that, in the interests of economic development, there is and will be a role for public funding of commercially oriented research until such time as some unspecified level of private sector R & D investment is attained. This position is reflected in 'carrot and stick' funding measures which aim to encourage the research organisations to direct their research efforts accordingly.

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6. ASTEC. Public Investment in Research and Development in Australia, AGPS, Canberra, November 1985, p. 25.

7.20 However, it is important that a focus on catching up with other countries or increasing levels of private sector expenditure does not obscure the paramount importance of the returns such investments might yield. Higher levels of private expenditure will do little for Australia if companies research their way into bankruptcy. Likewise, the achievement of arbitrary external funding targets by research agencies will do little to improve the allocation of public resources to research, if reaching those targets leads to an inappropriate balance between long term and short term research efforts.

7.21 If 'market failure' arguments are to be used as the economic basis for government intervention in the research system, the limitations of the construct of 'market failure' as a basis for forward planning must be reflected in specific funding decisions. 'Failures' of the market do not necessarily mean that companies are making investment decisions which are irrational from the point of view of their own interests.

7.22 The actual and potential R & D capacity of the private sector at any particular point in time can only be discovered by trial and error. As pointed out by ABARE in its submission to ASTEC's review of Research Directions for Australia, no system of funding will always lead to the optimal balance between private and public financing of research, mainly because there will always be limitations on the data available for decision making. 'The issue', the submission continues, 'is whether there is scope to move closer to an optimal allocation than at present'.[7] From the Committee's perspective, the optimal allocation at any point in time will be that which fully exploits private sector R & D investment capacity.

7.23 The need to improve the level and utilisation of data on research activities was canvassed in Chapter 4. Data are necessary not only in respect of what research is or is not being conducted; why it is or is not being conducted by particular sectors is also crucially important. The accuracy of forward assessments of market movements will be maximised only where the wider policy climate can remove as many as possible of the disincentives to private companies to invest in research or supply research results to a wider group of users. It is important, then, to continually assess exactly what those disincentives might be and how they might be replaced with positive incentives.

7.24 The Committee therefore takes the view that, if public funds are to be used to fill in 'market gaps' in research, they must be applied in such a way as to avoid providing a disincentive to private companies which might consider investing in these 'gap' areas in response to evolving economic and social conditions.

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7. ABARE. Submission to ASTEC's, Review of Research Directions for Australia, 1991, p. 14.

7.25 In summary, minimising wastage of taxpayers' moneys and maximising the returns on public funds expended requires that:

- the effectiveness of mechanisms designed to increase industry investment in research which the Government currently funds - or cannot afford to fund - are continually investigated; and

- the type of research that is undertaken as a result of these investments is rigorously monitored, to ensure that increased private funding of research is not achieved at the expense of the performance of important public good research.

Public Good Research: Funding Levels and Funding Mechanisms

7.26 The Committee believes that three issues are currently of particular importance to funding for public good research and the cost-effectiveness and efficiency of that funding. These issues are equally relevant to research directed towards economic development and that which falls within ASTEC's 'national responsibilities' category. They relate to:

- the effects of funding practices by government and granting bodies on the capacity of the research organisations to conduct public good research;

- the scope for encouraging the private sector to take over the funding and performance of research in areas which are currently seen as 'national responsibilities', such as the management of the environment; and

- the capacity of those government agencies which are the main users of many types of 'national responsibility' research to access and apply the findings of the research.

7.27 Chapter 6 raised concerns about the adequacy of funds for equipment and facilities within the Commonwealth research system. It was suggested that one consequence of current funding mechanisms was the depletion of capital stock, as grants generally barely covered even the most direct costs of research.

7.28 General appropriation funding is seen by many of the organisations as inadequate to pay for ongoing maintenance and re-equipment costs, particularly now that the research organisations have to make these funds stretch to cover the purchase of capital items worth less than $250,000. Given current funding levels, the major research organisations have found that they cannot conduct adequate maintenance and re-equipment programs unless they cut back on core research programs.

7.29 ASTEC's Funding the Fabric report, released in February 1991, raised concerns about the manner in which funding arrangements were affecting the balance between short term and longer term strategic research within the research organisations, and particularly within CSIRO. In the first place, inadequate funding for infrastructure tends to reduce the quality of the basic research which can be conducted. Secondly, reduced appropriation funds available for core research tends to reduce the amount of longer term research the organisations can conduct. ASTEC stated that 'this is a matter for concern, because it diminishes the base on which future research achievements depend'.[8]

7.30 Reductions in the level of funds which research agencies have at their disposal for longer term strategic research may also affect their capacity to attract required levels of external funding in future years. During one of the Committee's inspections CSIRO officers made the point that, in order to attract the interest of commercial organisations, CSIRO needs to have conducted sufficient strategic research to generate hard data which clearly demonstrates the benefits which will accrue to the firm if it agrees to fund further work. Therefore, reductions in public funding, which supposedly form part of a set of incentives to the research agencies to attract higher levels of external funding, may place research agencies in a 'catch-22' situation. That is to say, insufficient public funds for strategic research may, in the long term, hinder the research agencies in their attempts to attract the 30% external funds required of them.

7.31 A recent independent review of the Australian Animal Health Laboratory (AAHL) pointed to another reason for maintaining long term research capacity. The review noted the high proportion of the AAHL's research which was short term and tactical in orientation, and stressed that appropriation funding for longer term research must be maintained at the very least at current levels. Apart

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8. ASTEC. Funding the Fabric: Should Commonwealth Government Competitive Research Granting Schemes Contribute More to Research Infrastructure Costs, ASTEC Occasional Paper No. 14, AGPS, Canberra, February 1991, p. 16.

from the need to conduct longer term research in the public interest, the Laboratory would not be able to retain or attract excellent scientific staff if it did not provide some opportunity for challenging original research.[9]

7.32 Funding for basic research by the Commonwealth increased in real terms by 24% between 1981-82 and 1987-88. Nevertheless, this 'real' increase may have barely covered the real rising costs of research, which have been somewhere between 3.5% and 7.5% per year.[10] Although funds have been made available for the conduct of research within new research centres such as the CRCs, the work to be conducted in these centres will not provide a substitute for the core public good research relevant to the missions of existing public sector research organisations.

7.33 Finally, the application of the 30% external funding target is inconsistent with the invocation of 'market failure' principles to justify public funding of research.[11] If, in principle, public funding is appropriate in cases where the output of research is a public good, the level of external funding which may reasonably be required of particular research agencies, or sections of particular agencies, needs to be assessed on the basis of full consideration of the nature of the research which is conducted by those agencies or sections.

7.34 **The Committee recommends that:**

- **the Government ensure that funding levels and mechanisms do not compromise the capacity of Commonwealth research agencies to conduct the core research which is necessary to the achievement of their respective missions.**

Contracting Out Public Good Research

7.35 In 1985, ASTEC's report on Public Investment in Australia argued that government departments frequently did not provide the proper environment for the conduct of research relevant to departmental needs. It also noted that, in comparison with many other OECD countries, Australian government departments

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9. CSIRO. Australian Animal Health Laboratory: Program and Priorities Review, June 1990.
10. ASTEC. Profile of Australian Science, AGPS, Canberra, August 1989, p. 3.
11. CSIRO Division of Entomology. Entomological Research and Development: a High Yielding, Low Risk Investment, 1988.

contracted out very little research to the private sector. Accordingly, ASTEC recommended that departments source their research requirements externally on a contract basis and provide details of all contracts let in their annual reports.

7.36 The Committee noted that the Auditor-General's recent review of the operations of the Australian Government Analytical Laboratories (AGAL) recommended that AGAL explore the possibilities of increasing the amount of work it subcontracted to the private sector. It was suggested that:

> ... subcontracting may result in reduced costs (and savings for the clients) and a more efficient allocation of resources within AGAL by avoiding duplication of private sector expertise. It would also provide AGAL with a means of monitoring the capabilities of external laboratories.[12]

7.37 The Australian National Audit Office (ANAO) also made a number of comments which are generally applicable to the need for the public sector to avoid 'crowding out' private sector initiatives in the provision of research services. The ANAO recommended that AGAL continually 'monitor the capabilities of the private laboratory industry', and phase out suitable areas of its public good expertise as private sector capacities in these areas developed.[13] The Committee notes that GBRMPA, for example, monitors private sector capabilities relevant to its role and responsibilities by regularly advertising the existence of its register of consultants in the national press.

7.38 Public sector research organisations differ in the extent to which their public good activities are suitable for contracting out. Furthermore, the services of private sector consultants are not necessarily cheaper or more cost-effective than those of public sector researchers. GBRMPA, for example, told the Committee that:

> In our experience there is no consistent pattern in efficiency or effectiveness of private or public sector consultants. Both sectors have at times been cheaper or more expensive than the other, less or more effective, and better or poorer in

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12. The Auditor-General. Department of Administrative Services - Australian Government Analytical Laboratories, Audit Report No. 21 1990-91, AGPS, Canberra, 1991, p. 42.
13. The Auditor-General, op. cit., p. 19.

> quality of work undertaken. For this reason the Authority has found it necessary to deal with each case on its own merits, with emphasis on prior experience and credibility.[14]

Nevertheless, while bearing these caveats in mind, the Committee strongly concurs with the principles behind the Auditor-General's recommendations for AGAL.

7.39 **The Committee recommends that:**

- **research agencies be required to continually monitor private sector capabilities in relevant research areas, and actively explore the possibilities of subcontracting work to private sector agencies; and**

- **research agencies be provided with sufficient resources to enable them to carry out these functions.**

7.40 Submissions to this Inquiry from a number of Commonwealth departments indicated that they relied on external organisations or independent research bureaux attached to their portfolios for their research requirements. Public and Parliamentary scrutiny of contract research arrangements is, however, hindered by the lack of consolidated data on trends in research work contracted out to the private sector. The ABS does not keep detailed data on the composition of extramural payments for research by government organisations, nor on the percentage of privately performed research funded by Commonwealth agencies on a contract basis.

7.41 **The Committee recommends that:**

- **the Australian Bureau of Statistics collect and regularly publish sufficient information on research contracts let to private industries by government agencies to allow regular monitoring of the extent of this practice.**

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14. Evidence, p. S1857.

Can Users Afford Public Good Research?

7.42 The Auditor-General's report on AGAL raised the issue of how the pricing of public sector research services affects the capacity of users to purchase research services. The Auditor-General noted that AGAL had not always charged its public sector clients the full cost of its public good services because it believed that the full cost would have placed an 'unfair burden' on these clients. The Auditor-General commented that, as AGAL's charter required it to charge the full cost of relevant services, its underpricing practices amounted to a 'subsidy for underfunded programs' in other government agencies.[15]

7.43 During the course of the Inquiry, the Committee heard of other examples of public research users being unable to afford the more commercial prices which research agencies are now encouraged by the Government's policy of charging. Representatives of GBRMPA advised the Committee that the Authority could not always afford to buy the services of AIMS, even though one of AIMS's roles is that of adviser to the Authority. Rather, GBRMPA often contracted its requirements to cheaper private consultants.

7.44 Whilst the Committee is fully supportive of the contracting out of research requirements to the private sector, it is concerned that current pricing arrangements may act to reduce the level of cooperation between public sector agencies, and perhaps to reduce the quality of research undertaken in the public interest. ASTEC has recently expressed similar concerns:

> ... some costs have increased to levels which appear to be restricting access to data and information, a situation that is counter to the national interest. The short-term gains from cost recovery have to be balanced against the benefits which can accrue from the wide dissemination of relevant national interest data and information ... .[16]

7.45 It must be remembered that full returns on public good research will not be achieved if other public agencies, which require access to that research to perform their designated functions adequately, cannot afford that access. From the point of view of resource allocation, there are many excellent reasons for charging at prices which reflect the real costs of research. If the full costs of research are

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15. The Auditor-General, op. cit., p. 19.
16. ASTEC. Research and Technology: Future Directions, AGPS, Canberra, September 1991, p. 96.

passed on, appropriation funding for government agencies or departments, which require access to publicly performed research, must be sufficient to cover these costs.

7.46 Alternatively, consideration should be given to defining those situations in which full costs should not be passed on, in order to ensure that work is carried out in the national interest. The Committee welcomes the paper prepared by the Coordination Committee on Science and Technology on costing and pricing public sector research.[17] This paper represents a useful step in canvassing the issues involved and could contribute to establishing guidelines for selecting which research projects merit being charged for at less than cost.

7.47 **The Committee recommends that:**

- **the Government review the effects of commercial pricing by research agencies on the capacity of users to access and apply that research; and**
- **sufficient appropriation funding be provided to government departments and agencies to enable them to meet the cost of contracting good quality research.**

Cost-Benefit Analysis

7.48 Once it has been established that the market is 'failing' in respect of certain broad areas of public good research at a particular point in time, what is the most appropriate means of allocating scarce resources to the many potential research projects which could shore up some of the gaps in the national research effort?

7.49 There are sound economic and non-economic reasons to improve our knowledge of so many areas of the natural and social world that a persuasive case can be made for public investment in almost any kind of research. Clearly, there will always be more worthwhile research projects than there will be government funds to support them. The Committee therefore shares ASTEC's view that increasing the

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17. Department of the Prime Minister and Cabinet, Office of the Chief Scientist. Costing and Pricing of Public Sector Research, paper prepared for the Coordination Committee on Science and Technology, AGPS, Canberra, January 1992.

proportion of research funds allocated on a competitive basis is a reasonable means for rationing scarce resources for research relating to the Government's national responsibilities.

7.50 In this section, the Committee comments on a number of questions pertinent to the cost-effectiveness and efficiency of the rationing process:

- how should those bodies charged with the responsibility of allocating funds on a competitive basis choose between different research proposals?

- by what means should research agencies allocate the scarce untied research moneys that are available to them?

7.51 Cost-benefit analysis is one approach to answering these questions. Cost-benefit analysis is also useful in evaluating the returns from completed research. Evaluations of this type provide useful indicators of how appropriate past decisions regarding research priorities have been, and information which can be used to continually improve the effectiveness of the priority-setting process. The following issues relevant to the evaluation of research priorities and performance will be discussed in Chapter 9:

- the extent to which cost-benefit analysis provides accurate evaluations of the cost-effectiveness of the public research effort; and

- the adequacy of the funding available to the research agencies and three research bureaux with responsibilities in this area - ABARE, BRR and the BIE - for evaluating the cost-effectiveness of the public research effort.

Cost-Benefit Analysis in the Priority Setting Process

7.52 Economic theory suggests that the efficient allocation of public funds will only obtain when funds are provided to those projects from which the expected return exceeds that from the best alternative use of those funds. The successful application of economic concepts to the funding question is, therefore, predicated on a capacity to quantify the likely returns from research in advance and with a fairly high degree of accuracy.

7.53 However, the value of 'social returns', such as improved quality of life, are more difficult to quantify than 'economic' benefits, and it is not always easy to measure potential social benefits against expected financial costs. Estimating likely returns is particularly difficult in the case of basic research, as it may involve higher levels of risk and produce entirely unexpected social or economic benefits. Furthermore, the final returns on the research may not be apparent for many decades after the initial basic research is conducted.

7.54 In their evidence to the Committee, representatives of both the BIE and ABARE put forward the view that the 'social returns', or secondary benefits, from research are extremely difficult to quantify. Indeed, ABARE representatives noted that the Bureau directs most of its cost-benefit analysis work 'at the applied end of the research spectrum'. In respect of basic research, Dr Johnston of ABARE noted that economists are not generally in a good position to judge the level of risk or the probability of success. He suggested that this was a role better suited to 'a reasonably independent scientific panel'.[18]

7.55 A number of submissions to the Inquiry have suggested that it is important to increase the level of industry representation within agencies which have responsibility for the allocation of competitive research grants. On the other hand, several bodies representing the views of scientists themselves, such as the CSIRO Officers' Association, expressed concern in their evidence to the Committee that an increased national focus on the commercialisation of research may lead to an inappropriate reduction in the level of scientific representation on such bodies.

7.56 The Committee believes that the use of cost-benefit analysis techniques by such agencies to assess alternative research opportunities will be most effective when these assessments are the product of input from those with economic, scientific and commercial expertise. It is important that such expertise continue to be represented on bodies responsible for these assessments.

7.57 **The Committee recommends that:**

- **the Government carefully monitor the level of economic, commercial and scientific representation within research funding agencies to ensure that an appropriate balance between these different forms of expertise is maintained.**

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18. Evidence, pp. 851-2.

7.58 In order to improve the quality of resource allocation decisions within the organisation, CSIRO has developed its own priority-setting mechanism, which ranks competing research proposals against two broad criteria: attractiveness and feasibility.

7.59 The 'attractiveness' variable encapsulates the calculations involved in simple cost-benefit equations, by considering the potential benefits to industry and the nation which might be expected from conducting the research. The 'feasibility' criterion considers a broader range of variables, such as CSIRO's capacity to perform the research and whether or not Australian industry is likely to be able to successfully commercialise the research results. Figure 7.1 provides a graphic representation of this model and Box 7.1 gives details of the attractiveness and feasibility criteria used by CSIRO.

7.60 The Committee congratulates CSIRO on the development and use of this model and supporting criteria. It notes that ANSTO has carried out a similar priority setting exercise to CSIRO. The Committee also applauds ASTEC on recognising the wider applicability of the model in its use of CSIRO's approach to frame its national program for major research facilities. The model can clearly be used both to set national research priorities and, as suggested by ASTEC, to assist planning within individual research agencies.[19] However, as discussed in Chapter 4 of this Report, the success of this technique will depend on the availability of up-to-date information on many issues, such as the capacity of Australian industry to commercialise the products of different areas of research.

7.61 **The Committee recommends that:**

- **the Government consider extending the use of the attractiveness/feasibility model developed by CSIRO in the development of national research priorities; and**

- **other Commonwealth research agencies evaluate the appropriateness of the attractiveness/feasibility model for use in the internal assessment of priorities for the expenditure of untied research funds.**

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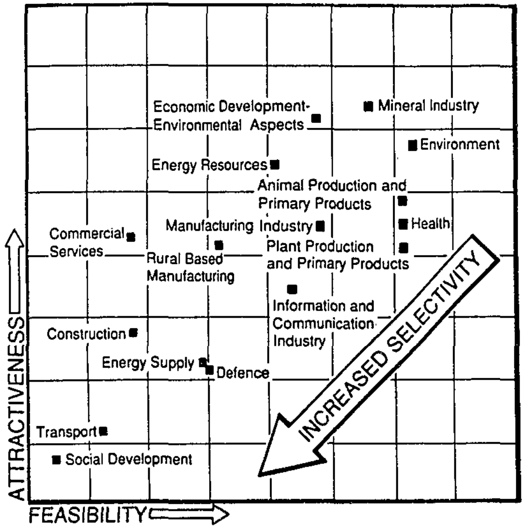
19. ASTEC, Research and Technology: Future Directions, AGPS, Canberra, September 1991, p. 36.

Figure 7.1. CSIRO's National Research Priorities.



Areas of high attractiveness and feasibility warrant strong emphasis while areas of low attractiveness and feasibility warrant only limited support. Other research areas may gain selective emphasis. CSIRO notes that further decision making must necessarily have regard to the full range of conclusions arising from the priority assessment.

Source: ASTEC. Research and Technology: Future Directions, AGPS, Canberra, September 1991, p. 19.

Box 7.1. **Criteria used by CSIRO to Assess Different Areas of Research.**

a. Benefits Criteria.

The research areas are to be assessed according to these criteria for their potential benefits, assuming the research is successful and that the result are successfully transferred, marketed or otherwise exploited. (The feasibility of actually achieving these benefits is considered separately on p. 131.)

R & D Benefits - Economic

Extent of the economic benefits to Australia from research in this area. These include:

- creation of new products, processes or services;
- improvement of existing products, processes or services;
- contributions to lower costs, higher productivity, or the resolution of problems facing the industry; and
- reduced environmental damage costs.

Contributions to an improved balance of trade through wealth creation as above, but with particular attention to current or potential export or import replacing industries able to capture a greater proportion of the net value of products in Australia.

R & D Benefits - Social

Extent of social benefits from research in this area. These include:

- community health;
- education (generally and in relation to workplace skills);
- creation of employment opportunities;
- quality of life (not included elsewhere under economic or environmental); and
- security.

R & D Benefits - Environmental

Extent of environmental benefits from research in this area. Note that much environmentally directed work leads to substantial economic benefits which should be taken into account under that criterion. Here the focus should be on environmental benefits which would not be included in an economic assessment. These include:

- achievement of sustainable resource use which would be rendered insignificant by conventional discounting procedures;
- basic background knowledge and understanding required to address problems and assess risks; and
- intangible benefits which cannot be quantified.

b. **Feasibility Criteria.**

These criteria are designed to assess whether the benefits of research in particular areas (assessed under the benefits criteria) can actually be achieved within a reasonable time.

Research Prospects

Fertility of the field in Australia.

Availability of necessary scientific and technical skills.

Research Costs

Resources required to mount an internationally competitive research effort in the field.

Technology Transfer

To what extent are there Australian based/owned companies or agencies able to exploit the results of research for this purpose?

- Have they the necessary skills?
- Are they willing to make the necessary investment to bring the new technologies to market?
- Have they access to international distribution and marketing networks?

If suitable Australian based/owned companies do not exist, can arrangements be made in which substantial benefits are retained in Australia?

Competitive Advantage

Can research in this area build on an existing competitive advantage? That is, by using the industry which enjoys the competitive advantage as a vehicle to carry its technology to the international market (the technology itself might not relate to the advantage).

Can research increase or create a competitive advantage where little or none exists? The research results would constitute the advantage.

Political Acceptability

Are there any special political or other considerations which affect the feasibility of exploiting the results of work in this research area?

Source: Evidence, p. S912-3.

Chapter 8

HIGH PRIORITY PUBLIC GOOD RESEARCH ON THE ENVIRONMENT, INDUSTRIAL NEEDS AND SOCIAL ISSUES

Introduction

8.1 In recent years, a number of reviews of funding for research related to various 'national responsibilities' have argued for shifts in funding priorities towards certain key areas of research. Calls for greater funding have come from Committees of this Parliament, ASTEC, CSIRO and a wide range of interest groups.

8.2 Among those fields of research which have received attention are:

- health and medical research;
- environmental research;
- research directed at the development of various sectors of Australian industry; and
- social research into a variety of contemporary social problems.

8.3 The Committee has selected the last three of these fields for attention in this Chapter. Although the Committee considers the public funding of health and medical research to be of enormous importance to the lives of Australians, it has not been possible to cover this particular field within the time available to the Committee. The Committee does, however, note ASTEC's claims that 'some areas of Australian health research are not supported well enough to meet national goals and strategies, and some programs lack coordination'.[1]

8.4 Another area of research that is of great significance but not dealt with in this Report is Australia's Antarctic research program.

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1. ASTEC. Research and Technology: Future Directions, AGPS, Canberra, September 1991, p. 76.

8.5 Environmental research and research directed at the development of Australian industry were given particular attention by the Committee for two major reasons. Firstly, they have been identified as priority areas by the Government. Secondly, rationalisation of funding in these areas seems warranted, as is the provision of additional funds.

8.6 A number of recent assessments of environmental research and evidence provided to this Committee by the then Department of the Arts, Sport, the Environment, Tourism and Territories (DASETT)[2] and relevant research agencies suggested the need for further scrutiny of environmental research funding matters

8.7 Australia is one of a small number of countries that has been identified as having a natural environment characterised by great biodiversity. It is clear that increased funding now for many types of environmental research could save Australian taxpayers millions of dollars in the future. Research necessary to ensure the preservation of existing resources will help to reduce the need for public expenditures on crisis management measures in later years.

8.8 The case for increased expenditure on environmental research is not based only on quality of life issues; it is also directly linked to the long term health of the Australian economy. A report by CSIRO's Institute of Natural Resources and Environment stressed the adverse long term economic consequences of continuing to mismanage our natural resources. The seriousness of these consequences is easily underestimated, because the economic and social costs to society of overexploitation and pollution of resources are 'overlooked in the traditional national accounts'.[3]

8.9 This Chapter first addresses the following issues, and related funding matters, in relation to environmental research:

- the inadequacy of the knowledge base on which environmental research policy and environmental management decisions are made;

- the need for improved environment information management;

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2. DASETT was subdivided when the Department of Tourism was established in December 1991 and become the Department of the Arts, Sport, the Environment and Territories (DASET).
3. CSIRO, Institute of National Resources and Environment, Australia's Environment and its Natural Resources - An Outlook, CSIRO Institute of National Resources and Environment, Dickson, ACT, 1990, p. 3.

- the need for an improved system of coordination of the research effort;

- the lack of current research expertise in a number of areas; and

- the role the private sector might play in the funding and performance of environmental research.

8.10 The second section of this Chapter addresses several issues relating to public good research that are directly relevant to the needs of Australian industry Specifically, it comments on the following:

- the danger that public funding of longer term industrial research is 'crowding out' the investments of private companies; and

- the possibility that the Commonwealth is 'wasting' taxpayers' money on longer term industrial research that might have attracted full private sponsorship.

8.11 In the final section of this Chapter, the Committee comments on the need for research into the social ramifications of technological change. Here it is argued that such research should complement support for technological innovation itself, as there is evidence that a greater understanding of the social consequences of the 'technologising' of society may afford long term savings to the Government and the community.

Environmental Research

8.12 Although direct power in relation to management of the Australian environment rests, in theory, with the States, the Commonwealth performs some 60% of all public sector environmental research, and its share of total funding has been rising significantly in recent years.

8.13 CSIRO conducts a large proportion of Commonwealth environmental research, whilst much of the remainder is conducted by research organisations which report to the Ministers for the Arts, Sport, the Environment, and Territories, and the Minister for Primary Industries and Energy. The Commonwealth is also the major supporter of environmental research conducted within higher education institutions, although these institutions also receive funds from the private sector and overseas sources. A recent development in Commonwealth support of environmental research is the establishment of six CRCs with a strong or dominant environmental theme.

8.14 Environmental research is carried out under the umbrella of the Department of the Arts, Sport, the Environment and Territories (DASET) by:

- the Bureau of Meteorology;
- the Great Barrier Reef Marine Park Authority;
- the Office of the Supervising Scientist for the Alligator Rivers Region;
- the Australian National Parks and Wildlife Service, which includes:
  - the Australian National Botanic Gardens;
  - the Australian Biological Resources Study; and
  - the Environmental Resources Information Network; and
- the Australian Heritage Commission.

The Need for More Environmental Data and Improved Environment Information Systems

8.15 The Committee received a submission to the Inquiry from the Conservation Division of DASETT in September 1989. At the time, the Conservation Division was responsible for programs which endeavoured to protect the environment and harmonise conservation and sustainable development through:

- environmental impact assessments; and
- the development and maintenance of appropriate standards and measures of environmental quality.

8.16 DASETT's submission stated that:

> The knowledge base on which the work of the Division is run - both in making decisions on cases (e.g environment impact assessments or sea dumping permits), and in providing soundly-based policy judgements - is inadequate. This is due to the fact that insufficient research is undertaken, partly resulting from inadequate levels of funding. A consistent difficulty in the work of this Division is that the issues on which the Minister needs to be advised do not always have a strong scientific base. A recent example is the Senate Inquiry on Agricultural and Veterinary Chemicals.
>
> It is a common occurrence that when a new issue emerges, particularly in the environment area, the existing knowledge base is inadequate, the required research has either never been undertaken or has not been made available. The necessity of providing extra funds by the Government for greenhouse research is a clear example.
>
> The Division covers a large range of issues which have an ever changing nature, making it difficult to retain experts in-house. The Division must therefore rely on research done outside the Department, which as mentioned is often unavailable, or use consultants. Any increase in funding which would broaden the range of environmental research could only improve the quality and relevance of the work done in the Division.[4]

8.17 These comments accord with findings presented in ASTEC's April 1989 report on The Core Capacity of Australian Science and Technology, specifically, that 'Australia's level of expertise is relatively strong, but thinly spread and non-existent in important areas'.[5] ASTEC's four-volume review of environmental research in Australia, published in 1990, again notes the 'dearth of environmental data' on which to base resource management decisions.[6] These observations were one of the catalysts for the extra funding for the environment provided in the Government's July 1989 Environment Statement.

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4. Evidence, p. S799.
5. ASTEC. The Core Capacity of Australian Science and Technology, AGPS, Canberra, April 1989, p. 67.
6. ASTEC. Environmental Research in Australia: a Review, AGPS, Canberra, June 1990, p. 93.

8.18 Nevertheless, the need for an intensified research effort was stressed again by several departmental witnesses in October 1990:

> ... all the baseline data, ... that we really need if we are to do ... our work in the most effective way, simply does not yet exist in Australia.[7]

> ... it is hard to pinpoint anywhere where we would not benefit from further research.[8]

8.19 Departmental witnesses suggested that the heated debates between interest groups over resource use decisions could be resolved more readily if there was better access to information.[9] ASTEC's 1991 report, Research and Technology: Future Directions, again repeated the point that:

> ... there is no coordinated long-term research and baseline monitoring of the environment to provide the necessary data for informed decision making by government.[10]

8.20 Research into biological systems is distinguished from much research in the physical sciences or in manufacturing technology by the fact that it must deal with constant changes in those systems. If unforeseen effects of human use, or sudden natural changes to these systems, are to be identified and dealt with quickly, these systems must be continuously observed and investigated.

8.21 Recommendation 4 of ASTEC's report, Environmental Research in Australia: the Issues, stated that the Government should:

(a) fund a system of national long-term monitoring and research sites to assess environmental change; and

7. Evidence, p. 202.
8. Evidence, p. 207.
9. Evidence, p. 206.
10. ASTEC. Research and Technology: Future Directions, AGPS, Canberra, September 1991, p. 65.

(b) co-ordinate and where necessary fund long-term baseline research to support the development of national quality standards.[11]

8.22 The Committee concurs with this recommendation and notes that a number of initiatives have been taken in the last two years to establish monitoring programs, particularly in relation to climate change. However, much still remains to be done.[12]

8.23 **The Committee recommends that:**

- **further steps be taken by the Government to finance and coordinate sufficient long term baseline research and monitoring to enable the assessment of environmental change.**

8.24 ASTEC has recently expressed concern that:

> ... the environment research dollar is being spread more thinly than in previous years.[13]

Furthermore:

> ... pressure for instant answers to an array of high profile problems ... has drawn research scientists and funds away from fundamental, long term research in taxonomy, entomology and soil science.[14]

8.25 The diminution of funds available for core long term research and data collection in these fields concerns the Committee. Reducing funding for these activities does not make long term economic sense. CSIRO's 1990 report, Australia's Environment and its Natural Resources - an Outlook, suggests that much of the

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11. ASTEC. Environmental Research in Australia: the Issues, AGPS, Canberra, December 1990, p. 41.
12. Evidence, pp. S1866, S1869.
13. ASTEC. Environmental Research in Australia: a Review, AGPS, Canberra, June 1990, p. 85.
14. ASTEC. loc. cit.

enormous damage that has already been sustained by our natural environment has *occurred because successive Australian governments have not invested enough in the* acquisition of knowledge about the nature of Australia's ecosystems.

8.26 The economic ramifications of reductions in public investment in fundamental basic research in many biological fields are enormous. Entomological research provides an example of one such field. The savings and wealth that entomological research has already generated for Australia and the potentially huge savings that would result from relatively small increases in funding for this activity have been documented by CSIRO's Division of Entomology.[15]

8.27 **The Committee recommends that:**

- **the Government take action to redress the reduction in funding for long term basic research in taxonomy, entomology and soil science.**

Coordinating and Monitoring the Research Effort

8.28 In May 1988, the Commonwealth Government established a National Resource Information Centre (NRIC), located within DPIE. NRIC is based on a computer directory of sources of resource information. It provides users with information about where, how and from whom available data may be accessed. A further development was the establishment of the Land and Water Resources Research and Development Corporation (LWRRDC) in 1990. The functions of the LWRRDC include monitoring research relating to Australia's natural resources.

8.29 Although the establishment of NRIC was a much needed step towards *the coordination of information relevant to environmental management,* ASTEC's April 1989 report, The Core Capacity of Science and Technology, suggested that much more needed to be done in this area. Specifically, it argued that DASETT:

> ... should consider whether the Commonwealth's responsibilities in the broadly environmentally related areas

15. CSIRO. Entomological Research and Development: a High Yielding Low Risk Investment, Canberra, 1988.

are presently being well enough supported and coordinated.[16]

8.30 In response, the Government's July 1989 Environment Statement announced the provision of funds for the establishment of an Environmental Resources Information Network, a Resources Assessment Commission and a National Forest Inventory.

8.31 Furthermore, during 1990, there were a number of rather complex changes to the structure of those areas of DASETT responsible for the environment. Amongst other things, the changes involved the establishment of a new Environment Program within DASETT, which combined the old Conservation and Natural Environment Programs.

8.32 The aim of the Environment Program is:

- to encourage an integrated approach to the protection and enhancement of the environment and the ecologically sustainable use of land and natural resources;
- to promote and provide for the identification and protection of the terrestrial and marine environment which is of national and international significance; and
- to enhance the quality of the environment and avoid or minimise risks to or degradation of the environment by:
  - providing information and advice on the environmental effects of proposals for projects and policies to decision makers and the general public;
  - establishing and monitoring environment quality standards; and
  - developing effective legal and administrative regimes for managing activities affecting the environment.

8.33 In evidence provided to the Committee at a public hearing in October 1990, the DASETT advised that it expected that the establishment of a new position

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16 ASTEC The Core Capacity of Australian Science and Technology, AGPS, Canberra, April 1989, p. 67.

within the Department, that of Chief Science Adviser, might lead to better coordination of research commissioned within the portfolio. The Chief Science Adviser has, as part of his role, responsibility for advising and reporting to the Minister and Secretary, carrying out reviews and liaising with the wider scientific community.

8.34 Nevertheless, departmental representatives agreed that there was still no body with an overall coordination role in respect of environmental research in Australia. DASETT apparently did not at the time keep a monitoring brief on relevant public sector environmental research: 'we really do not have any overall charter to look at environmental research across the board'.[17] Recent information provided by the Department indicates that this situation persists.

8.35 Information collection, coordination and dissemination were also major themes of ASTEC's 1990 review of environmental research. ASTEC commented that, despite the positive initiatives already taken, the nature and extent of environmental research were not known at the commencement of the review.[18] The review paid considerable attention to the difficulties that ASTEC experienced in attempting to compile sufficient information to make a fully informed assessment of research needs and necessary modifications to existing programs.

8.36 Evidence provided by DASETT corroborated ASTEC's argument that there remains a pressing need for improved information systems to synthesise what is known on particular problems and topics and to provide a base for quality advice to the Government.

8.37 Furthermore, in its report Research and Technology: Future Directions, ASTEC identified a need for greater coordination of the research efforts of State and Commonwealth departments. Evidence received by ASTEC suggested that 'priorities in environment programs frequently reflect competing portfolio interests rather than the national interest'.[19]

8.38 Despite recent initiatives by the Government to investigate and clarify the prerequisites of ecologically sustainable development of the nation, ASTEC felt the need to repeat its earlier recommendations regarding the need for a national environment strategy in its report. The Committee shares ASTEC's view and

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17. Evidence, p. 199.
18. ASTEC. Environmental Research in Australia: a Review, AGPS, Canberra, June 1990, p. 7.
19. ASTEC. Research and Technology: Future Directions, AGPS, Canberra, September 1991, p. 63.

welcomes the signing of the Intergovernmental Agreement on the Environment (IGAE) by the States, Territories and Commonwealth Government in May 1992.

8.39 The IGAE provides a means by which a cooperative national approach to the environment can be developed. It embraces the need 'to achieve sustainable land use and to conserve and improve Australia's biota and soil and water resources' through attention, among other things, to:

- data collection and handling;
- resource assessment;
- environmental impact assessment;
- natural environment protection measures;
- climate change; and
- biological diversity.

The Committee believes that the IGAE represents a first step in the direction of establishing a national environment strategy and should be further developed.

8.40 **The Committee recommends that:**

- **the Government provide further support for the development and coordination of Commonwealth and national environmental research priorities.**

Shortages in Environmental Research Expertise

8.41 It is apparently not only an absence of funding which limits the collection of urgently required baseline environmental data. Qualified researchers in particular fields are also lacking. ASTEC and the Department agree on the inadequacy of the current and prospective supply of research expertise in certain areas.

8.42 In <u>Environmental Research in Australia: a Review</u>, ASTEC stated that the 'poor recruitment of scientists and the rapidly ageing structure is very important in the environmental sciences'.[20] It also pointed to a need to restructure the universities to accommodate and stimulate the interdisciplinary studies which are crucial to solving environmental problems.

8.43 In his evidence to the Committee, the Director of the Australian National Parks and Wildlife Service suggested that, although there were still huge gaps in the baseline data on indigenous species, there was a limit to the extent that investing more money in research itself would advance that situation. Although some extra funds could be absorbed, funds were also needed to ensure a supply of researchers to conduct the required work:

> It is not an area in fact where one can say, 'If the Government made $500m available for the next 10 years, could you not fix it?'. The answer is no, because there are not the people who have been trained. It is a field where classically you have the idea of someone working in the dusty bowels of a museum poring over insects or worms or so on. This has proved in the last 20 years or so not to be an attractive field for teaching or research.[21]

8.44 **The Committee recommends that:**

- **the Government support a research training program to ensure an adequate supply of highly qualified environmental researchers, in accordance with Recommendation 2 of ASTEC's report, Environmental Research in Australia: the Issues.**

The Roles of Government and the Private Sector in Funding and Performing Environmental Research

8.45 Environmental research provides an example of potential synergies between publicly performed and funded research and the activities of the private sector. First, *the case for both public and private funding of environmental research* is a strong one. As ASTEC noted, the environmental research currently conducted

20 ASTEC. Environmental Research in Australia: a Review, AGPS, Canberra, June 1990, p. 91.
21. Evidence, p. 205.

by the private sector is predominantly short term and firm specific. It 'makes only a limited contribution to an integrated approach to environmental research'.[22]

8.46 Public research, on the other hand, meets not only the long term needs of the nation as a whole, but also the more immediate needs of private companies themselves. The collection of baseline environmental information frequently involves research of a public good nature, and it may also be a prerequisite for the private sector to invest in research directed at solutions to specific environmental management problems. ASTEC pointed out that:

> Environmental research tends to be a multi-disciplinary activity which draws on the traditional sciences across a range of disciplines for particular applications. High quality basic science is necessary for the applied environmental research that ultimately follows. [23]

8.47 Furthermore, due to its 'commercial-in-confidence' status, information on new environmental technology developed within the private sector to improve efficiency or meet regulatory requirements is not available to benefit other potential users, unless and until it is marketed as a product.

8.48 The Committee examined whether public sector funding and performance of environmental research currently 'crowd out' private sector efforts. The Committee was also concerned to establish how the Government can ensure that taxpayers' funds are not spent on research for which there is a clearly identifiable group of users who might contribute to the costs.

8.49 ASTEC reported that 'only the largest resource development industrial corporations have their own environmental staff'; the little in-house research that is conducted is generally very company specific.[24] The more common pattern is for companies to rely on consultants, including public sector research organisations, on an 'as needs' basis.

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22. ASTEC. Environmental Research in Australia: a Review, AGPS, Canberra, June 1990, p. 59.
23. ibid, p. 6.
24. ibid, p. 59.

8.50 Nevertheless, a recent feature of Australian Business magazine notes that:

> ... the environment as a business enterprise is becoming all-pervasive. Entrepreneurs and business leaders no longer view the environment or environmental issues as an unnecessary cost factor, but are starting to recognise that 'one man's waste is another man's fortune'.[25]

8.51 Environmental technologies have been identified as 'the boom industry of the world ... predicted to be worth more than $1,000 billion by 2000'.[26] DITAC has commissioned and conducted research into the area of waste management technology, and predicted that an Australian waste management export sector could bring in some $6 billion a year by the turn of the century.[27]

8.52 This opportunity provides an example of successful innovation based on Australian research which has the potential to work in the public and the private interest simultaneously. It could reduce our trade imbalance, preserve the natural environment and provide jobs for Australians in innovative Australian businesses.

8.53 Public sector research has already provided the basis for a number of private sector opportunities, for example, the planned commercialisation of CSIRO's sewage treatment process, Sirofloc, by Siddons Ramset. Environmental audit and monitoring is another area that has become a certain growth industry with the advent of new environmental regulations. Although some government laboratories, such as the Office of the Supervising Scientist (OSS), provide monitoring services, this has not stopped private companies entering the market. ICI, for example, now has a team which is reaping profits providing these services to industry on contract.

8.54 Two recent reports on the waste management industry, commissioned by DITAC, indicate the scope for industry initiatives in the field of environmental

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25. J Arbouw, 'Environmental Solutions - Birth of a New Industry', Australian Business, Vol. 11, No. 35, 26 June 1991, p. 47.
26. Arbouw, loc. cit.
27. B O'Gallagher. Waste Management Technologies: Opportunities for Research and Manufacturing in Australia, DITAC, August 1990, p. xiv.

technology[28] Recommendation 3 of ASTEC's Environmental Research in Australia: the Issues also argued that:

> ... the development of environmentally benign technologies for cleaner production [should] be recognised as a priority by the Commonwealth Government through the funding criteria of its industry research and development programs.[29]

8.55 In response, the IRDB announced that environmental technology would be made a priority area for funding. A number of Australian companies were awarded grants for projects which draw on the expertise of public sector researchers in the universities and other Commonwealth organisations, such as CSIRO. A Cooperative Research Centre for Waste Management and Pollution Control, which involves industry, universities and Commonwealth and State agencies, was established in March 1991.

8.56 Whilst there is no apparent evidence of 'crowding out' of private efforts by public research agencies at the current time, the situation must be monitored so that the Commonwealth does not invest resources in areas where the private sector is developing the capacity to fulfil private demand and/or government requirements.

8.57 The detection of overlap between public and private environmental research, and effective Parliamentary scrutiny of this issue are currently hampered by the limited collection and dissemination of relevant data. To date, it has been extremely difficult to estimate the level of private sector environmental research, as the ABS has not collected private sector data by socio-economic objective.[30]

8.58 In its 1990 review of environmental research, ASTEC recommended that the ABS compile and publish more detailed breakdowns of environmental research such as those it currently provides for energy research. At present, the ABS collects data on this topic only from non-profit organisations, which include government agencies, higher education bodies and privately funded organisations. The Committee believes that comparable data for the private sector would be useful

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28. O'Gallagher, op. cit. and K T Hubick. Management and Technologies of Wastes: a Perspective - Australia 1990, DITAC, February 1991.
29 ASTEC Environmental Research in Australia: the Issues, AGPS, Canberra, December 1990, p. 35.
30 ASTEC. Environmental Research in Australia: a Review, AGPS, Canberra, June 1990, pp. 83-4.

8.59 **The Committee recommends that:**

- **the Australian Bureau of Statistics regularly collect data on the nature and extent of private sector environmental research, and publish detailed breakdowns of publicly and privately performed environmental research.**

8.60 There is also scope to optimise the allocation of public research funds; user pays principles could be extended to more areas of publicly performed environmental research, and the money previously used to fund this research redistributed through the Commonwealth research system. A report by CSIRO's Institute of Natural Resources and Environment addressed this issue, and proposed a number of principles as a basis for improving the mix of public and private funding for environmental research:

- a polluter pays principle;
- a user pays principle which requires users to pay the full lost opportunity cost and replacement cost of natural resources to society; and
- an offsets principle according to which any future developments likely to cause additional environmental degradation should be offset by environmentally positive investments elsewhere so that there is no net loss of environmental quality.[31]

8.61 One of the principles of environmental policy adopted in the IGAE is charging users, including polluters, for their activities. Acting on these principles, one of the means by which the private sector might contribute more to research is through the imposition of a levy on industries such as tourism, waste disposal and forestry, which benefit from and utilise natural resources and the environment. Such levies or 'pollution taxes' will inevitably increase consumer prices of relevant products and services, an effect which may help to reduce the demand for pollution-creating products. Nevertheless, these potential solutions to funding problems raise a number of complex issues which require serious examination.

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31. CSIRO Institute of National Resources and Environment. Australia's Environment and its National Resources: an Outlook: Key Issues Summary, CSIRO Institute of National Resources and Environment, Dickson, ACT, 1990, pp. ix, xi..

8.62 **The Committee recommends that:**

- **the Government address the potential of user pays mechanisms in the area of environmental management in order to achieve a better allocation of public and private resources in the field of environmental research.**

Public Good Research Directed Towards Economic Development

Basic Industrial Research in Australia

8.63 The OECD's report Technology and Global Competition suggested that 'access to basic research has become a crucial prerequisite for the progress of technology'. This development has led Japanese, American and European companies 'to experiment with new strategies for more direct access to basic research, including *strategic partnering with public domain research laboratories*'.[32]

8.64 The development of new technologies and the increasing ferocity of global competition have also 'added substantially to the investment thresholds required for successful industrial manufacturing'.[33] The need to pool the ever increasing costs of complex basic research has led to a large increase in the level of pre-competitive research cooperation between firms. At the same time, companies are also increasingly blocking the access of 'outsiders' to the results of strategic research in new technology areas.

8.65 Although a handful of Australian firms, such as Comalco, have invested in joint basic research projects with overseas companies, most Australian companies are too small to afford the large investments in basic research which may hold the key to maintaining or developing a competitive edge.

8.66 The Government has taken a number of steps to attempt to increase the level of basic or longer term industry research which is conducted in Australia. For example, support of excellence in longer term research projects, which pool expertise from the public and private sectors, is amongst the objectives of the CRC

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32. D Ernst and D O'Connor, Technology and Global Competition: the Challenge for Newly Industrialising Economies, Development Centre, OECD, 1989, Paris, p. 23.
33. Ernst and O'Connor, loc. cit.

Program announced in the May 1989 Science and Technology Statement. As at December 1991, the establishment of 26 centres had been announced.

8.67 Likewise, the Generic Technology Grants Scheme supports public and private collaboration in longer term research related to strategically important new technologies. Such technologies will provide the springboard for further innovation by individual firms.

8.68 According to witnesses from DPIE, the R & D Corporations established under legislation for rural and energy industries are conscious of the strategic importance of basic longer term research:

> ... with the withdrawal of government appropriations to CSIRO these bodies ... have had to take a more active role and fund a greater proportion of CSIRO work.[34]

8.69 One function of the Primary Industries and Energy Research Council, which is discussed in Chapter 2 and includes executives of major research organisations conducting rural research, is to monitor broader issues such as the optimal mix of applied and strategic research across the rural and energy industries.

8.70 Examining the extent to which longer term research is carried out in the private sector in Australia highlights the likelihood of 'market failure'. Specific market conditions, such as the high cost of capital, may lead firms to under invest in longer term research, even if the investment is highly likely to generate large returns. In such conditions, a firm may not invest even if the returns it is likely to reap are so high that the potential for 'spillover benefits' to other parties or the wider public does not constitute a significant disincentive to investment.

8.71 During an informal exchange with several Sectional Committee members, the R & D manager of one of Australia's top five companies suggested that such companies are tending to make R & D investment decisions on the basis of cost-benefit formulas which, whilst making short term commercial sense from the point of view of the company, are not in the long term interests of the nation. This perspective receives support from data collected by the IRDB for its review, Industrial Research in Australia.[35]

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34. Evidence, p. 781.
35. Research Committee of the IRDB. Industrial Research in Australia, Vol. 2, 1990, p. 8.

8.72 The BIE's report, Commercial Opportunities from Public Sector Research, couches the problem in similar terms:

> ... some government funding of particular strategic research projects which are aimed at commercial results is still required, as Australian industry is probably not sufficiently developed to adequately assess their commercial potential while the research is at an early stage. This is often felt to be the case when research projects are in very new technology areas that may form the basis for quite new activities and no significant returns are expected in the short-term.[36]

8.73 Yet significant gains in industrial knowledge tend to produce many 'positive externalities' and hence have a positive 'multiplier' effect all through the economy. Indeed, the total social return to sound basic industrial research investments is frequently so high that it is categorically in the public good for the Commonwealth to strongly support the conduct of such research, where factors such as poor capital availability hinder private investment.

8.74 Representatives of the major R & D performing Australian companies are certainly in favour of further government support of long term research, and value the expertise which is available from the large industry-oriented research organisations like CSIRO.

8.75 Industry also clearly sees a role for government funding of long term research, even in sectors where industry is already funding relatively high amounts of this type of research. An example of this is Australia's highly profitable value-added minerals sector, which invested in some $160m worth of R & D in 1989-90.

8.76 As part of the evidence that AIRG presented to the Committee in November 1990, Comalco provided a sketch, which is shown in Figure 8.1, of the role it saw as appropriate for the Government in the funding of minerals-related research. The company clearly preferred that the Government take a greater role in funding public/private, collaborative, pre-competitive R & D for Australian industry.

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36 BIE Commercial Opportunities from Public Sector Research, Research Report 32, AGPS, Canberra, 1990, p. 94.

Funding Arrangements: Issues of Concern

8.77 The Committee has made a number of comments in this Report on the consequences of reducing the proportion of total funds for research agencies which are provided directly to the agencies through Budget appropriations. However, the Committee does not question the need to apply some form of user pays mechanism as a means of minimising wastage of public funds and redirecting the efforts of research agencies towards industry objectives.

8.78 Nevertheless, the Committee views with some scepticism the ultimate cost-effectiveness of certain aspects of current user pays funding mechanisms. The following are treated in this section:

- the effect of external earnings targets on the balance between short and long term research;
- the levy system applying to certain primary industries; and
- arrangements for the funding of industry-relevant research by agencies, such as R & D Councils and Corporations, which are partly funded by the Government.

External Earnings Targets

8.79 In its submission, AIRG expressed concern at the effects of the current thrust towards user pays in funding for major research organisations. It suggested that some divisions of the research organisations:

> ... are being driven by short term commercialisation and survival constraints under the present government policy to make science pay its own way. This conflict is clearly distorting the long-term nature of research and balanced industrial interaction.[37]

The submission goes on to suggest that 'a small proportion of the CSIRO's budget should be set aside for long term strategic research'.[38]

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37. Evidence, p. S252.
38. Evidence, p. S253.

8.80 CRA provided a particularly clear and well argued submission to ASTEC's inquiry into Research Directions for Australia's Future. The submission pinpointed another aspect of current funding mechanisms which requires review: the 30% external funding target which has been applied to CSIRO, AIMS and ANSTO by the Government. CRA claimed that:

> ... requiring 30% funding direct from industry may be inappropriate. This particular move is resulting in too much short term work, often of a consulting nature, at the expense of developing the stock of centres of excellence at the leading edge of world science and technology.[39]

8.81 ANSTO's submission to this Inquiry expressed similar concerns:

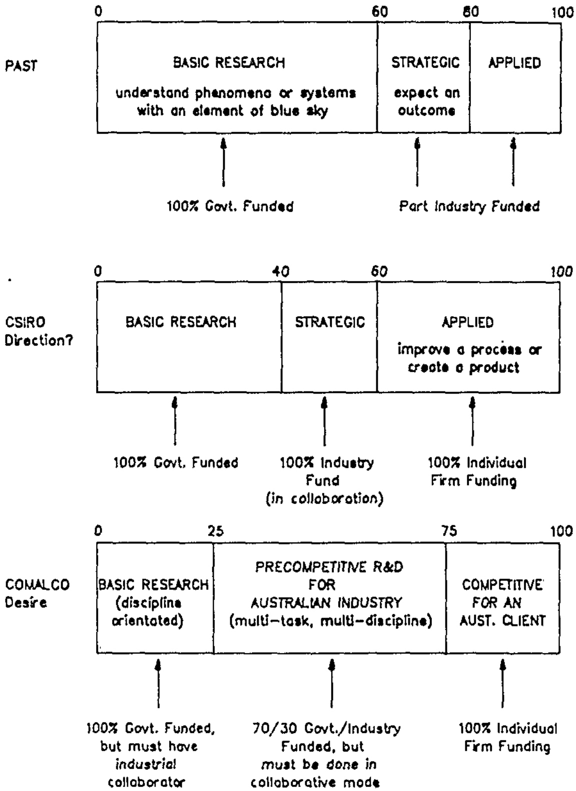
> The provision of consultancy services presents ANSTO with a dilemma. On the one hand ANSTO's consultancy services are highly successful in terms of demand, which is indicative of the requirements of Australian Industry. The income generated in these commercial operations also provides ANSTO with discretionary monies ... On the other hand, the use of highly experienced scientists to solve routine problems in industry may not at times be cost effective and certainly reduces the time these scientists can allocate to retaining basic expertise in areas of nuclear technology considered important to Australia.[40]

8.82 A related point is raised by AIRG's submission to the Inquiry. It suggested that restrictions on salaries for public sector scientists may make it easier for private companies to 'headhunt', but will not benefit Australian industry as a whole:

> Although in the short term it may benefit some members of industry in the longer term it may lead to a loss of the expertise in specialist groups and a diminishing of the breadth of the technical resources of CSIRO. The size of Australian industry is often such that individual companies can seldom afford to maintain highly specialized groups which may be vital for them to compete in the export

39. CRA. Submission to ASTEC's inquiry into Research Directions for Australia's Future, February 1991, p. 10.
40. Evidence, p. S37.

Figure 8.1. **Balance and Funding of Minerals Research in CSIRO.**



Source: AIRG, Evidence, p. 576.

> markets ... such specialised groups have been available within CSIRO for industry to consult and it is important that these should be retained as a national resource.[41]

8.83 **The Committee recommends that:**

- **the Government urgently review the effects of the 30% external funding requirement on the capacity of those organisations affected to best serve the needs of Australian industry and to maintain relevant basic research expertise.**

Levies: the Need for a Review

8.84 In terms of optimising both the allocation of public funds for research and the level of basic research which is conducted for industry, another funding mechanism which concerns the Committee is the levy system used to fund research within rural industries.

8.85 Certainly, the very small size of many producers within these industries means that individual producers have a very low capacity and very little economic incentive to conduct longer term research which may be of benefit to the whole industry. Nevertheless, it is not clear that the levy mechanism, as it currently stands, provides the most appropriate means of ensuring that an optimal amount of public good strategic research of relevance to whole industry sectors is performed.

8.86 The amount which is levied from industry and consequently matched by the Government is based on a measure of gross value of production (GVP) in each industry. As rural industries are particularly vulnerable to cyclical changes in supply due to changes in the weather and other external factors, amounts available for R & D can fluctuate markedly from year to year. The R & D Councils and Corporations which administer the levies generally maintain reserve funds to help level out these fluctuations. However, as ASTEC has pointed out, the knowledge that these fluctuations will occur may mitigate against the funding of longer term, higher cost, higher risk research.[42]

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41. Evidence, p. S253.
42 ASTEC Funding the Fabric: Should Commonwealth Government Competitive Research Granting Schemes Contribute More to Research Infrastructure Costs?, ASTEC Occasional Paper No. 14, AGPS, Canberra, February 1991, p. 16.

8.87 Secondly, it is not clear that the GVP measure provides a sensible basis for government funding decisions. If the Government is of the opinion that there are significant public good reasons for funding research in these industries, it is incongruous that government contributions should change from year to year according to the vagaries of the weather.

8.88 The 'matching' principle applied to rural R & D funding is designed to provide an incentive to industry to maximise its contribution to research. The levy system finds its justification in the belief that there is 'market failure' in the sense that the industries do not appreciate how much R & D can benefit them. The hope is that the 'demonstration effect' of research achievements will gradually change the attitudes of private firms to R & D investment.

8.89 However, in respect of some of the rural industries at least, it may be that sufficient time has elapsed for there to have been a significant 'demonstration effect'. For these industries, the case for a system of levies and matching funds is likely to be considerably reduced.

8.90 The industries involved in the levy scheme were basically self-selected, in that they came to the Government with a request that such a scheme be put into operation. One obvious anomaly, which astounded Committee Members, is the fact that the Commonwealth provides matching R & D funds to the tobacco industry, an industry which clearly reaps its profits at a great cost to the public health.

8.91 **The Committee recommends that:**

- **the Government review:**
  - **which particular rural industries should receive public R & D funding support on the basis of public good grounds; and**
  - **whether or not the levy mechanism is the most rational means of providing support where support is deemed necessary.**

Statutory Funding Agencies: R & D Corporations and Councils

8.92 Two of the objectives of the new system of Corporations are:

- to direct the national research effort more closely towards the needs and objectives of relevant industries; and
- to increase industry's awareness of the economic sense of increasing R & D investments.

8.93 The Government's requirement that the research agencies seek funding from such bodies may indeed have the intended result of focusing the national research effort more closely on the needs of relevant industries. However, these arrangements necessitate administration at two levels: by the research agencies and by the Corporations and Councils, which are partly funded by the Commonwealth. Research proposals are prepared by the research agencies for consideration by the Corporations and Councils, which administer the grant funds. A submission provided to the Committee by the Bureau of Sugar Experiment Stations suggested that providing the documentation required by these Corporations is much more costly for the Bureau than obtaining funds directly via the levy mechanism.[43]

8.94 The Committee believes that the ultimate goal of the present system of competitive funding for industry-relevant research should be to hasten the development of a mature private 'market' for R & D which will improve the competitiveness of Australian firms. If the Corporations manage industry contributions effectively and so produce significant returns for the industry and raise awareness of those benefits, they should help to bring about the change in firm culture, which would remove all justification for levy legislation and for any public involvement in their operations.

8.95 Clearly, there may remain some justification for limited public funding of research relevant to industry competitiveness. This would be the case where the industry is comprised of immature firms or the capital market is unresponsive to changing signals. It would also be true of situations where 'underfunding' of strategic or basic research by private companies or consortia is likely because significant spillover benefits might accrue to competing companies.

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43. Evidence, p. S1462.

8.96 The Committee believes that the most efficient and cost-effective model for distributing industry R & D funds is one controlled by industry representative associations which maintain close links with relevant policy makers and research agencies. Research agencies, such as CSIRO, which have significant responsibilities with respect to the support of Australian industry, should be directly accountable to those industries for the expenditure of industry funds and, where possible, those funds should be provided directly to the research agencies by the industries themselves.

8.97 The Committee has not attempted to review the system of R & D Councils and Corporations serving industries covered by the DPIE portfolio. Many have been in operation for only a short a time and a meaningful assessment of their cost-effectiveness and efficiency in meeting their objectives may be premature for some of them. However, the Committee is of the view that the benefits accruing to relevant industries as a result of the efforts of these Corporations must be closely monitored over the next few years.

8.98 The Committee notes that a review of the R & D Corporation Model was recently completed for the Primary Industries and Energy Research Council and is now under discussion by interested parties., The review covers, among other topics:

- an emphasis on a clearer definition of the Corporations' role in commercialising research;
- setting and evaluating R & D priorities over a number of years in a way that includes all the players over an entire industry and among several industries;
- the implications of the Corporations' commercial thrust on the maintenance of research infrastructure;
- improved interaction between Corporations and research organisations; and
- the adequacy of the accountability process.[44]

8.99 The Committee believes that reviews of this kind serve a useful purpose and should be carried out on a regular basis.

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44. T Gleeson and A Lascelles for the Primary Industries and Research Council. Review of the Research and Development Corporation Model, February 1992.

8.100 **The Committee recommends that:**

- **the efficiency and effectiveness of the organisational, administrative and funding arrangements of the R & D Corporations be reviewed on a regular basis.**

Social Research

8.101 A number of witnesses to the Inquiry stressed the need for more research in the social sciences. They argued that such knowledge is of paramount importance in increasing our success rate at innovation and dealing with many of Australia's economic and environmental problems.

8.102 For example, ASTEC's review of Environmental Research in Australia stated that not enough is known about 'the relationship between the biological and physical components as well as the social and economic components of the environment'. In terms of finding quick and effective solutions to conflicts over resource use, ASTEC believes that 'the social and economic components may turn out to be the most important'.[45]

8.103 The need for social science research to enable various departments to provide high quality advice on environmental management issues to Cabinet or relevant agencies is but one part of a broader need for the strong support of social research. Another part of this need is for more research to increase our understanding of the dynamics of Australian society. This topic has been highlighted in reports such as Casualties of Change, prepared for the Commission for the Future in 1988.

8.104 Casualties of Change, which presented an analysis of the social and psychological problems faced by young people in Australia, expressed grave concerns about the plight of Australia's youth It found that problems such as rising crime, suicide, drug abuse, apathy and intolerance of those with different lifestyles or ethnic backgrounds, are unlikely to disappear with the return of economic prosperity. 'In some respects', the report argued, these problems could 'become even worse because of the structural and technological changes on which increased economic growth depends'.[46]

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45 ASTEC Environmental Research in Australia: a Review, AGPS, Canberra, June 1990, p. 93.

46 R Eckersley Casualties of Change - The Predicament of Youth in Australia, Commission for the Future, Melbourne, July 1988, p. 2.

8.105 Later Chapters of this Report suggest that success in innovation and the commercialisation of public sector research is partly dependent on more social research. Although our economic prosperity is determined by the extent to which we can harness technology to reach the level of national income required to reduce our burgeoning national debt, it must not be forgotten that technological change is having a complex - and frequently negative - impact on the lives of Australians.

8.106 Casualties of Change cited a number of recent surveys which provided grounds for believing that technological change has been a contributing factor, not only in the sorts of social pathologies which are readily captured in statistics, but to a debilitating sense of hopelessness. In fact, this theme has echoed through major sociological studies dating from the time of the founding father of sociology, Emile Durkheim.

8.107 One survey cited in the report suggested that an 'inescapable conclusion to be drawn from the evidence ... is that Australians believe they are losing control over their own destiny'.[47] Another survey of the Australian middle class finds that:

> ... ordinary Australians are deeply concerned about the pace of change in their society. They feel changes are random and uncontrollable. And this perceived lack of control over change produces anxiety and apprehension.[48]

8.108 A number of Committees of this Parliament have criticised the lack of research in Australia on the social impact of technology.[49] These criticisms are repeated in Casualties of Change. In the long term, our continued neglect of this area of research and of other research relevant to current and prospective social pathologies will cost Australia far more dearly than the current price of the necessary research.

8.109 The Committee notes with concern ASTEC's recently stated conclusion that:

> Research in the social sciences and humanities seems

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47. ibid., p. 38.
48. Eckersley, loc. cit.
49 See, for example, Senate Standing Committee on Science, Technology and the Environment, Technology Assessment in Australia, AGPS, Canberra 1987.

unrelated to contemporary national concerns, and needs to be aligned more closely with economic and social imperatives.[50]

Possible means of rectifying this situation suggested by ASTEC include:

- competitive funding by the ARC of social science and humanities research that addresses specific national needs; and
- competitive funding of a small number of social policy research centres.[51]

8.110 The Committee welcomes ASTEC's recent announcement that it will undertake a study into the relationship between the social sciences and humanities and social and economic problems. The Committee also applauds such initiatives as that taken by the Academy of the Social Sciences with its Australian-Asian Perceptions Project. This Project looks beyond Australian concerns with the impact of technology on society and is analysing cultural differences and conceptual structures, an understanding of which will assist Australia's commercial, political and strategic relations in the Asian region. The Committee believes that social research has useful role in relation to the wider implications of R & D.

8.111 **The Committee recommends that:**

- **the Government take action:**
  - **to identify the national needs for social science research, including humanities research and research into the social impact of technology;**
  - **to improve the coordination of social research; and**
  - **to ensure the adequacy of funding for social research.**

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50 ASTEC, Research and Technology: Future Directions, AGPS, Canberra, September 1991, p. 71.

51. ibid., pp. 71-2.

Chapter 9

RESEARCH MANAGEMENT

Introduction

9.1 Responsible Ministers, the Parliament and the Auditor-General all have an interest in scrutinising the returns from the Government's investment in the public research effort. It is, however, difficult, especially in the short term, to identify all such returns, which include both direct and indirect benefits. Under these circumstances, other indicators of the quality of the research effort must be rigorously monitored.

9.2 The Committee considers that the following indicators are of particular importance and comments on them in this Chapter:

- the appropriateness of the organisation of the Commonwealth research effort; and
- the effectiveness and efficiency of research and resource management both within agencies responsible for the allocation of research grants and within research agencies themselves.

Organisational Structures

9.3 In recent years the question of the appropriate size, structure and breadth of focus for publicly funded research organisations has been raised regularly at the political level These topics have also been the subject of independent reviews of agencies such as CSIRO and the OSS. Attention has focused on the relative costs and benefits of transferring the responsibilities of smaller agencies to larger establishments, or breaking down larger agencies such as CSIRO.

9 4 The increasing segmentation and decentralisation of the national public sector research effort was noted in Chapter 2. In recent times, a number of smaller centres have been set up to specialise in particular fields of teaching or

research. Although CSIRO performs a very great variety of research across a wide spectrum of scientific disciplines, most research agencies concentrate on more limited sets of scientific problems that relate to a narrow range of uses.

9.5 Other new initiatives have been designed to break down the organisational separation of the publicly and privately-funded research efforts. Of particular note in this regard is the establishment of CRCs. The objective of this initiative is to bring together researchers from industry, the universities and research agencies, enabling them to focus on the achievement of excellence in narrow fields of specialisation.

9.6 In addition, most of the major research agencies have undergone wide ranging internal and external reviews in the course of the past decade. These reviews have encompassed their organisational structures, establishment profiles and research priorities, and have resulted in a number of positive changes to the organisation of their research. Several of the resultant changes are addressed in chapters dealing with individual research organisations later in this Volume of the Committee's Report.

9.7 In his evidence to the Committee, Rear Admiral Bill Rourke, Chief Executive of the Institute of Engineers, pointed to a major danger of organising the research effort into a series of large, permanent research agencies. Such organisations tend to be less flexible, and less capable of adjusting to changing research priorities than are other forms of organisation.[1]

9.8 Although the Committee accepts this point, it shares ASTEC's view that further major changes to the structure of the research effort would be counterproductive at this point in time.[2] There is no evidence that splitting existing research organisations into smaller, less permanent entities would be a cost-effective or efficient step at present.

9.9 Incentives to private sector investment in R & D and efforts to increase interaction between private companies and private sector researchers should gradually result in a greater decentralisation of the research effort to private laboratories. In the meantime, however, and as noted in Chapter 8, industry itself has expressed support for the continued existence of major research agencies such as CSIRO.

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1. Evidence, p. 289.
2. ASTEC, Research and Technology: Future Directions, AGPS, Canberra, September 1991, p. ix.

9.10 Evidence provided by research agencies stressed the necessity for the maintenance of an up-to-date core of expertise in their relevant research fields. The Committee agrees that agencies need to maintain their 'core expertise'. However, as new private sector research capacities emerge in the future, public sector research agencies will need to continually review and change the direction of some of their research efforts and, in some cases, the structures of their programs.

9.11 The Committee considers that it is essential that the administrative and organisational structures of research agencies are responsive and flexible. Agencies should adopt innovative initiatives to ensure that:

- the trend to allocate increasing human resources to corporate support activities is avoided;
- annual reviews ensure that resources allocated to research activities are cost-effectively utilised; and
- financial savings are made when possible by contracting research to the private sector, provided that the core expertise necessary to enable the research agencies to continue relevant 'public good' research is not lost in the process.

9.12 The Committee notes that Commonwealth-funded research agencies have been subject to various reviews and revised funding arrangements in recent years. The Committee considers that the agencies need time to achieve stability, implement changes and acclimatise to revised funding and organisational arrangements.

9.13 **The Committee recommends that:**

- **the recent organisational and funding changes to Commonwealth research agencies be allowed to stabilise before any further major changes are considered by the Government.**

Research Management

9 14 The quality of research management is important in obtaining value for money from public expenditures on the research. Equally, the capacity of relevant research agencies to generate and maintain desired levels of external

funding will depend in part on their capacity to deliver excellent work on time and within budget.

9.15 The Committee notes that internal and external reviews, and ANAO audits of most of the major research agencies over the past decade, have led to significant improvements in the quality of research management. Furthermore, each of the research agencies that provided evidence to the Committee exhibited a commitment to further increasing its level of efficiency and effectiveness in this area.

9.16 However, the Committee believes that further improvements in the quality of research management within Commonwealth research agencies will be facilitated by:

- improvements in the level and quality of research management training available to university graduates and the staff of Commonwealth research agencies; and
- a return to a more stable working environment for research managers, away from one in which resources for day-to-day management and administration are constantly being stretched to accommodate new functions and additional tasks that stem from changes to organisational structures and funding arrangements.

Research Management Training

9.17 In the process of preparing its September 1991 report, Research and Technology: Future Directions, ASTEC received written submissions, interviewed senior managers in industry and government and consulted widely. It found a widespread perception among all these sources that there is a lack of appropriately qualified research managers:

> There is, in Australia, a dearth of managers experienced in running research enterprises.
>
> The need for experienced managers of research is escalating rapidly; for example, establishment of the CRCs is creating

> a major demand for outstanding research leadership combined with a high degree of management skills and insight.[3]

9.18 Some in-house training in research management skills is provided by Commonwealth research agencies, but the level and quality of the training is variable. Furthermore, the provision of research management training courses by the universities and the private sector remains to be developed. A recent report to NBEET and DITAC commented that management courses provided only `sparse and scattered' coverage of science and technology issues. Management courses that specialise in such issues:

> ... are very new or have not yet started. They face difficulties in finding staff worth qualifications and experience adequate to the new tasks. In some cases, they have difficulty in attracting students.[4]

The authors of the report suggested that greater emphasis on science and technology will come only with `a reorientation in thinking and of attitudes so basic that it can without any exaggeration be called a cultural change'.[5]

9.19 In 1989, ASTEC had pointed to a need to improve the management of publicly funded research in Australia. It stated that:

> ... the evident paucity of research management expertise in Australia lends weight to arguments for a dedicated research management centre, associated with a business school ... this centre would be able to digest overseas developments in research management, relate them to the Australian context, and provide training for those with research management responsibilities. It would fit well within the structure of the Key Centres for Teaching and Research.[6]

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3 ASTEC. Research and Technology: Future Directions, AGPS, Canberra, September 1991, pp. 84-5.

4. F Jevons, F B Dowling and M Saupin. Science and Technology Issues in Management Education, AGPS, Canberra, February 1992, p. 23.

5. F Jevens et al., loc. cit.

6 ASTEC Profile of Australian Science: a Study of the Current State and Potential of Basic Scientific Research, AGPS Canberra, 1989, p. xvii.

9.20 In 1991, the ARC announced funding for a Centre for Research Policy under the Special Research Centres Program. The Centre, located within the University of Wollongong, has four foundation research programs, among which is a program of studies of research culture, organisation and management. The Centre can be expected to contribute to building much needed theories concerning science and technology in industry.

9.21 **The Committee recommends that:**

- **the Minister for Employment, Education and Training urgently consult with the Australian Education Council, the Centre for Research Policy and other relevant bodies as to the most appropriate means of increasing the supply of dedicated research management training in Australia.**

Research Management Controls

9.22 Research into the qualities of successful research managers reveals that there is no single 'best way' to manage research.[7] Nevertheless, the following conditions, which characterise the Japanese research management style, appear to be conducive to successful research management:

- a low-key, participatory style of management; and
- a climate of trust and understanding, which is promoted if researchers are not too preoccupied with job security.

9.23 The Committee notes the view of the Canadian Auditor General that:

> ... different types of research call for different types of controls; different organisations can manage in different ways and still demonstrate due regard for economy, efficiency and effectiveness.[8]

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7. M A Muspratt, 'Environmental Influences on Managing Research Organisations', Engineering Management International, Vol. 5, 1987, p. 73.
8 Auditor General of Canada. Report of the Auditor General of Canada to the House of Commons, 1981, p. 29.

9.24 The Committee believes that the research agencies themselves are best placed to develop program management structures appropriate to the particular research endeavours they are required to undertake. Nevertheless, the Committee believes that there are a number of basic characteristics of effective, efficient and accountable project management. These characteristics relate to:

- strategic planning;
- operational planning;
- project proposals;
- project selection;
- operational control of projects; and
- evaluation of projects.

9.25 Several of the research agencies have commented on the fact that the Government's requirement that they re-orient their operations has significantly reduced the time available to research managers to oversight the conduct of research and monitor the documentation of the various phases of the research. Contributing factors have been:

- the extra work associated with significant, recent changes to the structure of some of the research agencies, such as CSIRO;
- reductions in funding and personnel for various sections of many of the research agencies;
- the requirement to take a more proactive role in seeking funds from industry and other external sources;
- the extra burden imposed by the administration of funds obtained from external research funding bodies; and
- the need to spend more time liaising and negotiating with industry during the research process to facilitate the translation of research results into commercial applications.

9.26 The increasing demands that have been placed on senior research managers in recent years have made it difficult for them to ensure that sufficient time is devoted to guiding research projects as efficiently and effectively as possible.

The Committee believes that it is essential that recognition is given to the time consuming nature of the additional tasks that have been given to senior researchers, and the possible negative effects on the quality of the effort that they are able to put into managing their research. When additional responsibilities are given to senior researchers, serious consideration should be given to providing them with assistance to perform all of them adequately.

Project Selection and Evaluation

Cost-benefit Analysis in Project Selection and Evaluation

9.27 Both ABARE and the BIE have called for the increased application of cost-benefit analysis to the selection and evaluation of research projects. In its submission to ASTEC's recent Inquiry into Research Directions for Australia, ABARE stated that, in respect of primary industries and energy research, 'many more evaluations are likely to be needed to provide a sound guide for assessing the effectiveness of funding allocations or to provide guidelines for funding'.[9]

9.28 The Government has also foreshadowed a greater role for these bureaux in the performance of such evaluations. However, it has not at this stage provided these bureaux with any significant, real increases in funding for this purpose.

9.29 The Committee agrees that cost-benefit analysis is a useful tool in selecting research projects and monitoring returns from research. However, it must be clearly recognised that assessments based on this technique may underestimate the indirect benefits from research. Furthermore, as ABARE pointed out, the full assessment of all indirect benefits from research would entail a heavy, and perhaps inefficient, use of resources.

9.30 The accuracy of economic evaluations tends to vary directly with the length of time between the completion of the research and the evaluation process. Given the long lead times in the commercialisation of research, or in the application of new knowledge by all potential users, the full benefits to society from that research may not in some cases be evident for decades after the research is conducted.

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9. ABARE. Submission to ASTEC's Inquiry into Research Directions for Australia, 1991, p. 7.

9.31 This factor complicates the business of ensuring the accountability of those responsible for the resource allocation process, at both the national and organisational levels. Due to the unpredictable nature of research, a certain level of failure, in terms of an inability to achieve the technical objectives of a specific project, is to be expected. In addition, however, funding decisions may not be vindicated or shown to have been inefficient for many decades after the funds are spent.

9.32 Whilst the Committee supports the wider use of cost-benefit analysis in the evaluation of research, it considers that the results of such evaluations must be interpreted with caution, depending on the length of time that has intervened between the completion of the actual research and the evaluation.

Funding for Research Evaluation

9.33 Evaluations of the cost-effectiveness of different kinds of research have been conducted by independent agencies such as the BIE and ABARE. Such evaluations are also commissioned or conducted in-house by research agencies themselves.

9.34 Evidence before the Committee suggests that the BIE and ABARE are making important contributions to the evaluation of research. Both agencies have taken steps to ensure that their work does not duplicate work being conducted by other agencies.

9.35 Both ABARE and the BIE derive a proportion of their funding from external sources. In ABARE's case, the bulk of this income comes from R & D Corporations. ABARE and the BIE may have a capacity to attract further income from external sources but, in so doing, they would run the risk of jeopardising the independence and impartiality of their research work. The Committee takes the view that it is important that these agencies receive increased appropriation funding for any additional work relating to the Commonwealth research system that is required of them by the Government.

9.36 **The Committee recommends that:**

- **the Bureau of Industry Economics, the Bureau of Rural Resources and the Australian Bureau of Agricultural and Resource Economics receive increased funding for any additional research work required of them by the Government.**

Chapter 10

COMMERCIALISATION OF RESEARCH

Introduction

10.1 The legislation behind major Australian research organisations such as CSIRO, AIMS and ANSTO often includes the charge to transfer their technology for the benefits of Australia. Commercialisation of intellectual and industrial property is one means of transferring such technology. Other means are publishing the results of R & D, providing advisory and consulting services based on the results of R & D and responding to inquiries.

10.2 The thrust to commercialise the results of R & D has been increasing during the past decade. The resultant return from the commercial activities of major Australian research organisations has also increased. The Government has directed major research organisations such as CSIRO, ANSTO and AIMS to generate 30% of their annual budgeted recurrent expenditures from external sources, leaving the Government to fund the remaining 70% from appropriations. This has fostered, and is continuing to foster, organisational initiatives towards commercialisation.

10.3 However, in an absolute sense, the financial returns resulting from commercialised intellectual and industrial property have been limited by comparison with the size of the total investment in public sector R & D organisations. An opportunity exists to improve the commercialisation performance of major Australian research organisations and thereby ensure that the results of R & D are effectively transferred to Australian society.

Definitions of Commercialisation

The Committee's Definition of Commercialisation

10.4 The Committee noted that there was no widely accepted definition for the concept of commercialisation as it relates to public sector research. In very broad terms, commercialisation refers to the procedures by which potential commercial opportunities resulting from public sector research are identified and pursued. The Committee adopted a firm definition of commercialisation in order that its recommendations would be clearly understood and more easily implemented.

10.5 For the purposes of this report the Committee defined commercialisation as the transfer of intellectual and industrial property for financial return to the research organisation. Under this definition, common forms of commercialisation include licensing intellectual or industrial property and participating with a partner in a joint venture partnership or company.

10.6 The concept of commercialisation excludes various processes by which R & D is sometimes pursued. These processes include:

- the transfer of technology by means of publications and scientific papers for which there is no financial return for the entity;
- the provision of advice and the movement of scientists to industry;[1]
- the generation of external funds by consultancies, contract research, grants and contributions; and
- the transfer of intellectual and industrial property into related organisations, as in the case of DSTO transferring such property to the Department of Defence or the Australian Armed Forces.

10.7 While most intellectual and industrial property would be commercialised by the private sector, a certain amount of commercialisation may take place within the public sector, especially by statutory authorities and government business enterprises.

Other Definitions

10.8 The Committee's definition of commercialisation is narrower than that used by CSIRO. CSIRO defines commercialisation as the translation of technology

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1 BIE. Commercial Opportunities from Public Sector Research, Research Report No. 32, AGPS, Canberra, November 1989, p. 28.

into profitable industrial products or processes. It includes the following arrangements within the definition:

- a research contract, consultancy or technical services agreement;
- a collaborative R & D arrangement directed towards generating defined products or processes;
- an umbrella arrangement for companies to support research across an area of strategic business interest; and
- a project fully funded by CSIRO's appropriation budget with commercialisation arrangements sought relatively late in the process.[2]

10.9 Representatives of DSTO indicated that the term is used within their organisation to describe revenue which the organisation receives from either civilian spin-offs from its R & D or third party sales of defence exports.[3] Much of what DSTO calls commercialisation might be described as the civilianisation of DSTO's work[4] and includes what CSIRO would call the generation of external funds.

10.10 However, procedures for DSTO's Commercial Trust Account describe commercial arrangements as licensing, joint ventures, partnerships, spin-off companies, contract R & D, funded R & D, collaborative R & D and numerous other means of generating dollars from outside sources. DSTO representatives expressed some confusion about what commercialisation meant within DSTO.

10.11 The Committee believes that the variety of meaning attached to the word, 'commercialisation', militates against clear communication on the subject. A commonly accepted definition of commercialisation would assist, not only when commercialisation is being discussed, but also when statistics relating to R & D are collected.

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2. Evidence, p. S902.
3. Evidence, p. 671.
4. Evidence, p. 675.

10.12 **The Committee recommends that:**

- **the Government foster the acceptance of an agreed definition of commercialisation.**

Financial Returns from the Commercialisation of Research

10.13 At present, commercialisation by major Australian public sector research organisations yields them limited financial returns. At the time the Inquiry started, the total of royalties and licence fees received by Australia's five largest public sector research organisations, CSIRO, DSTO, ANSTO, AIMS and BMR, was less than $5m per year. A BIE report on commercialisation indicated that the total financial return from commercialisation for all survey respondents drawn from the public sector at the Commonwealth, State and university levels totalled $8m for 1988.[5]

10.14 The Committee noted that CSIRO generated income of over $2m dollars from royalty payments on the some 315 licences in place for the financial year 1990-1991. In addition, DSTO estimated its income from commercialisation for the 1990-91 financial year to be $1.9m, compared with $800,000 during the financial year 1988-89.[6] For ANSTO's company, Australian Radioisotopes, the income was $6.4m in 1990-91 and $5.5m in 1989-90.[7]

10.15 The returns that can be expected in the future from some of the products that are being developed from the work of public sector research organisations are considerable. For example, the sunscreen that AIMS is developing has the potential to tap into a market worth $600m, and the value of the products expected from Gene Shears is estimated at billions of dollars. The anticipated indirect returns derived from these products are also substantial, as is detailed, for example, for some of CSIRO's developments in paragraph 11.19.

10.16 Public reporting on corporate joint ventures in which the major research organisations are involved does not provide information on dividends returned to the organisation or to the Government. What financial statements do reveal are a number of investments in such ventures which have been written off over the last five years.

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5 BIE Commercial Opportunities from Public Sector Research, Research Report No. 32, AGPS, Canberra, November 1989, p. 38.

6. Evidence p. 614.

7. ANSTO. Annual Report 1990-91, p. 89.

10.17 The Committee concluded that the opportunity exists to improve the performance of major Australian public sector organisations in generating income from commercialisation.

10.18 The Committee identified some of the factors that have contributed to the limited financial return from the commercialisation of Australian research. They include:

- the amount of capital required to transform intellectual or industrial property from the scientific bench to the market place - ratios of 100:1 were mentioned during Committee hearings;

- the limited size and capitalisation of the Australian private sector;

- the high risk nature of commercialising R & D results - evidence before the Committee reflected a high failure rate for commercialisation initiatives;

- the varying stages that different R & D organisations have reached in their attempts to commercialise the results of their research;

- the time taken to fully commercialise research results - financial returns from R & D, should such accrue, may only come many years after the initial commercialisation; and

- the present recessed conditions in which the push to commercialise research is being conducted.

10.19 Nonetheless, substantial progress has been made by some of the major research organisations in acquiring and developing skill sets, setting up mechanisms and establishing arrangements to commercialise the results of R & D.

The Ingredients of Successful Commercialisation

10.20 The Task Force on the Commercialisation of Research lists a number of characteristics that are needed within firms for the commercialisation of research They include finance, time, management skills, distribution networks, marketing skills, access to markets, particularly overseas, and technology.[8] The Task Force found that past experience with commercialisation is a key ingredient in success because 'good judgement comes from experience; experience comes from poor judgement'.[9]

10.21 Many of the same characteristics are needed by research organisations. From its examination of the evidence presented to it, the Committee identified two of the more important features for success on the part of research organisations in commercialising their research as:

- a commitment to commercialisation that is reflected in the organisations' corporate objectives; and
- adequate human and financial resources.

Commitment to Commercialisation

10.22 At the start of its Inquiry in 1989-90, the Committee found that the objectives of the major research organisations did not make an explicit commitment to commercialisation. For example, AIMS's objectives as part of DITAC's Industry Policy and Development, mentioned only the creation of opportunities for commercial and technological developments.[10] The goals of CSIRO as presented in its 1988 strategic plan made no reference to commercialisation; nor did DSTO's objectives, which are driven by national security policy and the priorities of the Department of Defence.[11]

10.23 However, CSIRO's and ANSTO's recently developed strategic plans for 1991-92 to 1995-96 are explicit in their references to commercialisation ANSTO's strategies include ensuring that the applied research that it carries out is market-driven, selling ANSTO technology, products and services on a commercial basis and developing its Business and Technology Park and stand-alone enterprises to operate in the commercial arena.

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8 DITAC. Bringing the Market to Bear on Research, Report of the Task Force on the Commercialisation of Research, AGPS, Canberra, November 1991, p. 1.
9 Pappas Carter Evans and Koop. Innovation in Australia, Report for the IRDB, AGPS, Canberra, July 1991, p. 25.
10. Evidence, p. S1210.
11. Evidence, p. 645.

10.24 Furthermore, DSTO's objectives do refer to fostering scientific and technical expertise in industry and tertiary institutions, assisting non-defence bodies and fostering a viable and active defence industry and the development of the overall Australian industrial capability. Furthermore, the Department of Defence advised that DSTO's prime motive was to commercialise its defence capabilities to enhance the Australian economy, especially in the high technology and high value-added areas.[12]

10.25 The visible commitment of an organisation to commercialisation is significant if its commercialisation activities are to be taken seriously by its employees, and the organisation is to be motivated to ensure that appropriate systems and practices are set in place to meet its commercialisation objective. The Committee considers that major research organisations should demonstrate a visible commitment to commercialisation, and congratulates those that have already done so.

10.26 **The Committee recommends that:**

- **the goals and objectives of major research organisations, which have received a government directive to generate a portion of their funding from non-appropriation sources, include reference to commercialisation within their goals and objectives.**

Managing Commercialisation

10.27 With commercialisation of their R & D written into the objectives of Australia's major research organisations, this focus for the organisations can be expected to flow through to their corporate management plans In drawing up these plans, the Committee believes that the research organisations should consider:

- whether their commercialisation objectives are primarily related to revenue development or industry development;
- their position on commercialising internationally;
- the extent to which publication and information dissemination practices will be modified in light of requirements for commercial confidentiality;

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12. Evidence, pp. S287, S292.

- the degree to which commercialisation will be directed towards small or larger organisations; and

- whether joint ventures of a corporate or contractual nature will be used.

10.28 *The Committee recommends that:*

- **the commercialisation objectives of research organisations performing R & D be included in their management plans.**

Major Research Organisations as Venture Capitalists

10.29 The life cycle from idea to marketable product involves a number of steps. A research organisation can decide to proceed along any number of those steps even to the point of selling the product directly. In moving along the development and innovation continuum, the research organisation plays the role normally played by venture capitalists and technology diffusion firms. How far a research organisation moves along this continuum depends on the funds available to it. For example, the Department of Defence has limited the amount of investment that DSTO will put into commercialisation by limiting related spending to 1% of its budget.[13]

Skill Sets

10.30 Evidence before the Committee indicated that, by comparison with other countries, Australian research agencies lack skills related to marketing and deal making. In the course of its inspections and public hearings, the Committee formed the view that the level of business acumen among the staff of the major research organisations varied widely; some organisations had access to an impressive range of skills, others did not. The Committee considers that it is imperative that an appropriate mix of skill sets be applied by research agencies to the commercialisation of R & D.

13. Evidence, p. 690.

10.31 **The Committee recommends that:**

- **research organisations involved in commercialising their research:**

    - **consider the optimal profile of skill sets required in carrying the results of research from the laboratory to the market place; and**

    - **recruit and retain such skill sets.**

10.32 The Committee found, however, that there is a limited supply of individuals with appropriate skills in Australia. As such individuals are in demand, they command high salaries which public sector research organisations are unable to match. One solution to this problem is to capitalise on the fact that some research scientists have potential as business people and can be trained as effective managers. Once trained, however, the research organisations will have difficulty in retaining them unless higher salaries are available. Another possible approach to this difficulty is for research organisations to make use of the Australian Technology Group or an extended role for the IRDB, which are discussed later in this Chapter.

The Commercialisation Process

10.33 The BIE has identified several steps in the commercialisation process:

- identifying commercial opportunities;

- identifying commercial partners;

- assessing commercial partners; and

- transferring technology.

10.34 Research organisations have adopted different models to facilitate the commercialisation process. The research organisation may be the only party involved. It may own the industrial and intellectual property outright and decide to commercialise it itself, carrying R & D to the marketplace on its own.

10.35 Alternatively, the organisation can involve an external body to carry out the commercialisation. The Committee's review of commercialisation identified a number of different types of arrangements between research organisations and organisations commercialising research. They include collaborative research agreements and commercial intermediaries or brokers. In all cases when an outside organisation is involved in the commercialisation, there should be a formal agreement between the research producer and the organisation which is to commercialise the research.

Collaborative R & D Agreements

10.36 A commercialisation agreement may be a component of an ongoing collaborative arrangement where the research organisation and an outside organisation, often from the private sector, have been cooperating on R & D over a number of years. In normal circumstances, the agreement would provide that the external collaborator would have an option to share and/or license the intellectual property resulting from the R & D and commercialise it.

10.37 Examples of this type of arrangement are provided by the umbrella agreements which Sirotech and CSIRO have developed with major Australian and international corporations. Some primary industry funding bodies are also active in commercialising the results of sponsored research; examples include the commercialisation activities of the former Australian Wool Corporation (now the Australian Wool Realisation Commission) and the Australian Minerals Industry Research Association.

10.38 Collaborative research agreements of this kind have produced useful commercial results. The most cost-effective collaborative research agreement is one made early in the course of the R & D of a particular product and allows for continual feedback between those analysing the market, production and design aspects and those analysing the underlying technology. The early involvement of both parties is now standard practice in most of the more recently concluded agreements, and helps to ensure that the product of the R & D is aligned with market needs and so is market- rather that research-driven.

10.39 **The Committee recommends that:**

- **research organisations involve commercial partners with resources to successfully commercialise the results of R & D at an early stage of the R & D.**

10.40 The Committee notes the conclusion of the Task Force on the Commercialisation of Research that 'there is insufficient interaction between government-funded research institutions and industry'.[14] One of the Government's initiatives that is designed to enhance this interaction is the establishment of CRCs, the funding for which is shared equally between the Commonwealth on the one hand and industry and public sector research organisations on the other. The Task Force on the Commercialisation of Research noted criticism of the first CRCs selected on the grounds of their relatively non-commercial focus. Only 11% of these CRCs' funding was derived from industry, while the Task Force suggests that the figure could be expected to be 25% if industry fully supported the activities of the Centres being established. It proposed that 80% of any CRCs should have significant industry participation and funding should be withdrawn from any CRCs that failed to attract 25% of its funds from industry.[15]

10.41 The Committee believes that the CRCs will play a valuable role in bringing public sector research organisations and industry together and enhancing the commercialisation of Australian research results. It notes the controversy that has emerged with CRCs, as in other Australian R & D centres, about the right emphasis for shorter term as against longer term research. In regard to the involvement of public sector research organisations in CRCs, the Committee recognises both the capacity of, and the need for, these organisations to contribute to the commercialisation of their research. It believes, however, that it must be recognised that the prime function of the public sector research organisations is the conduct of essential, longer term research which the private sector cannot or does not choose to support. There is thus an urgent need for an examination of the appropriate balance between government support for basic, strategic and applied research in the light of the nation's research priorities.

10.42 **The Committee recommends that:**

- **in the context of establishing national research priorities, the Government:**
  - **define the appropriate balance between the support provided for R & D by the private sector and that given by the Government for the applied, strategic and basic research necessary to advance the knowledge base of the nation and its long term economic welfare; and**
  - **ensure that this balance is reached and maintained.**

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14. DITAC. Bringing the Market to Bear on Research, Report of the Task Force on the Commercialisation of Research, AGPS, Canberra, November 1991, p. 3.
15. ibid., p. 27.

Commercialisation Intermediaries

10.43 Commercial intermediaries are often involved in commercialisation. According to the BIE:

> The primary function of intermediaries in the commercialisation process is that of a broker, bringing together a research organisation with commercially valuable technology or scientific capability, and a firm well placed to commercialise the technology, or seeking benefit from research services.[16]

10.44 A survey of 24 research organisation by the BIE identified that:

- the largest group of intermediaries comprised those established by higher educational institutions;
- 80% of research organisations generally used an intermediary;
- about half the organisations that used intermediaries were required to use a certain intermediary in all technology agreements;
- research organisations varied in the use they made of the services of intermediaries:
  - 22% used intermediaries to assist them in all aspects of the commercialisation process;
  - the most commonly used service was the preparation of contracts;
  - the second most used service involved commercial negotiations to reach agreements; and
  - 30% of the BIE respondents used an intermediary to assist in assessing the commercial value of research results, their patentability or estimating the potential market for new technology.[17]

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16 BIE Commercial Opportunities from Public Sector Research, Research Report No. 32, AGPS, Canberra, November 1989, p. 74.
17. ibid., pp. 80-1.

10.45 The intermediary or broker used may be the central commercial office of the research organisation, a specialist private sector company or a public sector commercialisation company.

10.46 DSTO and a number of universities use their in-house business development or commercial offices to commercialise the results of their research. CSIRO and a number of other universities, on the other hand, use wholly owned subsidiaries to commercialise the results of their research. CSIRO's Sirotech, the Victorian Department of Agriculture and Rural Affairs, Daratech, and the Australian National University's ANUTECH are examples of this commercialisation model.

10.47 A number of private sector brokers have assisted Commonwealth research organisations. One such company is Invetech, which has assisted ANSTO to commercialise its research and related technical capabilities.[18] Australian Commercial Research and Development Ltd have contracted with DSTO to develop DSTO technology for non-defence purposes where commercial funding is required

10.48 Another form of private sector involvement in the commercialisation of R & D is the Commercial Research and Development Centre (CRDC), as it has been developed in Japan and the USA. The CRDCs encourage strong networking links between all participants needed to ensure the commercial viability of the products concerned. Evidence presented to the Committee showed that:

- CRDCs are supported by governments, industry, banks and the tertiary sector;
- they are run by commercial sector entrepreneurs rather than public servants;[19] and
- there are approximately 400 large scale CRDCs in Japan and 250 in the USA.

10.49 State Governments have sought to support the commercialisation of local research through the provision of services, such as the Victorian medical research commercialisation company, AMRAD. Technology parks in various Australian States are another means by which State Governments are assisting the commercialisation of research.

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18 BIE Commercial Opportunities from Public Sector Research, Research Report No. 32, AGPS, Canberra, November 1989, p. 75.

19. Evidence, p. S1015.

10.50 The Committee notes that there are a large number of offices specialising in the commercialisation of R & D in Australia. The Committee questions the economy, efficiency and effectiveness of each research organisation having its own commercialisation body or company. It believes that such brokerage services might operate more efficiently and effectively if there were fewer, larger organisations involved.

10.51 The Task Force on the Commercialisation of Research reached a similar conclusion. It noted that these technology transfer organisations are small, lack resources and are not all profitable. Furthermore:

> Factors that limit the effective transfer of technologies in these intermediaries are the wide ranging scope of research undertaken within any one organisation and the wide range of related industry both within Australia and overseas to which it might apply.
>
> Many existing technology transfer bodies do not possess the resources, expertise nor charter to widely source, supply and negotiate technology transfer. They are also not in a financial position to further develop and market promising technology.[20]

10.52 ASTEC, in its report, Research and Technology: Future Directions, pointed to the fact that the 1990s will be characterised by 'an increasingly complex environment for research and business', and suggested that new types of organisation will be required for the commercialisation of research. These organisations will need to be able:

> ... to interact with a broad range of interest groups both nationally and internationally. The kind of services these organisation will need to provide include analysis of complex and diverse end-user requirements and a capacity to identify advanced, interdisciplinary research capabilities in Australia and overseas. They will also need a high level of competence in international business law and in commercial negotiation.[21]

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20. DITAC. Bringing the Market to Bear on Research, Report of the Task Force on the Commercialisation of Research, AGPS, Canberra, November 1991, p. 29.
21. ASTEC. Research and Technology: Future Directions, AGPS, Canberra, September 1991, p. 50.

10.53 Both ASTEC and the Task Force on the Commercialisation of Research recommended the formation of a technology transfer and development company. The BIE drew the Committee's attention to the British Technology Group as a possible model for a commercialisation intermediary,[22] while the IRDB proposed an extension of its role to provide some of the services that will be needed.[23]

Australian Technology Group

10.54 In his One Nation Statement in February 1992, the Prime Minister, the Hon P J Keating, MP, announced the formation of the ATG to contribute to the commercialisation of research by:

- identifying research with commercial potential particularly from public sector research organisations;
- protecting and controlling intellectual property;
- marketing research output to Australian and overseas companies;
- providing seed capital to bring ideas to the stage at which they would be attractive to private sector partners;
- developing international trade in intellectual property; and
- commissioning research from public sector institutions for small and medium-sized companies.

10.55 Th Government will provide $30m of the initial ATG capital base in recognition of the long term, high risk nature of investment in the Group, but intends that it should be a fully commercial company. It will not therefore be subject to non-commercial restrictions or limitations, will compete for the right to exploit ideas generated by research bodies and will become self-supporting from fees and investment income.

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22 BIE. Commercial Opportunities from Public Sector Research, Research Report No. 32, AGPS, Canberra, November 1989, p. 88.

23. Science Technology, Vol 12, No. 5, May 1992, pp. 1-2.

10.56 The Committee notes that criticism of the concept of the ATG has been voiced. It has been claimed that:

- the ATG would distance public sector researchers from the market rather than stimulating the greater contact between the two that is needed;
- the British ATG has performed indifferently and it may not be an appropriate model for Australian conditions;
- no account is taken of the experience of existing organisations, including the universities' marketing bodies and the IRDB; and
- $30m is an insufficient sum with which to establish the ATG.[24]

10.57 The critics have suggested that commercialisation would be better achieved through CRCs, with assistance from strengthened networks among the existing technology transfer organisations and an extended IRDB. The IRDB has proposed that it have a more commercial focus and a greater involvement in the later stages of commercialisation than at present, through the establishment of a brokerage program that would complement the work of the ATG.

10.58 The Committee believes that there was a case for the establishment of a commercialisation intermediary large enough to benefit from the advantages of its size. The Committee acknowledges the criticisms that have been levelled at the ATG, and advocates close monitoring of the operations of the ATG. The Committee recognises that the IRDB represents a pool of considerable skill, expertise and experience and believes that the suggestion that its role be extended should be given careful consideration.

10.59 **The Committee recommends that:**

- **the performance of the Australian Technology Group be monitored and consideration be given to utilising more effectively the expertise of the Industrial Research and Development Board.**

24. Science Technology, Vol. 12, No. 3, March 1992, pp. 1-3.

Cost of Commercialisation

10.60 The Committee notes that in the past many intermediaries have not charged full commercial rates for the services they provided. This was particularly the case with intermediaries in educational establishments which were, for the most part, providing services only to their own institutions. These intermediaries earned most of their income from other activities, such as running courses, and generally spent less than half their time on commercialising research results. They also tended to receive less return from the time they spent on commercialisation activities than on other activities. However, the full costs of this aspect of the commercialisation process are becoming more apparent and more intermediaries are now passing on these costs.[25]

10.61 The Committee believes that major research organisations involved in commercialisation need to be aware of the total costs of commercialisation, including the costs of identifying and assessing potential partners, negotiating commercialisation agreements and providing additional assistance to the point of achieving successful commercialisation. Such information is the basis on which a cost-benefit analysis of the commercialisation of R & D can be carried out.

10.62 **The Committee recommends that:**

- **research organisations assess the full costs of commercialisation and, when commercialising their research, ensure that a reasonable rate of return is obtained on the Government's investment.**

10.63 In addition to the cost of employing an intermediary to commercialise its research, a research organisation also bears the cost of applying its own resources to assisting the process.

Monitoring the Commercialisation of R & D

10.64 The Sydney Business and Technology Centre told the Committee that:

> Commercial research and development is a very difficult commercial area and must be monitored by a range of

25 BIE. Commercial Opportunities from Public Sector Research, Research Report 32, AGPS, Canberra 1990, pp. 77-8.

experts. If monitored properly as in Japan, it can be highly beneficial, if not it can be a financial disaster.[26]

10.65 Various approaches can be taken to monitoring the commercialisation of R & D. One of these entails identifying the factors that have contributed to the success and failure of different projects and employing this knowledge to future projects. The Committee believes that this is a particularly useful approach.

10.66 **The Committee recommends that:**

- **research organisations regularly review the systems and practices used to commercialise their research and give priority to introducing any improvements suggested by these reviews.**

10.67 The IRDB has a monitoring role in relation to commercialisation carried out under the grants that it provides. In commenting on the IRDB, the Task Force on the Commercialisation of Research supported this role and urged its extension through the appointment of advisers from among recently retired senior company executives with relevant experience. These advisers would report to the Board.

10.68 The Committee noted, in the course of the Inquiry, that the commercial entities in which the public sector research organisations are involved tend not to be open to Parliamentary scrutiny. ANSTO told the Committee that its partnerships are formed at the discretion of the Minister but do not have to be notified to the Parliament. Furthermore, when it has a minority holding in a partnership with the private sector, the Auditor-General has no mandate to audit the accounts of such a partnership.[27] The Committee is concerned that the use of public funds in commercial undertakings of this kind cannot be adequately monitored.

10.69 This issue was discussed at some length in the 1989 report of the Senate Standing Committee on Finance and Public Administration, Government Companies and their Reporting Requirements, and a number of recommendations

26. Evidence, p. S1014.
27. Evidence, p. 382.

were made to improve the accountability of these entities.[28] The Government has not yet responded to this report, but proposes that the new legislation, that is being drafted to replace the *Audit Act 1901*, will require more disclosure of information about companies. A role is envisaged for the Joint Committee of Public Accounts in monitoring information that is commercial-in-confidence.

10.70 The Committee believes that it is essential that all government entities are open to public scrutiny and supports the moves that are being made to do this.

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28. Senate Standing Committee on Finance and Public Administration. Government Companies and their Reporting Requirements, AGPS, Canberra, November 1989.

Chapter 11

THE COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION

Without CSIRO, Australia is a Third World country. [1]

Introduction

11.1 The Commonwealth Scientific and Industrial Research Organisation (CSIRO) is Australia's largest scientific research organisation and one of the major national research institutions in the world. It conducts strategic research essential to improving Australia's economic performance and the care of the natural environment.

11.2 CSIRO's national headquarters are in Canberra, and its research is carried out by six Institutes at research facilities located in more than 150 laboratories and field stations in each State and the Northern Territory Its budget for 1991-92 was $635m and, as at 30 June 1991, CSIRO employed approximately 7,200 persons, including 3,000 professional scientists.

11.3 The research undertaken by CSIRO was traditionally oriented towards primary industries, but the new direction for CSIRO research since the 1980s has been to diversify into new areas of relevance to the Australian economy Recent CSIRO annual reports have highlighted CSIRO's revised functions and funding arrangements, which included the following:

- 30% of its funds are obtained from external sources;
- a comprehensive and systematic analysis of research projects has been carried out to identify and allocate resources to high priority national interest projects and to identify the best social environmental and economic returns to the nation;

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1. Evidence, p. S819.

- strategic, corporate and operational plans have been introduced and research objectives for the numerous programs under investigation have been defined;

- the Organisation's management structure, administrative policies and procedures have been significantly altered; and

- authority for the running of the Organisation has been devolved to line managers.

Objectives

11.4 CSIRO is a statutory authority, the charter, functions and powers of which are defined in the *Science and Industry Research Act 1949*. Its primary functions are:

- to carry out scientific research:

  - to assist Australian industry and to further the interest of the Australian community; and

  - to contribute to national and international objectives and responsibilities of the Commonwealth Government; and

- to encourage or facilitate the application and use of the results of its own or any other scientific research.

11.5 CSIRO also has other functions, which include international scientific liaison, training research workers, disseminating information about science and technology and publishing research results.

11.6 The Organisation has additional powers to do whatever is necessary to perform its functions with the maximum efficiency and effectiveness to achieve its objectives. In particular, it may:

- arrange for research and other work to be undertaken outside CSIRO;

- form partnerships or companies;

- make its discoveries and inventions available for fees, royalties or other considerations; and

- charge fees for research, facilities or services provided to others.[2]

Corporate Goals 1991-92 to 1995-96

11.7 Following the establishment of the CSIRO Board in 1987, the Chief Executive of CSIRO and the CSIRO Board were very proactive in identifying CSIRO's goals as it moved towards the 21st century. It also developed its corporate mission statement, a five-year strategic plan, annual operation plans and a corporate plan.

11.8 In May 1992, CSIRO published its strategic plan for 1991-92 to 1995-96. The plan identified CSIRO's corporate goals for the two major areas of research and research support. The corporate goals for CSIRO's research are:

- to improve the export and import replacement performance of Australia's primary and manufacturing industries;

- to develop ecologically and management principles and practices for the use and conservation of Australia's national resources;

- to achieve sustainable development in production systems and develop technologies to minimise environmental damage from economic development;

- to reduce the trade deficit of the information and communications industries; and

- to enhance productivity and effectiveness in the provision of infrastructure and services, particularly public health and construction.

The Organisations's corporate goals for research support include human resource development, communication and corporate development.

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2. CSIRO. Annual Report 1990-91, p. 9.

Activities

11.9 CSIRO advised the Committee that during the early 1980s it carried out about 20% of all Australian R & D, as much as the private sector and as much as all universities undertook in the natural sciences. In 1989-90, CSIRO performed about 13% of national R & D, while private industry's share increased to 34%.[3] There are no more recent figures available from the ABS to identify any further trends in the mix between CSIRO and private sector research.

11.10 The proportion of Commonwealth-funded research undertaken by CSIRO, based on Commonwealth outlays expressed at 1984-85 prices had decreased from 14% in 1981-82 to 10.7% in 1988-89.[4]

11.11 The range of research undertaken by CSIRO is diverse and encompasses work directed to most sectors of the Australian economy. CSIRO has the depth, experience and expertise to contribute significantly to the provision of a relatively stable environment for R & D in Australia. It provides the necessary infrastructure and pool of knowledge and skills to promote innovation, and serves as a conduit into Australia of R & D information from overseas, making it accessible to companies or groups without the capacity to obtain the information themselves.

Research Priority Determination

11.12 CSIRO's Board and the Executive, in consultation with the six Institute Directors, have introduced new methodologies to assess national research priorities and longer term strategies, the resources needed and the benefits of the research to the economy. As discussed in Chapter 7, the new approach is based on the assessment for each area of research of:

- its attractiveness, which is assessed on the basis of:
  - its potential benefits to Australia in economic, environmental and other social terms; and
  - Australia's ability to capture these benefits by converting technological progress to commercial or other gains; and

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3. Evidence, p. S820.
4. DITAC. Australian Science and Innovation Resources Brief 1992, AGPS, Canberra, May 1992.

- its feasibility, which is defined in terms of what the research might accomplish and the national capacity to achieve research goals in a timely way.

Further details of the methodology are provided in Figure 7.1 and Box 7.1.

11.13 Dr. Stocker, the Chief Executive of CSIRO advised the Committee that the new methodology:

> ... is an essential part of our development as an organisation, particularly in the interests of improving our performance in external delivery by setting priorities across research areas, firstly, for the nation and, secondly, for our organisation.[5]

The adoption of this new approach represents CSIRO getting 'more serious, much more transparent, much more quantitative, about setting its and the national research priorities'.[6] In this they have led the way.

11.14 The Science and Technology Budget Statement for 1991-92 provided further details concerning CSIRO's setting of research priorities. It stated that:

> CSIRO's senior managers examined 16 major areas of research directed to national economic, environmental and social objectives to reach conclusions on national priorities. These were used as a basis for assessing CSIRO's role in responding to them. The Organisation has now commenced significant resource reallocations, including to strategic research in the minerals sector and to research on the environmental aspects of economic development. Priority assessments will be regularly repeated both at the corporate level and in individual parts of CSIRO.[7]

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5. Evidence, p. 9.
6. Evidence, p. 66.
7. Science and Technology Budget Statement 1991-92, 1991-92 Budget Related Papers No. 6, AGPS, Canberra, 1991, p. 11.

11.15 The Committee was impressed with CSIRO's methodology for selecting the areas of research that should be supported. The Committee concurs with CSIRO's assessment that:

> ... many of the methodologies we are developing will be more broadly applicable to other research bodies and to other government and non-government instrumentalities.[8]

11.16 The Committee believes that the system that CSIRO has developed has the potential to focus a research organisation's attention on the most useful approaches to its work and is worthy of more widespread use. It also provides a basis for establishing national research priorities, as ASTEC has shown. The Committee has recommended the use of CSIRO's criteria for prioritising research objectives in paragraph 7.61.

Assessing Achievements

11.17 In 1989, BIE reported very favourably on the expertise, skills and innovative approaches undertaken by CSIRO to commercialise the results of its research. The BIE report indicated that CSIRO was well regarded by both the private sector and tertiary sectors of the economy for its efforts in effectively promoting the results of its research for the benefit of the Australian economy.[9]

11.18 The range of CSIRO's successful research efforts and the extent of its collaboration with private industry can be gauged from its 1,300 patents and other commercial arrangements. The estimated 1991-92 royalty revenues are $2.5m. In 1992, a BIE report reviewed four significant research projects undertaken by CSIRO and reported that the total benefits derived from three research projects were double the total costs of carrying them out.[10]

11.19 The Committee was impressed with the many successful processes, technologies and inventions made by CSIRO. These successes are too numerous to list in total, but some examples of recent projects with significant benefits to the Australian economy include:

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8. Evidence, p. 67.
9. BIE. Commercial Opportunities from Public Sector Research, Report No. 32. AGPS, Canberra, November 1989.
10. BIE. Economic Evaluation of CSIRO Industrial Research, Report No. 39 AGPS, Canberra, January 1992, pp. 6-7.

- the potential to prevent long term insect damage to radiata pines, which is estimated by the industry to cost $1 billion, by the release of nematodes;[11]

- Sirospun, with benefits of $908m or 123 times the cost of the research and the potential to increase returns to farmers by up to $36m per year by the year 2000;[12]

- the acceptance as a world standard of CSIRO's technique for testing and detecting blue tongue disease in sheep, which will assist Australia's export of sheep and minimise disruptions to the export program;

- the development of a new variety of plastic wrapping, the benefits of which were assessed as an additional $300m per year in exports of fresh produce;

- the Interscan microwave landing system for aircraft;

- the Airtrak air pollution monitoring technology, which is being marketed successfully in Australia and overseas;

- the Siromelt technology, a cleaner and cheaper way of producing tin, copper, lead and zinc, developed by CSIRO and Mount Isa Mines with an expected benefit-to-cost ratio of 4.1;

- the development of fast, flexible remote sensing systems and image processing methods for use in fishing, mining exploration, agriculture and environmental monitoring;

- the invention of safe pesticides with low toxicity, which are being developed by Du Pont Australia;

- Gene Shears, the ability to control genes;

- the development of new standards for the construction industry for use in relation to concrete cancer; and

- biological weed control, such as programs to control salvinia, the world's worst water weed.

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11. Evidence, p. 117.
12 ABARE. The Economic Gains from Sirospun Technology, Research Report 92.5, Canberra, March 1992.

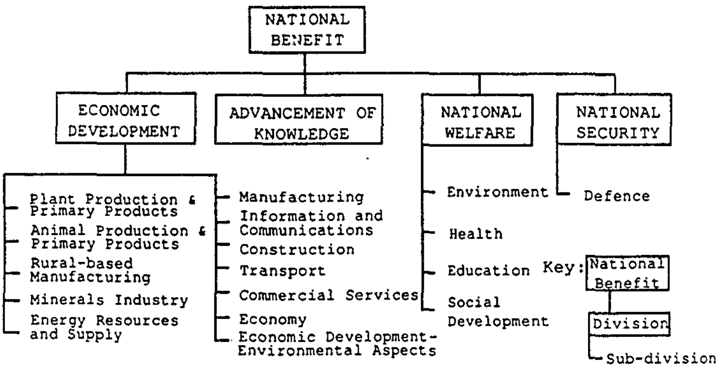
Reporting

11.20 Accounting for and reporting on CSIRO's activities and significant research issues is undertaken in a variety of ways that include:

- the annual report;
- the Budget explanatory notes provided to the Parliament;
- an extensive publication program; and
- media releases and publicity.

11.21 CSIRO has adopted the framework shown in Figure 11.1 to provide better information to the Parliament. This framework places emphasis on describing the purposes for undertaking research in terms of economic and social benefits.

Figure 11.1. CSIRO's Reporting Framework.



Source: DITAC. Program Performance Statement, 1991-92, p. 299.

Organisation

11.22 CSIRO's submission advised the Committee that 'CSIRO has probably undergone more change in the last decade than any other Australian research organisation'.[13]

11.23 In May 1985, the Government requested ASTEC to review public sector investment in R & D. The ASTEC report, titled Future Directions for CSIRO, was published in November 1985. ASTEC recommended that:

- CSIRO be managed by a Board of Directors;
- CSIRO's main role be the conduct of applications-oriented research combined with a commitment to ensuring the effective transfer of its research to end users;
- CSIRO concentrate primarily on research in support of existing and emerging industry sectors and measures to facilitate the adoption of the practical results of its research;
- CSIRO increase its interaction with industry;
- CSIRO actively seek more contract research from individual firms or groups of firms, and make its skills and technology available commercially by establishing independent and joint venture companies;
- Sirotech continue to provide links between CSIRO and the broader industrial community, with Sirotech's activities supplementing rather than supplanting direct researcher to industry contacts;
- the full costs of R & D and other services performed under contract to or in joint venture with industry be charged under normal commercial arrangements unless a demonstrable public benefit arises; and
- the organisational structure provide more flexibility in personnel matters.[14]

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13. Evidence, p. S840.
14 ASTEC, Future Directions for CSIRO, AGPS, Canberra, November 1985.

11.24 During 1986, a number of developments provided the future thrust for CSIRO; they included:

- the creation, by the *Science and Industry Research Legislation Amendment Act 1986*, of a new structure for CSIRO's management comprising:
  - the Board, composed of members from industry and the scientific community and responsible for setting broad policy directions for CSIRO within the general policy context established by the Government; and
  - the Chief Executive, the most senior member of the Organisation, who is responsible for the management activities of CSIRO within the directions established by the Board;
- the issuing by the Minister of guidelines setting out the policies and priorities which the Government wishes CSIRO to follow;
- the preparation of 3-5 year strategic plans together with annual operational plans, which are to be submitted to the Minister; and
- the continuation of CSIRO's primary role in:
  - applications-oriented research in support of major industry sectors and selected areas of community interest; and
  - the effective transfer of its results to users.[15]

11.25 In July 1987, the Chairman of CSIRO, the Hon Neville Wran, QC, announced a major reorganisation of CSIRO. The reorganisation, which followed the review by ASTEC and a study by consultants, McKinsey and Company, was designed to place greater emphasis on the link between scientific research and its economic and social benefits to Australia. The two main recommendations of the McKinsey report were that CSIRO needed:

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15. Hon B O Jones, Minister for Science and Technology. House of Representatives Hansard, Second Reading Speech, 17 September 1986, pp. 853-6.

- to make structural changes to enable the vigorous application of scientific research results; and

- to devise a streamlined management structure giving greater authority, autonomy and support to research managers at all levels.

11.26 The restructuring of CSIRO resulted in the former 41 Divisions, which were grouped into five Institutes, being replaced with 32 Divisions and six Institutes. As Figure 11.2 shows, the six Institutes cover information and communications technologies; industrial technologies; minerals, energy and construction; animal production and processing; plant production and processing; and natural resources and environment.

11.27 Other administrative initiatives following from the reorganisation were:

- the new Divisions and Institutes to be closely aligned to industry and community groups;

- tighter monitoring of CSIRO's research to maximise its economic and social value to the Australian community, while maintaining scientific excellence; and

- the Divisions and Institutes to perform more of their own administrative work, with line management being strengthened by giving Chiefs of Divisions and Directors of Institutes greater authority and accountability for their decisions and the efficient use of resources.[16]

11.28 As part of the process of increasing CSIRO's efficiency and effectiveness, further changes have been introduced since 1988. They involve new staff arrangements which include career prospects, a merit-based emphasis, peer review and assessment, a bonus system for rewarding commercialisation, and awards for academic excellence in research results.

11.29 The objectives of the CSIRO's Research Institutes are listed at Box 11.1.

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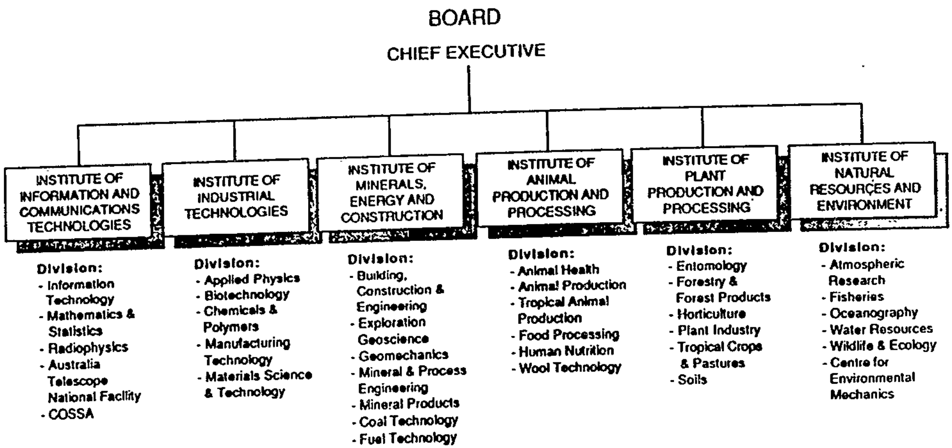
16 DITAC. Science and Technology Statement 1987-88, AGPS, Canberra, May 1988, p. 1.

Figure 11.2. Organisation Chart showing the Areas of Research covered by CSIRO's Institutes.



Source: Evidence, p. S311.

Box 11.1. **Objectives of CSIRO's Research Institutes.**

Institute of Animal Production and Processing:

Improve the range, quality and marketability of products, the efficiency of production and international competitiveness in the Australian animal and food industries in an ecologically sustainable manner.

Enhance human nutrition in Australia.

Institute of Industrial Technologies:

Increase the international competitiveness, efficiency and scope of Australia's manufacturing industries, and be a leader in strategic research for those industries.

Institute of Information Science and Engineering:

Be a leader in strategic research on information and communications technologies and the integration of systems based on these technologies for the benefit of Australia.

Help increase the international competitiveness and export orientation of the Australian information, telecommunications and space industries.

Assist other industry sectors to improve their competitiveness through the use of advanced computer, communications and space systems.

Institute of Minerals, Energy and Construction:

Increase the international competitiveness of the minerals, energy and construction industries and assist in the development of new industrial and export opportunities that maximise the contribution of the sector to the sustainable development of the Australian economy.

Institute of Natural Resources and Environment:

Provide the scientific knowledge required for the effective management and conservation of Australia's natural resources and environment, particularly in relation to the conservation and protection of natural heritage and sustainable use by dependent industries.

Institute of Plant Production and Processing:

Improve and sustain the productivity and profitability of industries based on field crops, pastures, horticulture and forests, and improve knowledge of Australia's soils, plants and insects.

Source: DITAC. Program Performance Statements 1991-92, pp. 298-9.

Resources

11.30 The majority of funds for CSIRO's operational expenditures are provided by the annual appropriation of funds by the Government. CSIRO's financial allocations represent approximately half the appropriations funds provided for public sector research organisations by the Commonwealth. In 1991-92, 69% of CSIRO's budget expenditures totalling $634.9m was expected to be funded by the Commonwealth. CSIRO estimated that it would be financed from the following sources:

- Government appropriations totalling $440.7m, comprising:
  - $416.5m for operational expenditures, salaries, administration and purchases of minor items of equipment; and
  - $24.1m for capital works, major equipment and services; and
- external sources totalling $194.2m, which include an estimated $16m from property sales, royalties and the sale of assets.[17]

11.31 CSIRO's 1991-92 budget allocated the following amounts to the six Institutes:

Animal Production and Processing	$130m
Industrial Technologies	$86m
Information Science and Engineering	$54m
Minerals Energy and Construction	$106m
Natural Resources and Environment	$85m
Plant Production and Processing	$127m
Total	$588m

An additional $47m was allocated to corporate research support.

17. DITAC. Program Performance Statement 1991-92, p. 297.

11.32 Table 11.1 shows the breakdown of CSIRO's 1991-92 budget in terms of its socio-economic objectives.

Table 11.1. Distribution of CSIRO's Budget by Socio-economic Objective.

Socio-economic Objective	$ Million	% of Budget
Plant Production and Primary Products	80	13
Animal Production and Primary Products	105	16
Rural based Manufacturing	63	10
Minerals Industry	52	8
Energy Resources and Supply	38	6
Manufacturing Industries	88	14
Information and Communications	33	5
Economic Development Environmental Aspects	42	7
Environment	66	10
Other Economic and National Welfare	68	11
Total	635	100

11.33 CSIRO's employees numbered 7,278 in June 1991. Professional staff make up 44% of the employees, technical staff 32%, personnel with trades qualifications 3% and administrative staff 17%.

Funding Levels

11.34 Funding from appropriations for CSIRO decreased in real terms by 19% between 1983-84 and 1988-89, from $442m to $358m in 1989-90 dollars. The Government's appropriation funding of CSIRO in 1988-89 accounted for 74% of

CSIRO's budget compared with 88% in 1983-84. During the same period, CSIRO's funding from all sources declined by 5% in real terms. Additional funding, announced in the May 1990 Science and Technology Statement, reduced the funding decline to 15% between 1983-84 and 1989-90.[18]

11.35 Figures 11.3 and 11.4 illustrate the trends over time in the funds received by CSIRO from appropriations and external sources. There has been only minimal growth in CSIRO appropriations over the period 1977-78 to 1991-92, except for some increases in capital funding in the last two years. Over the same period, CSIRO has been increasingly successful in obtaining external funds and estimates it will achieve the 30% external funding requirement in 1991-92.

11.36 The Committee notes the move made by CSIRO's Board to allocate 1.5% of its appropriation funds as 'initiative funds' for additional high priority national interest research. Five million dollars were expected to be available from this source in 1991-92. The Committee commends CSIRO for the implementation of an innovative approach of this kind.

Imposition of the Efficiency Dividend

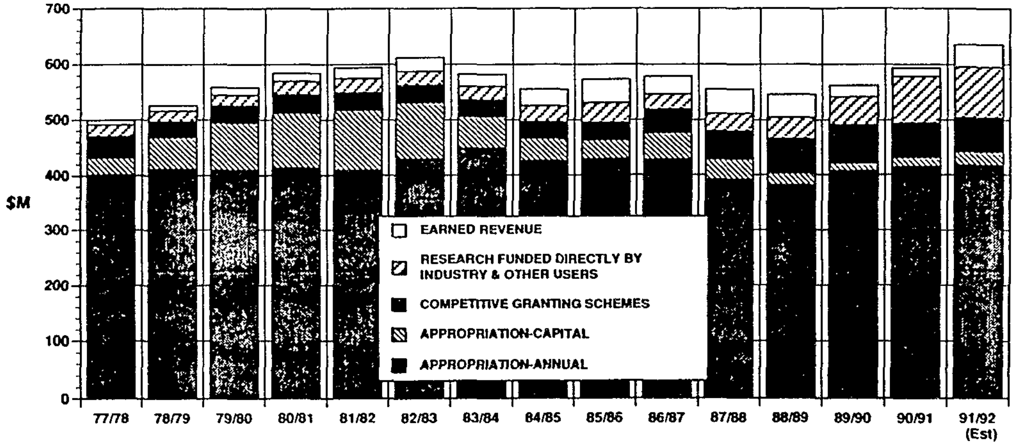
11.37 The efficiency dividend arrangements were announced by the then Prime Minister, the Rt Hon R J L Hawke, during September 1986. The efficiency dividend was initially applied in the 1986-87 Budget and subjects the running costs, (salaries, administrative and operational payments, including minor capital expenditures of less than $250,000 per item) of departments and budget-funded agencies to an annual 1.5% reduction. The efficiency dividend will be subject to a review in 1993-94.

11.38 The Minister for Finance advised the Parliament that:

> The efficiency dividend is the mechanism the Government uses to ensure that a proportion of productivity improvements achieved in the public sector are realised and made available for the Government to allocate according to its priorities.
>
> Indefinite application of the efficiency dividend would over time, (other things being equal) reduce an organisation's real

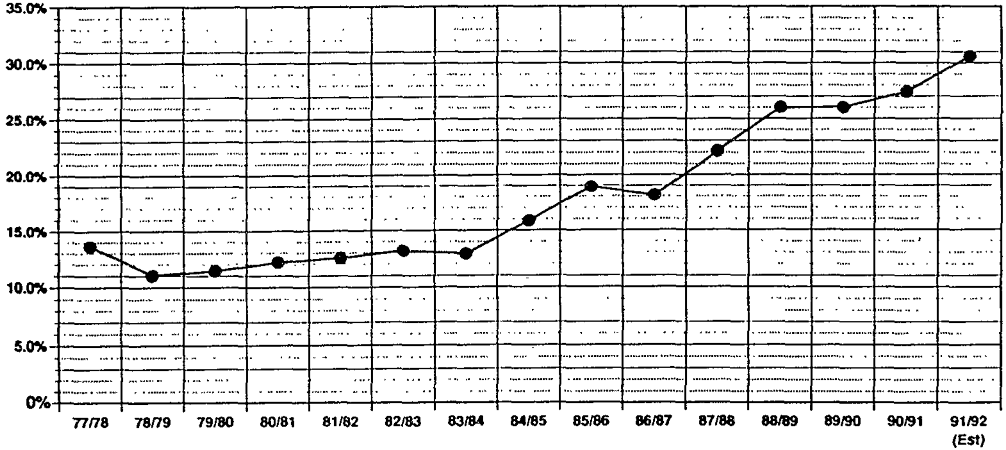
18. Evidence, p. S847.

Figure 11.3. CSIRO Cash Expenditure, 1977-78 to 1991-92 (estimated) at 1991-92 prices, showing the Source of Funds.



Source: CSIRO. Data Book, 1992, p. 20.

Figure 11.4. CSIRO Cash Expenditure, 1977-78 to 1991-92 (estimated), showing External Funds as a Percent of Total Funds.



Source: CSIRO Data Book 1992, p. 32.

> level of running costs funding but will have no effect on its ability to meet the Government's objectives provided genuine *efficiencies are realised.*[19]

11.39 CSIRO advised the Committee that it had improved its efficiency following the restructuring of its R & D programs, financial allocations and resource utilisation. It suggested to the Committee that the efficiency dividend should be applicable only to costs associated with administration and not to the costs of research. Based on the 1991-92 budget estimates, CSIRO claims that the efficiency dividend effectively decreases its funds by approximately $6m per year. The Committee considers that the imposition of the efficiency dividend has seriously limited CSIRO's ability to benefit the Australian economy.

11.40 **The Committee recommends that:**

- **the research costs of government-funded R & D organisations, such as CSIRO, be exempt from the application of the efficiency dividend.**

Adequacy of Funds

11.41 The Committee concludes that CSIRO has risen to the challenges of the 1990s, notwithstanding its needs for increased funding for both recurrent and capital expenditures. The Committee considers that CSIRO's continued viability is essential to the Australian economy, and notes that witnesses from government-funded research organisations, universities and the private sector concur with this point of view.

11.42 The Committee also notes that the management approaches implemented by CSIRO to identify and allocate its scarce resources to high priority national interest research are positive steps which will have longer term benefit to the Australian economy. The Committee considers it is essential, and in the national interest, for the Government to give a higher priority than at present to the funding of CSIRO's longer term strategic research.

11.43 CSIRO's long term strategic research is funded from appropriations and has been squeezed as funding declined during the 1980s. CSIRO regards its long

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19. Hon R Willis, Minister for Finance, House of Representatives Hansard, 20 August 1991, pp. 111-2.

term strategic research as being currently under-resourced and provided the Committee with examples of high priority research that was being hampered by the lack of resources. These examples included:

- biotechnology;
- the industrial development of land (acid soils and desalination);
- ecological problems with hardwood plantations; and
- genetic research directed to improving rural production by overcoming problems associated with grasses, noxious weeds, rabbits and other pests.[20]

11.44 The Committee commends CSIRO for its five-year strategic plan 1991-92 to 1995-96, but considers that CSIRO should also identify a six to 10-year research program, concentrating on national interest strategic research. This strategic R & D plan should meet the challenges of the 1990s and lead to improved research in the 21st century. It should be developed, in conjunction with CRCs, the private sector, universities and the primary industry R & D Corporations. The Committee considers that the proposed technology parks to be established at CSIRO facilities at North Ryde will materially assist the further development of the above objectives and promote the closer interaction with the private sector. A 10-year capital works program is considered necessary to accelerate the modernisation of CSIRO's plant, buildings and equipment.

11.45 The Committee concluded that it is essential in the national interest for adequate long term funding to be allocated to CSIRO. The triennium funding approach was regarded as being of benefit to CSIRO. However, CSIRO proposed that a longer term funding base should be established, especially since longer term strategic research needs longer time scales than the existing three-year triennium base.

11.46 **The Committee recommends that:**

- **the Government give high priority to increasing the funding for CSIRO's longer term strategic research;**

20. Evidence, pp. 23-5, 112-7.

- **the funding period for decision making be extended beyond the present three-year funding mechanism; and**

- **in conjunction with other research institutions, the universities, the private sector and the Cooperative Research Centres, CSIRO develop a 10-year master plan to identify high priority strategic research which is essential to the national interest.**

External Generation of Funds

11.47 In 1991, the Auditor-General carried out an efficiency audit of CSIRO's generation of funds from external services. The Auditor-General recommended various measures to improve CSIRO's systems, practices and management of its R & D. The Audit Report contained 30 recommendations, 22 of which were accepted by CSIRO. The more significant findings of the Auditor-General's report were that:

- existing management systems and practices did not provide CSIRO's management with adequate assurance that external funds were being raised and used economically, efficiently and effectively;

- opportunities remained for the improvement of the business practices employed in generating external funds;

- inconsistencies in costing, pricing and marketing procedures were leading CSIRO to undervalue the worth of its products and services, resulting in appropriation funds being used to subsidise externally funded research activities;

- external funding bodies were in a position to ensure more leverage over the direction of CSIRO research and development than was justified by the extent of their contribution to CSIRO costs, causing CSIRO to risk losing full control over its R & D program;

- CSIRO's project management practices for externally funded projects were inconsistent; and

- although CSIRO had implemented improved project management and financial and management systems, resource management systems had not been developed sufficiently to meet the needs of CSIRO's growing business and commercial activities.

11.48 CSIRO responded to the Auditor-General's report by pointing out that:

- whilst many of the recommendations contained in the report are helpful, they did not take adequate account of the restructuring that had been undertaken within the Organisation and the impact that this has had on the role of Institutes and Divisions; nor did it reflect the change in culture that had occurred within the Organisation over recent years;

- the report did not recognise the different circumstances which prevailed in an organisation with deliberately devolved accountability and the inappropriateness of centrally prescribing one best approach;

- in respect of many of the issues raised in the report, appropriate action was already in train at the time of the audit; and

- in the human resource area, CSIRO had made significant progress in implementing structural changes to develop new staff competencies for operating in a more commercial environment.[21]

11.49 The Committee notes that CSIRO had and/or was in the process of introducing revised procedures, management information and accounting systems which will assist its management and control of research. The Committee considers that CSIRO will achieve long term benefits from the implementation of the Auditor-General's recommendations, and considers that the Auditor-General should follow up, during 1993-94, the actions taken by CSIRO in response to the efficiency audit.

11.50 **The Committee recommends that:**

- **the Auditor-General follow up the audit of CSIRO's generation of funds from external sources.**

Recovery of Overhead Costs

11.51 The Auditor-General's efficiency audit report referred to CSIRO's subsidising external entities when undertaking research on their behalf. Evidence provided to the Committee was that external funding bodies wanted a quality

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21 Auditor-General. Report No. 8 1991-92 Efficiency Audit: the Commonwealth Scientific and Industrial Research Organisation - External Funds Generation. AGPS, Canberra, September 1991.

product from CSIRO but were reluctant to pay for the full overhead costs and the direct costs associated with the research. CSIRO's submission recommended that:

> Commonwealth competitive funding schemes be reviewed with the objective of having them fund the total cost, including overheads, of the project they select.[22]

11.52 CSIRO advised the Committee that it fully costs its projects, when it develops proposals for external entities, and seeks full cost recovery. However, CSIRO advised the Committee of cases in which CSIRO would not fully recover the total cost of research, for example when CSIRO wished to acquire intellectual property within the area of research and saw it as appropriate to negotiate shares of the total project based upon its full costing.[23]

11.53 In paragraph 6.17, the Committee recommended that, in principle, the full cost of carrying out research should be recovered from the user or granting body. The Committee does, however, acknowledge that, in some circumstances, less than full cost recovery is appropriate. As AIMS pointed out to the Committee, other government-funded organisations may be unable to meet the full cost of vital research. In such cases, the Committee believes that it is a managerial and commercial decision for CSIRO to negotiate a reasonable rate of recovery. On the other hand, in respect of research undertaken for the private sector, CSIRO should endeavour to recover the total costs of the research, with some lesser rate being applicable if CSIRO wishes to acquire intellectual property from the other contracted party.

11.54 **The Committee recommends that:**

- **budget-funded research agencies obtain some contribution to overhead costs when performing research financed by other government organisations.**

Capital Works and Infrastructure

11.55 CSIRO's activities are undertaken nationwide at 105 sites and within 150 laboratories. CSIRO advised the Committee that a study undertaken during 1980 disclosed that the replacement value of its buildings was $1.2 billon. This figure

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22. Evidence, p. S817.
23. Evidence, p. 49.

represented national facilities and the Australian Animal Health Laboratory. Additionally, the CSIRO Capital Works Program for 1991-92 to 1993-94 for capital replacement, refurbishment, repairs and maintenance totals $104m.[24]

11.56 The CSIRO Board assessed that $35m per year was required to fund essential expenditures to improve the CSIRO capital infrastructure. CSIRO had assessed that its available funds for replacing and refurbishing, repairs and maintenance was $15m per year, being provided by government appropriations and from other revenue generated by CSIRO. The CSIRO submission highlighted that, if the $20m shortfall was not provided from the annual government appropriations, 'research activity will need to be decreased in order to provide the resources'.[25]

11.57 The funding decreases of the 1980s have made maintenance of CSIRO's capital stocks particularly difficult. Dr Stocker, Chief Executive of CSIRO advised the Committee of the urgent need to arrest the degradation of CSIRO's buildings and capital resources. Dr Stoker advised:

> ... the difficult fiscal times of the early 1980s have clearly resulted in decisions having been taken in the organisation to maintain both staffing and scientific projects to the detriment of some of the capital resources and assets that the organisation has. These have simply not been adequately maintained.[26]

11.58 The Committee's inspection of various CSIRO facilities highlighted that national interest research was being conducted in unsatisfactory, dilapidated, substandard buildings and research laboratories. It was clear that the pressures on funding during the 1980s had curtailed planned and essential maintenance and the refurbishment of unsatisfactory facilities. Dr Stocker advised the Committee that:

> We have buildings which are sub standard, which are not satisfactory places to carry out scientific research in the last decade of the twentieth century and early into the twenty first century.[27]

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24. Evidence, pp. S1837-8.
25. Evidence, p. S1828.
26. Evidence, p. 12.
27. Evidence, p. 29.

11.59 The Committee was concerned that inadequate capital funds over many years has resulted in the neglect of CSIRO's infrastructure. The Committee notes that the Occupational Health and Safety Program which is promoted by the Government appears to have been overlooked, with the result that professional research and other staff work under unsatisfactory conditions. The Committee considers that the Commonwealth has a responsibility as a 'model' employer to ensure that the occupational safety and health of its workers is not jeopardised by substandard laboratories and buildings.

11.60 The Committee welcomes the recent reports of the Parliamentary Standing Committee on Public Works which recommended the upgrading of CSIRO facilities at North Ryde, NSW and Parkville in Victoria. The estimated cost of these redevelopments was $18.5m for the facilities at North Ryde (Phase 1)[28] and $12.25m at Parkville[29].

11.61 The Committee commends CSIRO on the preparation of its Capital Works Program for the 1991-92 to 1993-94 triennium and the measures proposed to redress the imbalance in CSIRO's infrastructure. CSIRO advised the Committee that a survey, conducted during February 1991, identified the need for 83 items of major equipment, which cost more than $250,000 per item and totalled $40m.[30] CSIRO also advised that it is able to provide economic benefits to the Australian economy from its research with the equipment available. However its capability and impact on leading edge technologies and on Australian industries' international competitiveness would increase if it were consistently able to maintain equipment at state-of-the-art levels.

11.62 The Committee considers that the 1991-92 Capital Works Budget of $24.1m is a positive step towards addressing the decaying infrastructure of CSIRO's plant, buildings and equipment together with the replacement of obsolete facilities.

Rationalisation of CSIRO Sites

11.63 The Committee considers that scope exists for the rationalisation of the numerous sites and laboratories operated by CSIRO. CSIRO's operation from

28. Parliamentary Standing Committee on Public Works. Report relating to CSIRO Redevelopment, North Ryde, NSW, 1st Report of 1992, AGPS, Canberra, 1992.
29. Parliamentary Standing Committee on Public Works. Report relating to CSIRO Redevelopment, Parkville, Vic., 10th Report of 1991, AGPS, Canberra, 1991.
30. Evidence, p. S1828.

108 sites, using 150 laboratories and field stations, may be an historical anachronism. The significant decline in the standard, suitability and safe working conditions for CSIRO personnel together with the significant investment needed to maintain them, necessitates as a matter of urgency that CSIRO initiate a comprehensive review of its existing facilities. The Committee notes that CSIRO's review of the utilisation of its North Ryde site identified surplus land which will be sold to finance the upgrading of CSIRO facilities and the establishment of the Science and Technology Park.

11.64 The Committee considers that, notwithstanding the existing triennium funding program for capital works, that CSIRO should adopt a longer term view, for example a 10-15 years timeframe to identify those sites and the required infrastructure where it is economical, efficient and effective for CSIRO to be located.

11.65 **The Committee recommends that:**

- **CSIRO assess the need to rationalise its location at 108 sites and 150 laboratories in terms of the economical, efficient and effective utilisation of its resources;**
- **CSIRO develop a longer term capital replacement program in the light of the assessment; and**
- **future annual reports of CSIRO provide information regarding rationalisation studies and the implementation of the 10 to 20-year building and refurbishment program.**

Commercialisation of Research

11.66 For many years, CSIRO has been actively liaising with industry, universities and other interested bodies concerning the commercialisation of its research for the benefit of the Australian economy. It has initiated an aggressive marketing of its skills and abilities and has placed priority on increasing its links with industry, for example, through investment in companies like Gene Shears Pty Ltd. The Committee was impressed with the action taken by CSIRO under the stewardship of its Board and Chief Executive, Dr J Stocker, to promote the involvement of the private sector in R & D.

11.67 CSIRO's goal of obtaining more funds from external sources has given added impetus to its liaison with the private sector and its attempts to form effective partnerships with private industry. CSIRO has recognised that an essential element in working successfully with private industry is the involvement of both parties from the early stages of any project. In addition to setting priorities for CSIRO, the Board and senior management have analysed the business of many larger companies, identifying the potential benefits it can offer an industry sector and the ability of industry to capture those benefits. CSIRO has approached these companies at senior management levels to promote CSIRO's work, to ascertain what were the longer term R & D requirements of the particular companies and to forge potential strategic alliances.

11.68 In its evidence to the Committee, CSIRO referred to the fact that winning international markets was a very intricate and complex process. It perceived a need to become cleverer at structuring arrangements and linkages to obtain the best outcome for the country.

11.69 CSIRO has benefited from its contracting SIROTECH to provide contractual, legal, licensing and patents services during the commercialisation of CSIRO's research. In 1991, Sirotech filed 183 provisional patents. From July 1975 to June 1990, CSIRO had filed 1,290 patent applications in Australia, accompanied by provisional specifications.[31] In addition, since 1984 they have established:

- 186 agreements with overseas or foreign owned companies;
- 758 agreements with Australian owned companies;
- 2 joint ventures with overseas or foreign owned companies; and
- 6 joint ventures with Australian owned companies.

CSIRO estimated that, in 1991-92, $2.5m would be received from royalties and licences associated with its research.

11.70 The Committee recognised that CSIRO has provided many benefits to the Australian economy from the commercialisation of its R & D. There is, however, room for improving these benefits. In the past, the private sector has not contributed enough funds and skills to commercialise research. The Committee commends CSIRO on its initiatives in identifying and entering into arrangements with various external organisations to commercialise its R & D. In its report,

31. Hon R V Free, Minister for Science, House of Representatives Hansard, 21 August 1991, pp. 268-9.

Commercial Opportunities from Public Sector Research, the BIE commented that its survey had disclosed that CSIRO was well regarded and provided excellent backup support and service in the commercialisation of its research.

Chapter 12

DEFENCE SCIENCE AND TECHNOLOGY ORGANISATION

Introduction

12.1 The Defence Science and Technology Organisation (DSTO) is the second largest research organisation in Australia. In March 1991, when it appeared before the Committee, its staff comprised about 3,500 people, of whom about 1,200 were engineers and scientists. Its annual budget was of the order of $212m.[1]

12.2 DSTO was created in 1975 from an amalgamation of elements of the Departments of Supply, Army, Navy, and Air. Its prime aim was then, as it is now, the provision of scientific support for Australia's defence effort. The oldest component of the organisation, the *Materials Research Laboratory*, pre-dates the First World War. Other laboratories were established during and after the Second World War to meet perceived science needs for Australia's defence and its international defence obligations.

Objectives

12.3 DSTO's primary goal is to help maintain Australia's defence through the application of science and technology. This takes the form of advice and support to the Australian Defence Force (ADF) and the Department of Defence, particularly on matters relating to the acquisition, modification and support of military equipment.

12.4 A secondary role is to enhance Australia's self-reliance by fostering the development of an industrial capacity within Australia that will meet defence production and support needs, both in peacetime and during conflict.[2] In both its roles, *DSTO differs from the other public sector organisations in being largely tied* to a single client, the Department of Defence, of which it is part.

1. Evidence, p. 642.
2. Evidence, p. 612.

12.5 The objectives of DSTO, as set out in its charter, are:

- to develop and maintain a base of skill and knowledge in defence science and technology and foster scientific and technological expertise in industry and tertiary institutions, concentrating on areas relevant to the Australian strategic and natural environment;

- to provide scientific and technical advice on defence policy matters and advice on the selection and acquisition of new equipment and systems and their suitability for operation in the Australian environment;

- to contribute to the solution of scientific and technological problems of the Australian Defence Force, the Department of Defence, other defence agencies and relevant Australian industries, including those arising from the operational use, maintenance, local production and extension of the life of equipment and systems;

- to conceive new devices, equipment or systems of potential value to Australian defence and, in accordance with delegated approvals, manage or undertake successive stages of development; and

- to assist appropriate non-defence bodies where DSTO has skills or facilities not available elsewhere in Australia; contribute to fostering a viable and active defence industry and contribute where appropriate to the development of overall Australian industrial capacity.

Activities

12.6 In its submission to the Committee, DSTO distinguished several areas in which its work has contributed to Australian development.[3] Firstly, it has developed and maintains a broad base of skills, facilities and knowledge in defence science and technology. Its in-house capabilities and expertise are complemented by fostering related expertise in industry, tertiary institutions and other research organisations. One way in which such expertise is fostered is by the issue of research contracts, particularly when DSTO does not have sufficient resources to conduct the research itself. DSTO, in fact, prefers to contract out its research when other institutions have the necessary expertise, because this is more cost-effective than

3. Evidence, pp. 612-4.

conducting it in-house. Since its reorganisation in 1987, DSTO has increased its expenditure on externally contracted research from $7m in 1988-89 to $9.3m in 1990-91.[4] Under the Commercial Support Program, which was instituted following recommendations of the Wrigley Report, further contracting out of research can be anticipated.

12.7 A second way in which DSTO advances Australia's development is through its role in inventing, developing and maintaining products for Australia's defence and solving problems related to the operational use, maintenance, extension of life and local production of military equipment and systems. In this role, it enhances Australia's military self-reliance and consequently its social and economic well-being. Examples of DSTO innovations that are being further developed by industry include the slimline towed acoustic array for the new Type 471 submarines and the Jindalee over-the-horizon radar system.

12.8 Thirdly, DSTO provides assistance to non-defence bodies where DSTO has skills or facilities not available elsewhere in Australia. Assistance is given to other government departments or agencies as, for example, with the conduct of tropical exposure trials for Telecom and provision of advice on chemical disarmament to the Department of Foreign Affairs and Trade. Assistance is also provided through the commercialisation of DSTO's capabilities and innovations.

Organisation

12.9 DSTO is responsible for the conduct of the Defence Science and Technology Program of the Department of Defence. This Program focuses on intelligence, surveillance, electronic warfare, mine countermeasures, and command, control and communications.[5] It is structured around five subprograms, of which four relate to R & D. The R & D subprograms cover:

- aeronautical research which is carried out by the Aeronautical Research Laboratory in relation to aircraft structures and materials, flight mechanics and guided weapons, propulsion, and aircraft systems, with particular emphasis on through-life support and operational performance of military aircraft;

- electronics research which is performed by the Electronics Research Laboratory in relation to information technology, communications, and electronic warfare;

4. Evidence, p. S1803.
5. Evidence, pp. S1801-2.

- materials research which is carried out by the Materials Research Laboratory in relation to ship structures and materials, explosives ordnance, maritime operations, and protective chemistry; and

- surveillance research which is performed by the Surveillance Research Laboratory in relation to high frequency radar, microwave radar, and optoelectronics.[6]

A fifth subprogram, which dealt with weapons systems research, has been discontinued recently and elements of the subprogram have been distributed among the other subprograms.

12.10 DSTO is headed by the Chief Defence Scientist, who reports directly to the Secretary of the Department of Defence, but also responds to operational priorities and standards determined by the Chief of the Defence Force. The Director of each of the four DSTO laboratories is responsible to the Chief Defence Scientist for the efficient and effective management of the laboratory. Each laboratory is divided into divisions, each with a Divisional Chief, a business manager, and a public relations manager, all whom report to the Director.

12.11 In response to the policy information paper, The Defence of Australia 1987, DSTO concentrated its efforts on research and exploratory development and reduced its emphasis on the later stages of engineering development. As a general rule, it took development only to the stage of demonstrating technological feasibility or proving a concept; further development was conducted by industry and funded by the customer.[7]

12.12 This approach was confirmed in 1990-91, following the Force Structure Review and a review of its research priorities by DSTO that aligns its priorities more closely with defence priorities. DSTO will reduce its manpower by 20% between 1991-96. Much of the reduction will be achieved by handing over most aspects of the development of DSTO's R & D to industry and by cutting back on administration and technical support.[8]

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6. Evidence, p. S1800.
7. Evidence, p. 613.
8. Evidence, p. S1799.

Resources

12.13 In the 1991-92 Budget, the Defence Science and Technology Program received funding outlays totalling \$212.5m, which represented 2.3% of the Department of Defence's funding outlays.[9] While there have been variations, DSTO's appropriations have remained at very much the same level over the past nine years.[10]

12.14 Only 1% of DSTO's appropriated funds are devoted to commercialising its R & D.[11] A Commercial Activities Trust Account, which operates on a full accrual accounting basis, has been set up for transactions relating to DSTO's commercial activities for non-defence customers.[12] This account does not fund any non-current assets used for commercial tasks, such as computer and office equipment, furniture, plant or machinery; these are funded from appropriations. On the basis of decisions by Cabinet and the Minister for Defence Science and Personnel, DSTO retains the income from its commercial activities as working capital.[13] In 1990-91, the retained profits were \$566, 605.[14]

Issues

12.15 The Committee identified a number of issues for examination in detail. They include:

- planning and reviewing DSTO's research programs;
- staffing and collaboration with other organisations;
- accommodation;
- the adequacy and cost-effectiveness of its funding;

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9. Defence Industry and Aerospace Report, 27 September 1991, p. 5.
10. Evidence, p. 615.
11. Evidence, p. 690.
12. Evidence, pp. 692-4.
13. Evidence, p. S17'5.
14 Department of Defence, DSTO. Commercial Activities Trust Account Report and Financial Statements 1990-91, p. 5.

- the transfer of technology and the commercialisation of DSTO's research, including the impediments to their being successfully achieved; and

- reporting on DSTO's achievements.

Planning Research

12.16 DSTO's R & D priorities are determined by the needs of the ADF and the Department of Defence, after consultation among all eight of the Department's programs. The Defence Science and Technology Committee determines the broad deployment of DSTO's resources and advises on its plans and policies. A three-year strategic plan was developed in 1987 at the time when DSTO was restructuring to match its R & D more closely to the defence priorities identified in the defence White Paper. Following the Force Structure Review in 1991, a similar process was undertaken, as indicated in paragraph 12.12. The Committee formed the opinion that the planning processes that guide DSTO's work should be more rigorous.

12.17 **The Committee recommends that:**

- **the Defence Science and Technology Organisation review and update the policies and procedures which define the strategic and corporate planning process and the fit between its own plans and the Defence Five Year Plan; and**

- **the plans be updated on a yearly basis in the light of both performance against timed targets within those plans and factors external and internal to the organisation.**

Reviewing Research

12.18 Since the introduction of program budgeting in 1985, a system for reviewing DSTO's performance has evolved. Each component of DSTO's subprograms is reviewed annually by the Chief Scientist, senior management and the Chief Defence Scientist's Advisory Committee. The reviews by senior management concentrate on the technical quality of the scientific and engineering research, while the Chief Scientist's Advisory Committee examines performance, use of resources and future plans. The criteria used by the Committee to assess DSTO include:

- the achievement of previously agreed milestones;
- the efficiency and effectiveness of the use of the resources allocated to each component;
- the potential of its work to help Australian industry and to assist non-defence bodies where DSTO has skills or facilities not available elsewhere in Australia; and
- its transfer to industry on a commercial basis of technology generated through its research and invention.[15]

12.19 The tasks of individual divisions are reviewed by committees composed of the chiefs of the responsible divisions, scientific advisers from each of the Services and the ADF, and 'customers' from the relevant section of the ADF.[16]

12.20 A number of external reviews of DSTO's activities have also been carried out in the past.[17] In 1989, for example, the Aeronautical Research Laboratory (ARL) was reviewed by the Inspector-General's Office in the Department of Defence, with the help of independent advisers. This evaluation was seen as a model that could be followed in assessing other parts of DSTO. A smaller evaluation is planned for the underwater weapons and countermeasures component of the Materials Research Laboratory.[18]

Staffing and Collaboration

12.21 When DSTO adopted its current emphasis on research and only the early stages of development, the ratio of professional to support staff was dropped from 1:3 to 1:1.7, which is close to that regarded as desirable for applied research

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15. Department of Defence. Defence Report 1990-91, p.133.
16. Evidence, pp. 664-5.
17. Evidence, p. 616.
18. Evidence, pp. 666-7, S1801.

organisations in the public sector.[19] Staff reductions planned for 1991-96 will further lower the number of support personnel relative to the number of researchers.[20]

12.22 In common with other public sector research organisations, DSTO needs to maintain its skills base in order to fulfil its objectives. It has experienced some problems in this respect, for example, 'there are many cases where the technology base is very fragile, relying on the skills of only one or two individuals'.[21] Furthermore, recruiting and retaining high calibre researchers with specialised skills can be difficult; increasing numbers of DSTO's staff have been lost to private industry because the salaries and working conditions there are 'often much more attractive than those available to government researchers'.[22] Salaries within DSTO are $5,000 to $10,000 per annum lower than in the private sector and lack the fringe benefits available there. Retaining middle and higher ranking personnel is particularly difficult.[23]

12.23 DSTO has met these problems by increasing its contacts with the academic community, particularly through contracting research to universities, which also has served to enhance the overall skills base in the local science community. In addition, DSTO has increased the number of undergraduate and postgraduate cadetships that it offers.

12.24 The Committee notes that, by recruiting a number of younger people over the last few years, the aging profile of DSTO's researchers has been reversed. However, many of these individuals leave for the private sector after three or four years training.[24]

12.25 DSTO is constrained in its ability to pay competitive salaries to all its professional staff. It has so far relied on selectively rewarding some researchers, for example, through a system of awards, and:

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19. Evidence, pp. 643-4.
20. Evidence, p. S1799.
21. Evidence, p. 615.
22. Evidence, p. 614.
23. Evidence, pp. 648-9.
24. Evidence, p. 647.

ensuring and emphasising that DSTO is a worthwhile and exciting place in which to work and that its research capabilities are second to none, both here and overseas. ... DSTO's major challenge, however, remains the recruitment and retention of skilled staff.[25]

12.26 Collaboration with other bodies, both in Australia and overseas, presents opportunities to pool skills and overcome staffing deficiencies as well as share expensive equipment. DSTO has collaborative projects with Canada, Thailand and Malaysia, is involved with the multilateral Technical Cooperation Program with Canada, the USA, the UK and New Zealand and is participating in a number of the Australian Government's CRCs and projects with Australian universities, CSIRO and Telecom.[26] In its submission to the Inquiry, DSTO admitted that 'linkages with ... tertiary institutions are still areas with scope for improvement'.[27]

Accommodation and Equipment

12.27 Several of DSTO's laboratories are housed in aging buildings that are not suited to the uses to which they are now put. Scientists working at Salisbury, for example, are located in some of the 1,100 small buildings that were used for munitions development during the Second World War, while their requirement is for significantly sized laboratories linked to offices. ARL's premises are also substandard, as are its wind tunnels, which date from the 1950s. The Committee regards it as unsatisfactory that DSTO's staff should be working under substandard conditions and believes that these conditions should be improved.

12.28 **The Committee recommends that:**

- **adequate capital funding be provided for the accommodation and equipment needs of the Defence Science and Technology Organisation.**

25. Evidence, p. 617.
26. Department of Defence. Defence Report 1990-91, pp. 123-5, 127, 132-3; evidence, p. 706A.
27. Evidence, p. 634.

Funding

Level of Funding

12.29 Evidence provided to the Committee in March 1991 indicated that DSTO spent approximately 70% of its approximately $212m budget on 'customer-oriented research', that is, research requested by the ADF and the Department. Long term strategic research devoted to Australia's defence needs received roughly 15%-20% of funds and the remainder was used to support and maintain facilities.[28]

12.30 DSTO judged that its funding was at 'a fairly satisfactory level at the moment, given the realities of the Budget'.[29] It pointed out, however, that:

> Because we are a client-oriented Program, we have given priority to the areas of R&D related to problem solving and policy advice. This is an ever-growing demand on our resources, and in a zero growth economic climate, we have had to make some inroads into the level of funding which we would prefer to devote to maintaining our longer term R&D technology base.[30]

12.31 One of the recommendations emanating from the evaluation of the Aeronautical Research Program was that:

> ... the proportion of ARL resources invested in the technology base should not be eroded, and if anything, should be increased.[31]

The Department's response to this recommendation has been to increase funding for technology and monitor the balance between expenditure on the technological base and customer-oriented research. The Committee believes that the maintenance of the technology base of all DSTO laboratories is essential.

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28. Evidence, p. 643.
29. Evidence, p. 702.
30. Evidence, p. S1757.
31. Department of Defence. Aeronautical Research Laboratory: Program Evaluation, Inspector-General's Office, Canberra, December 1989, p. iv.

12.32 The Committee heard from the Acting Chief Defence Scientist that:

> ... I do not believe that at the present time there is a systematic process in our corporate headquarters which tries to balance needs against the available funding which would then say that we need more for this or that.[32]

The Committee believes that such a process is necessary and notes that, when the ARL was evaluated, the reviewers recommended the more effective use of the Defence Science and Technology Committee to examine and advise on the technology base program.[33]

12.33 **The Committee recommends that:**

- ***the Defence Science and Technology Organisation* establish a mechanism whereby it can effectively establish its funding needs and attach priorities to these needs; and**

- **the Department of Defence monitor the adequacy of the funds allocated to the Defence Science and Technology Organisation in relation to its capacity to maintain its technological base and provide additional funds when they are needed.**

Cost-effective Use of Funds

12.34 DSTO distinguished three indicators of the cost-effectiveness of its work. The first is provided by the savings accruing to the Department of Defence as a result of DSTO's work, although they cannot always be accurately quantified. DSTO cited as an example the saving of $33m to the F/A-18 project that resulted from the attachment of an engineer to the F/A-18 Project Office in St Louis. Another *example is the saving of $2.66 billion from 75 projects undertaken during the last* 10 years.[34]

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32. Evidence, p. 645.
33. Department of Defence, loc.cit.
34. Department of Industry, Technology and Commerce <u>Bringing the Market to Bear on Research</u>, Report of the Task Force on the Commercialisation of Research, AGPS, Canberra, November 1991, p. 23; evidence, p. 615.

12.35 A second indicator of performance is the income from the commercialisation of its research. At present, earnings from this source are low, but significant profits are expected from joint ventures such as that mentioned in paragraph 12.40. A third indicator is the value to Australian industry of manufacture resulting from DSTO's work:

> DSTO's research and development currently underpins more than $1.5b in contracts to Australian industry. In addition, the provision of technology transfer support in areas of DSTO expertise creates the opportunity for Australian industry to participate in subcontracts related to the Collins submarine and ANZAC frigate valued at more than $8 billion.[35]

12.36 Other indicators that could be developed are an assessment of how well DSTO is meeting the needs of its customers and the performance of the elements of Australian industry that benefits from DSTO's assistance. Following a recommendation stemming from the review of the ARL, DSTO is continuing to improve its indicators of performance.[36]

12.37 There are some aspects of DSTO's cost-effectiveness that are hard to assess. In its submission to the Inquiry, DSTO pointed out that:

> It is difficult to assess the value of increases in military capability as an outcome of DSTO's work. ... it is difficult to put a quantitative value on the strategically desirable independence from overseas suppliers. In other cases ... , no one else in the world may be able to make the equipment required, or the Australian-made equipment may meet a unique need (for instance, the Jindalee radar system ...).[37]

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35 Department of Defence, DSTO Commercial Activities Trust Account Report and Financial Statements 1990-91, p. 1.

36. Evidence, p. S1764.

37. Evidence, p. 632.

Technology Transfer and Commercial Activity

12.38 There are two strands to DSTO's approach to transferring technologies that it has developed and commercialising its research. In one case technology is transferred to the private sector so that goods required by the Defence Forces can be supplied by Australian industries. This is seen as the 'civilianisation' of defence production. In the other case, DSTO's research is made available for the commercial production of non-defence-related products.

Mechanisms for Transfer and Commercialisation of Technology

12.39 DSTO transfers technology to Australian industry through Department of Defence-funded contracts during the early stages of R & D, as well as for the support or adaptation of locally manufactured equipment throughout its life cycle.[38]

12.40 In some cases, there is also a financial gain to DSTO from the transfer of technology. In its annual report for 1990-91, the Department of Defence lists a number of DSTO's achievements in relation to its key emphasis on the commercialisation of its research. Two joint venture companies were mentioned, one of which, Defence Technologies Australia, will commercialise a modification of Allison T56 turboprop engines that reduces smoke emissions. With 16,000 such engines in civil and military aircraft round the world, this modification has a large potential market.

12.41 Licensing agreements were signed for the transfer of ARL's aircraft repair technology to a Brisbane firm, Helitech Industries Pty Ltd, and the transfer of the Surveillance Research Laboratory's (SRL) radar target generator technology to a subsidiary of the South Australian's Government's Innovation Management Pty Ltd. Sales were made of colour periscope cameras by the SRL, and the Electronics Research Laboratory sold the design for a computer chip. Royalty payments were also received.[39]

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38. Department of Defence. Overview of DSTO Commercialisation for the JCPA Inquiry into R&D, p. 1.
39. Department of Defence. Defence Report 1990-91, pp. 134-5.

12.42 In addition to the income derived from its research, DSTO receives payment for consultancies and the provision of services to non-defence bodies. At present, most of DSTO's income is derived from this source.[40]

Policy and Strategy

12.43 DSTO's ability to maximise its commercial potential is limited to some extent. It is not able to act with full commercial flexibility because of its prime responsibility to serve the ADF and the Department of Defence.[41] The Guidelines for the Conduct of DSTO Commercial Activity specify that, with respect to such activity:

> a. its level and conduct should have regard to Defence priorities;
>
> b. it should be pursued only as a by-product of activities initiated for defence purposes;
>
> c. its management should avoid arrangements with private industry that could disadvantage Defence or the Commonwealth; and
>
> d. it should not impede the free international flow of defence information through arrangements such as the American, British, Canadian and Australian Quadripartite Standardisation Agreement ... and the Technical Cooperation Program ... .[42]

12.44 Because of DSTO's primary responsibility to the ADF and the Department of Defence, only 1% of its budget is devoted to its commercial activities. DSTO told the Committee that:

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40. Evidence, p. 679.
41. Evidence, p. 679-81.
42. Annex A to DESTEC [Defence Science and Technology Committee of the Department of Defence] Minute No 8/1990.

> It is a limit that was imposed in order to provide some visible assurance ... to our prime customers, the defence organisations, that we would not allow ourselves and our efforts to be distracted away from them towards pursuing the commercialisation dollar.
>
> As to why it is not some other figure, there really is no answer. That was just the figure that was negotiated and agreed.[43]

12.45 The Committee notes that the Task Force on the Commercialisation of Research concluded that:

> ... it is not realistic to assume that there are a large number of significant inventions in DSTO waiting to be commercialised.[44]

Hence, it appears that the limit of one per cent is not a deterrent to the exploitation of the commercial potential of DSTO's research. The Committee believes, however, that the adequacy of this level of funding should be monitored and, in the light of cost-benefit analyses, adjusted if it is found to be inadequate or unnecessarily generous.

12.46 **The Committee recommends that:**

- **the level of funding provided for the commercialisation of Defence Science and Technology Organisation's research be monitored; and**
- **this funding be adjusted in the light of cost-benefit analyses, to maximise the income from the Defence Science and Technology Organisation's commercial activities.**

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43. Evidence, pp. 690-1.
44. Department of Industry, Technology and Commerce. Bringing the Market to Bear on Research. Report of the Task Force on the Commercialisation of Research, AGPS, Canberra, November 1991, p. 23.

12.47 DSTO's commercial activities can be expanded beyond the limits imposed by the 1% cap on diverting appropriated funds, but only with funding from commercial profits or capital supplied by industry partners. One of DSTO's goals for technology transfer is for its commercial activities to become self-funded in the next five years.[45]

Impediments to Commercialisation

12.48 Although the 1% limit on the budget is not impeding the commercialisation of DSTO's research, it has been recognised for some time that there are other respects in which the commercialisation of DSTO's R & D has been hampered. The Joint Committee of Public Accounts (JCPA) Report 280 on task force management within DSTO drew attention to the problems in 1987, and the evaluation of the Aeronautical Research Laboratory in 1989 suggested that there was much room for improvement in commercialising its R & D.[46]

12.49 DSTO drew the Committee's attention to its failure to exploit certain windows of opportunity because it could not move fast enough to take them up. Its failure stemmed from slow responses and decision making, both in the Department of Defence and other departments. For example, the need to seek approval from the Department of Finance for the establishment of joint companies has led to delays. DSTO pointed out that 'getting an export licence is, if nothing else, a matter measured in months'.[47] The Committee believes that delays of this kind are clearly counterproductive, should be identified and eliminated as far as is possible.

12.50 **The Committee recommends that:**

- **the Department of Defence, the Department of Finance and any other organisations, that are identified as delaying the commercialisation of the Defence Science and Technology Organisation's research, review their procedures with a view to streamlining them.**

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45 Department of Defence, DSTO Commercial Activities Trust Account Report and Financial Statements 1990-91, p. 6.

46. Department of Defence. Aeronautical Research Laboratory: Program Evaluation, Inspector-General's Office, Canberra, December 1989.

47. Evidence, pp. 694-5.

12.51 DSTO recognises that another reason for its failure to capitalise on some its research is the lack in the past of links with industry at an early enough stage of R & D. It told the Committee that:

> ... there is a need ... to introduce a more commercial attitude in the minds of the researchers and the task managers right at the inception so that when a research program starts one examines it from the standpoint of whether ... there are commercial opportunities potentially in this line of research. If there are, there should be some very early interaction with industry to get some guidance as to whether or not this is a line of opportunity.[48]

12.52 DSTO is attempting to make industry more aware of DSTO's programs and capacities so that initiatives from industry are encouraged, and business development units have now been established in each of the research laboratories to assist the laboratories in interacting with industry. The Committee observed that there is variation in the level of business skills across DSTO's laboratories. For example, at the time of the Committee's inspections of the laboratories, ARL exhibited a more impressive capacity to seek and manage commercial ventures than did the Materials Research Laboratory.

12.53 The Committee has concerns about the skills profile of the personnel involved in the commercialisation, marketing and business development process within DSTO. The Committee appreciates that its concerns here may stem from the inadequacy of the funds available to DSTO to hire well qualified personnel.

12.54 **The Committee recommends that:**

- **an independent review be carried out of the adequacy of the funds available to employ individuals with the best available skills for negotiating, establishing and managing the commercialisation arrangements of the Defence Science and Technology Organisation.**

12.55 For links between DSTO and industry to be of greatest value, DSTO requires a long term strategy for its commercial efforts. DSTO pointed out to the Committee that there is an increasing convergence between military and civilian interests in areas such as aerospace, communications and information technology.

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48. Evidence, pp. 677-8.

In these areas there should be expanding possibilities for DSTO's involvement, some of which have already been exploited, as in DSTO's research agreement with Telecom.[49] The Task Force on the Commercialisation of Research suggested that DSTO should identify the industrial capability for its industrial innovations, as CSIRO and ANSTO have done, and concentrate its efforts in those areas where industrial capacity, defence requirements and its research expertise coincide.

12.56 The Task Force went on to recommend that DSTO's charter should be amended to allow it to work more closely with industry. It should also establish more long term alliances with companies, undertake a priority-setting exercise to identify areas of potential commercialisation and set up an industry advisory group to devise industry development strategies based on DSTO expertise.[50] The Committee supports these recommendations.

12.57 **The Committee recommends that:**

- **the Defence Science and Technology Organisation identify those areas where its expertise coincides with Australian industrial capability and defence requirements, and concentrate on these areas by:**
  - **setting up an industry advisory group to devise industry development strategies for the Organisation's expertise; and**
  - **forming long term alliances with companies.**

Commercialisation Agents

12.58 A final impediment to commercialisation of DSTO's research has been the means by which it has been sought. In its Report 280, which was published in 1987, the Committee found that the system in place at the time for the marketing of DSTO's products by the Department of Defence was fragmented and lacked commercial expertise. The Committee recommended the use of agents by DSTO's

49. Evidence, p. 678.
50. Department of Industry, Technology and Commerce. Bringing the Market to Bear on Research. Report of the Task Force on the Commercialisation of Research, AGPS, Canberra, November 1991, pp. 23-4.

laboratories, provided the products were expected to cover costs and earn an income. The Committee also considered whether a single marketing body should be formed.[51]

12.59 In responding to the report, the Department of Defence accepted in principle the Committee's recommendation, but pointed out that there were many means by which commercialisation might be achieved.[52] With variations in the technologies being developed in each laboratory and different markets for them, flexibility to choose the most appropriate avenue of commercialisation was preferred

12.60 The Department of Defence entered into an agreement with Australian Commercial Research and Development Ltd (ACR & D) whereby proposals for developing DSTO technologies for non-defence uses are submitted to the company for commercial exploitation. ACR & D acts to seek funds for the development within DSTO's laboratories, so far without success. The team that evaluated ARL concluded that the existence of this agreement limited the possibilities open to DSTO in seeking to commercialise its research. However, the Department stated that there would be no conflict between the existing agreement and any new agreement because, while ACR & D's role is to raise funds for work in DSTO's laboratories, any new agreement would cover the transfer of technology to industry.

12.61 One of the recommendations stemming from the ARL's evaluation was that DSTO submit a proposal to the Departments of Defence and Finance to set up a commercial technology broking company to market ARL's technology. This recommendation was based on the argument that it would avoid the drawbacks of the present system. These drawbacks include the slow responses and decision-making processes that were alluded to in paragraph 12.49, as well as:

- the heavy burden placed on ARL's financial resources and the senior officers who personally market their technologies; and
- the reluctance of the private sector to make commercial arrangements with the Government.[53]

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51 JCPA Defence Science and Technology Organisation: Task Cost Management Report 280, AGPS, Canberra, 1987.

52. JCPA. *Finance Minutes. Report 301*, AGPS, Canberra, 1989.

53 Department of Defence. Aeronautical Research Laboratory. Program Evaluation, Inspector-General's Office, December 1989, p. 99.

12.62 The Department of Defence reported that:

> There has been no progress [on the recommendation] ... Lack of enthusiasm, amounting to opposition, from within the Department, and opposition from the Department of Finance meant that more effort would have been needed to progress the proposal than current resources permitted.[54]

12.63 However, in responding to the recommendations of the Task Force on the Commercialisation of Research, DSTO has decided, as its first initiative, to establish an Industry Support Office (ISO) at the ARL. As well as handling ARL's licensing activities, the ISO will purchase R & D of relevance to the aerospace industry from the ARL for retailing to industry. The ISO is seen as a pilot scheme that would be extended to the other laboratories if successful. The Committee welcomes this initiative by DSTO, but is concerned that the ISO will be established only 'subject to the availability of funds'.[55]

12.64 **The Committee recommends that:**

- **priority be given to making funds available for the establishment of the Industry Support Office at the Aeronautical Research Laboratory.**

Reporting

12.65 Each year the Chief Defence Scientist produces a brief report, summarising DSTO's major achievements and a classified, detailed report. At the time of the Committee's public hearing with DSTO in March 1991, the production of the shorter, public report had lapsed, and only the more detailed, classified report was being produced. This larger report had been the subject of some criticism within the Department, and DSTO was in the process of reviewing what sort of report it should produce.[56]

12.66 The Committee notes that DSTO has now resolved to produce five classified reports, four of them for different groups of customers in the Department of Defence and one on DSTO's work on maintaining its technology base In addition,

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54. Evidence, p. S1762-3.
55. Evidence, p. S1799.
56. Evidence, pp. 663, 665-6.

a single public document will be produced in 1992-93. The Committee welcomes DSTO's decision to produce a public report on its work, particularly in view of the need for details of DSTO's work to be widely known by a variety of audiences.

12.67 **The Committee recommends that:**

- **publicly available reports of the work of the Defence Science and Technology Organisation be produced annually.**

Is the Defence Science and Technology Organisation Needed?

12.68 In a speech to the National Science Forum in September 1991, Dr Ward, the Chief Defence Scientist, indicated that consideration was being given to whether Australia needed an organisation like DSTO. Could the services provided by DSTO be obtained from the private sector? At its appearance before the Committee in March 1991, DSTO made a strong case for the retention by the Department of Defence of a core capability to perform the functions undertaken by DSTO. DSTO identified several areas as ones in which the private sector could not be expected to operate effectively, for example, the provision of impartial, objective advice, the maintenance of secrecy, the carriage of long term strategic research and the maintenance of research capabilities. DSTO indicated to the Committee that about the right balance had been achieved in contracting out research and maintaining DSTO's core capabilities.[57]

12.69 The Committee concurs with DSTO's evaluation of the need for its continued existence.

57. Evidence, pp. 654, 657-61.

Chapter 13

AUSTRALIAN NUCLEAR SCIENCE AND TECHNOLOGY ORGANISATION

Introduction

13.1 The Australian Nuclear Science and Technology Organisation (ANSTO) is Australia's only research institute with broad capabilities in nuclear science and technology. It was created by the *Australian Nuclear Science and Technology Organisation Act 1987*, following the dismantling of the Australian Atomic Energy Commission. It is situated at Lucas Heights, to the south-west of Sydney.

13.2 The establishment of ANSTO reflected a change of direction in Australia's policies on nuclear activities. In particular, the mandate of the new organisation involved a shift from involvement in uranium enrichment research and other activities associated with the introduction of nuclear power to Australia, towards concentration on the use of nuclear technology in areas such as medicine, industry and agriculture.

Objectives

13.3 ANSTO's strategic plan for the period 1991-92 to 1995-96 was revised in December 1990 and has been approved by the Minister for Science and Technology. It is based on the two corporate objectives of ensuring that:

- ANSTO's applied research, commercial and training activities in nuclear science and associated technologies contribute to Australia's industrial innovation, and environmental and health management; and

- Australia has the technical expertise and credibility essential to further its non-proliferation and wider national and international nuclear technology policies and interests.

Research Priorities

13.4 During 1991, ANSTO conducted a review of its research projects. It used the approach developed by CSIRO, which is discussed in paragraphs 7.58-7.59, to determine its national interest research priorities. They comprise:

- waste management;
- crystal and molecular structures;
- radiopharmaceutical sciences;
- advanced ceramics; and
- processing and utilisation of radioactive materials.[1]

Activities

13.5 ANSTO has facilities for and expertise in a wide range of fields which include nuclear medicine, soil conservation, water salinity, advanced processing of materials for fabrication and manufacture, air pollution measurement, damage detection in industrial plant and equipment, the management of mine wastes and archaeological dating. It operates in these fields through a variety of arrangements:

- in-house research;
- making its facilities available to others;
- providing consultancies;
- setting up stand-alone businesses and joint ventures to capitalise on its knowledge base; and.
- having international agreements for the interchange of nuclear science and technology.

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1. ANSTO. Research for Australia's Future, 1991.

13.6 ANSTO's stand-alone businesses are:

- Australian Radioisotopes, which markets products for medical, industrial and research uses; and
- a wholly owned company, Environmet Limited, formed during 1991 to provide services to the metallurgical and environment industries.

13.7 ANSTO has established a partnership with ICI Australia Operations Pty Ltd, trading under the name of Tracerco Australia, to market tracing services. It has also entered into joint ventures with:

- Sydney University to promote risk and reliability engineering techniques;
- Fujitsu Australia to operate an advanced supercomputer; and
- the Royal Prince Alfred Hospital for a National Medical Cyclotron.

ANSTO is also involved with the establishment of two Cooperative Research Centres, and is planning to expand its involvement in the CRC process.

13.8 Legislation was introduced into the Parliament during April 1992 to amend the *Australian Nuclear Science and Technology Organisation Act 1987*. The proposed amendments to the Act include:

- extending ANSTO's functions to condition, manage and store radioactive materials and waste;
- emphasising ANSTO's commercial role; and
- granting immunity to the Organisation from certain State and Territory laws.

Organisation

13.9 ANSTO is responsible to the Minister for Science and Technology. It operates under an Executive Director who is responsible to a board of six members. Its major functions are organised into three groups, scientific, commercial and corporate. Two further organisational units deal with:

- communication with the media, the general public and site visitors; and
- Australia's participation in international and bilateral undertakings.

13.10 Sections in the scientific group cover research into:

- biomedicine and health;
- environmental science;
- nuclear physics;
- advanced materials; and
- nuclear technology.

13.11 The commercial group covers ANSTO's stand-alone businesses and industrial technology, which relate to:

- isotopes;
- radiation;
- advanced analytical methods;
- quality assurance and control; and
- safety and reliability.

13.12 The Nuclear Safety Bureau (NSB), which also forms part of ANSTO, is responsible for monitoring and reviewing the safety of the nuclear plant operated at Lucas Heights. It reports its findings directly to the Minister.

13.13 ANSTO's strategic plan foreshadows a restructuring of the Organisation to separate more completely ANSTO's market-driven and basic, longer term research from its independent, self-sustaining, commercial entities. These two groups will be supported by corporate and engineering groups.

Resources

13.14 At 30 June 1991, ANSTO employed 908 persons. In 1990-91, it received $62.5m in appropriations; $64.9m was budgeted for the 1991-92 financial year In 1989-90, ANSTO's budget allocation was $57.5m[2], which represented a cut of 1.2% in real terms and followed two years of dropping budget allocations. According to its strategic plan, ANSTO will assign 70% of the Organisation's research resources to applied research and 30% to longer term, basic projects.[3]

13.15 The Government has set ANSTO the target of earning external revenue equivalent to 30% of appropriations by 1992-93. ANSTO achieved the 30% external funding goaling in 1990-91, when it earned $19.4m.[4] This figure represented 31% of its total operating revenue, in comparison with 22% for 1989-90. ANSTO advised the Committee that it would meet the 30% target for the 1992-93 financial year.[5]

Issues

13.16 There is considerable evidence that ANSTO is providing services and products for which there is a ready market. As mentioned in paragraph 13.6, ANSTO has established several stand-alone businesses and joint ventures Most of these will take several years to generate any significant return. For example, in 1990-91 ANSTO subsidised Australian Radioisotopes (ARI) activities by $1.7m. Following its restructuring, however, ARI was not expected to need a subsidy during the 1992-93 financial year.[6]

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2. ANSTO. Annual Report 1989-90, p. 61.
3. ANSTO. Strategic Plan: an Update 1991/2 - 1995/6, p. 5.
4. ANSTO. Annual Report 1990-91, p. 60.
5. Evidence, p. S1844.
6. Evidence, p. S1845.

13.17 ANSTO's consultancy services are lucrative. At an informal meeting with the Committee, the Executive Director summarised his view of ANSTO's commercial activities thus:

> ... in the work we have done over the last two and a bit years in taking our skills to industry, we have found no shortage of customers - in fact, we have found a great alacrity to take up what we do. I think this is evidence that there is the need for nuclear science and technology across the area of our skills in this country.

13.18 ANSTO is banking on the following key factors to help it to continue to increase its share of targeted markets:

- the advantage of a single site location;
- breadth of expertise, covering many technologies and skills;
- ownership of Australia's only nuclear reactor;
- world recognition of its capabilities; and
- strong links with the nuclear development programs of the South East Asia/Pacific regions.

Funding

13.19 For several years, ANSTO's funding, like that of other public sector research institutions, has been inadequate to meet equipment and maintenance needs and to cover the cost of replacing obsolete equipment. At an informal meeting, ANSTO's Executive Director pointed out to the Committee that:

> ... over the last decade the resources in my organisation, because of inappropriate budgets, have been allowed to deteriorate.
>
> ... it was extremely difficult to fund for capital, and indeed the capital level that we had was just inappropriate for the level of investment in building stock that we had and also more specifically for the new directions that the organisation had. We needed new equipment to take up the new mandate

> of science and technology; we did not have the financial resources to undertake what we needed to do.

13.20 Initiatives taken following the Government's Science and Technology Statement in 1989 have slightly improved the situation. These include the following:

- $0.5m has been provided for the five years from 1988-89 for re-equipment;
- external earnings may now be retained; and
- the advent of triennial appropriation commitments has eased forward planning and increased the efficiency with which equipment and laboratories are upgraded.

However, ANSTO claims that additional funds have allowed only modest progress in upgrading its infrastructure to the standard required if it is to meet its mandate as effectively as possible.[7]

13.21 One of ANSTO's most urgent needs is the replacement of its aging High Flux Australian Reactor (HIFAR). HIFAR is a materials research reactor which was constructed in the 1950s as part of Australia's nuclear power program. This program never eventuated, and ANSTO's amended role requires a multi-purpose research reactor. HIFAR was refurbished during the 1980s and adapted for use as a multi-purpose reactor for research and the production of radioisotopes and irradiated silicone. However, it is reaching the end of its operating life and does not have the capacity required to improve the efficiency of ANSTO's operations. Furthermore, due to its age and increasing obsolescence, the cost of maintaining the old reactor is increasing. Replenishment or refurbishment of the old reactor are not viable options in the medium to longer term. The cost of a new reactor which would meet ANSTO's requirements is in the order of $75-$100m.[8]

13.22 The Executive Director of ANSTO, Dr Cook, told the Committee that a new reactor is 'absolutely essential':

> ... the production of radiopharmaceuticals that we are undertaking at Lucas Heights ... would not be possible without a reactor source. ... there are some

7. Evidence, p. S39.
8. Evidence, pp. 352, 374.

[radiopharmaceuticals] that can be imported, but there are many crucial radiopharmaceuticals that are provided for clinical and therapeutic use that would simply not be available because of their half life.[9]

13.23 ASTEC's report Major National Research Facilities identified seven proposed national research facilities, including a high-flux research reactor to replace the existing HIFAR reactor. ASTEC identified the cost of the new reactor as $150 million and proposed that preliminary studies commence in 1994, with the reactor being commissioned in 2002.[10]

13.24 ASTEC identified other capital needs:

> By and large, these relate to the refurbishment of the site and new equipment. We still have asbestos on site. We have an ongoing program to remove that asbestos. We have a building stock that goes back to the early 1950s. In the new directions of the Organisation, much of the laboratory space needs to be refurbished. We have increasing health and safety standards that are applied to all research facilities in this country, and we need to ensure that we will meet them.

However, according to Dr Cook, inadequate budget funding has meant that:

> ... quite well accepted figures of 4 per cent, for example, for maintenance have never been met and provide an ongoing problem ... .[11]

13.25 In answer to a supplementary question, ANSTO estimated a requirement for an extra $50.45m, (gross expenditure of $70m less $19.6m for items already funded), between 1991-92 to 1993-94, of which $24.7m would be spent on upgrading facilities at the Lucas Heights site and $43.3m on new initiatives. Details of ANSTO's new initiatives are:

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9. Evidence, p. 377.
10. ASTEC. Major National Facilities: a National Program, AGPS, Canberra, March 1992, p. 44.
11. Evidence, p. 352.

Environmental Science Program	$10.15m
Occupational Health and Safety Program	$ 1.05m
Engineering Program	$19.30m
Nuclear Technology Program	$ 5.12m
Physics Program	$ 1.22m
Australian Radioisotopes	$ 3.00m
Corporate Program	$ 3.45m

13.26 The Committee regards ANSTO's need for additional funding as urgent, particularly for the purchase of a multi-purpose reactor to replace HIFAR.

13.27 **The Committee recommends that:**

- **increased funding be provided to the Australian Nuclear Science and Technology Organisation to enable it to upgrade its facilities and purchase new equipment, particularly a new reactor.**

Availability of Skilled Staff

13.28 Given the market that clearly exists for ANSTO's products and services, it is a matter of concern that there has been a decline in locally available expertise in nuclear science and technology. ANSTO's staff with nuclear expertise are aging and, because of the existence of only one elderly nuclear reactor in Australia, career opportunities are limited and not as attractive as in other related areas. Some staff members newly recruited to the area have to be sent overseas for training.[12]

13.29 The Committee notes that an interdepartmental committee under the chairmanship of the Department of Foreign Affairs and Trade is examining the issue. It supports such initiatives that will assist Australia to obtain and develop the expertise needed to ensure the future of its nuclear products and services industry.

12. Evidence, pp. S38, 368.

Safety

13.30 The major concern with safety at Lucas Heights relates to the operation of the two reactors on the site. Institutional mechanisms for safety monitoring include a number of committees that deal with general safety issues on the site, and three groups that deal specifically with nuclear and reactor safety. An internally staffed Nuclear Safety Unit reports to an externally chaired Reactor's Safety Committee; both of these bodies report to ANSTO's Chief Executive.

13.31 The NSB reviews and monitors the safety of the two nuclear plants at Lucas Heights and reports on a quarterly basis directly to the Minister. These quarterly reports are made public in the annual report to the Parliament from one of ANSTO's other committees, the Safety Review Committee.[13]

13.32 Although the NSB reports directly to the Minister, it has not always been perceived as a totally independent body. ANSTO's Chief Executive commented that:

> ... the way in which the Nuclear Safety Bureau operates has been quite independent of my organisation but, because of the fact that it reports to the Minister but that I provide its staffing and it lives on site, it is generally perceived that it is not independent.[14]

Furthermore, the Bureau is staffed largely by engineers appointed from among those working in the reactor area. In other words, Bureau staff are monitoring the activities of their erstwhile colleagues. As acknowledged by Dr Cook, this situation is perhaps 'too much of an in-house arrangement' and 'a little bit too chummy'.[15]

13.33 The Committee notes that amendments contained in the *Australian Nuclear Science and Technology Organisation Amendment Bill 1992* would make the position of Director of the NSB a statutory one, appointed by the Minister and reporting directly to him. This move should emphasise the separation of the NSB from ANSTO, but it would not address the problem of the staff originating from within ANSTO. As the Executive Director pointed out:

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13. Evidence, pp. 370-1.
14. Evidence, p. 373.
15. Evidence, p. 397.

> ... the fact is that we only have one reactor in the country and, if these people are going to have experience on reactor technology, where else are they going to come from?[16]

13.34 An external review of the Nuclear Technology Program was commissioned by ANSTO in 1989. The review was carried out by Atomic Energy Canada Ltd, an organisation that had no previous contact with ANSTO. It resulted in 54 recommendations, of which all but two have been implemented. One of the recommendations not accepted related to work practices which were inappropriate in the Australian industrial relations field. The other advocated the purchase of particular computer software at a time when ANSTO had just invested in a different package.

13.35 The use of overseas consultants appears to the Committee to have been a wise move, in that it provided a visibly independent view of the operations of ANSTO's reactors. The Committee believes that it would benefit both ANSTO's operations and its relations with its neighbours at Lucas Heights if such a review were carried out on a regular basis.

13.36 **The Committee recommends that:**

- **the nuclear reactors and associated plant belonging to the Australian Nuclear Science and Technology Organisation be reviewed regularly by an appropriate, independent, overseas organisation.**

Storage of Radioactive Wastes

13.37 The New South Wales (NSW) Land and Environment Court decision in February 1992 restrained the transfer of radioactive wastes from Australian Defence Industries to Lucas Heights and required ANSTO to remove, by 1995, 2,000 cubic metres of contaminated wastes held at its Lucas Heights site. The Court's decisions highlighted the need for a national repository for radioactive wastes. The Minister for Science and Technology, the Hon R V Free, MP, advised the Parliament that:

16. Evidence, p. 397.

- the judge accepted that the Lucas Heights Research Laboratories are presently the safest site in Australia for the storage of such material;[17]

- the Government has no intention of permitting Lucas Heights to become a national radioactive waste dump; and

- the Government recognises that a permanent national radioactive waste repository must be established and is actively seeking the cooperation of the State Governments in locating areas for a suitable site.[18]

13.38 Over the past 20 years a number of reviews have been undertaken by both Commonwealth and State Governments in an endeavour to establish:

- uniform procedures for the storage of nuclear wastes;

- the methods and practices for the storage of low and high level radioactive wastes;

- the location and control of nuclear waste stores; and

- a national nuclear waste repository.

13.39 The Committee noted the following chronology regarding the above matters:

1975 the National Health and Medical Research Council recommended the establishment of a central repository for the storage of long life radioactive wastes;

1979 the former Prime Minister, the Rt Hon J M Fraser invited State Premiers and the Chief Minister for the Northern Territory to jointly consider the management and disposal of radioactive wastes and the development of coordinated policies;

1980 the Commonwealth and State Consultative Group was formed;

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17. Hon R V Free, MP, House of Representatives Hansard, 2 April 1992, p. 1779.
18. Hon R V Free, MP, House of Representatives Hansard, 4 May 1992, p. 2320.

1981 the first report of the Consultative group was provided to the Commonwealth and State Ministers;[19]

1984 an ASTEC report recommended that Australia proceed to complete a code of practice for the disposal of radioactive wastes, identify sites suitable for the disposal of low level radioactive wastes and develop facilities for the interim storage of low and intermediate level radioactive wastes;[20]

1985 the Commonwealth-State Consultative Committee presented its second report and recommended a national program to identify suitable sites for shallow ground burial of radioactive wastes and that the Commonwealth investigate and receive advice from State authorities, concerning the availability of suitable sites for interim and longer term waste repositories;

1986 the Commonwealth-State Consultative Committee presented its third report, in which it discussed the need for an interim store for wastes;

1987 a feasibility study was conducted in the Northern Territory for a national disposal site; and

1991 August: following public pressure from Lucas Heights residents, a Safety Review Committee (SRC) provided a special report to the Minister for Science and Technology. The SRC reviewed ANSTO's management practices for the handling and storage of radioactive wastes. The SRC concluded ANSTO's practices and procedures were sound and safe for its staff and for members of the public.[21]

13.40 The Committee notes that as at February 1992 NSW, Victoria, Queensland, South Australia, Tasmania and the Northern Territory (NT) have all refused to allow a national radioactive waste repository within their boundaries.[22]

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19 Report of the Commonwealth-State Consultative Committee, Canberra, January 1985.

20 ASTEC. Australia's Role in the Nuclear Fuel Cycle, AGPS, Canberra, May 1984, p. 23.

21 Safety Review Committee Report, Management of Radioactive Waste at Lucas Heights Laboratories, AGPS, Canberra, August 1991.

22 Department of the Parliamentary Library, Radioactive Waste Disposal in Australia, Canberra, 28 April 1992.

13.41 On 1 June 1992 the Minister for Primary Industries and Energy, the Hon S F Crean, MP, announced that the Commonwealth was searching for a suitable site to establish a national repository for radioactive wastes, with a report on the Government's initiatives expected in September 1992. The Committee notes that any proposed site would be remote from large population centres, have a dry climate and be relatively close to transport routes.

13.42 The Committee notes that ANSTO's Synroc research program may provide a solution to one of the problems involved in storing radioactive wastes. In December 1989, BHP, CRA, ERA, Western Mining, ANSTO and the Australian National University agreed to investigate the international, commercial opportunities for Synroc in the field of nuclear waste management. During 1991, the ANSTO Board approved a new program of R & D on the Synroc process; the Synroc process is now a priority research item within the Waste Management Research Program.[23]

13.43 The Committee welcomes the opportunities that Synroc appears to provide and its potential to immobilise radioactive wastes and so contribute to the possible safe storage and management of such wastes. The Committee recognises the urgency of the problem of radioactive waste management and the commercial potential on the international market of technologies in this field. It believes that the work of Australian R & D in radioactive waste management should be regarded as a high priority national interest research.

13.44 **The Committee recommends that:**

- **the Government ensure that sufficient resources are provided for R & D on radioactive waste management and its commercialisation.**

13.45 The Committee notes that there is a considerable degree of local concern about the potential danger posed by stored radioactive wastes and the reactor at Lucas Heights. Such concerns are not limited to Lucas Heights, as radioactive wastes are stored in other places in Australia under unsatisfactory conditions.[24] In particular, the potential threat to the community from having radioactive wastes stored in built up areas needs to be urgently addressed and prompt action taken.

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23. ANSTO. Annual Report 1990-91, p. 35.
24. Department of the Parliamentary Library, loc. cit.

13.46 The possibility of using a process, such as Synroc, to manage the radioactive wastes would increase the safety of the area. Another safety measure is obviously the provision of a repository for nuclear wastes, which the Government is currently seeking.

13.47 The Committee considers the announcements made during 1992 by the Minister for Science and Technology, the Hon R V Free, MP, and the Minister for Primary Industries and Energy, the Hon S J Crean, MP, indicate that 20 years of indecision and procrastination are being actively addressed. The Committee further considers that the Government must ensure that the previous delays are not repeated and that national interest decisions involving the long term national radioactive repository be expeditiously made.

13.48 **The Committee recommends that:**

- **the Commonwealth take urgent action to select a site for and construct a safe and secure nuclear waste repository.**

Monitoring and Control of Radioactive Material

13.49 The Commonwealth, State and Territory Governments have separate powers and mechanisms to control and monitor radioactive materials. The Australian Safeguards Office (ASO), a Commonwealth statutory authority, is responsible for monitoring Australia's obligations and bilateral nuclear safeguard agreements in accordance with the *Nuclear Non-Proliferation (Safeguards) Act 1987*.

13.50 ASO's annual report outlines the quality assurance audits undertaken in respect of nuclear materials, the issue of licences and other matters associated with the administration of its Act. ASO conducts annual audits of ANSTO's nuclear materials and the associated records to ensure that all movements and physical inventories of nuclear material are properly accounted for.

13.51 The *Nuclear Non-Proliferation (Safeguards) Act 1987* excludes from ASO's review the control, monitoring and reporting of radioactive isotope wastes held by State and Territory Governments and the private sector. The Committee notes recent media reports have mentioned the absence of any regular audit or accounting to a central authority to identify private industry's holdings of radioactive wastes and their location. ANSTO maintains comprehensive records of radioisotopes sales to all of its clients.

13.52 The Committee concludes that the Government should review the adequacy of the present arrangements for the control and monitoring of radioactive materials and wastes, which are not subject to the ASO supervision in accordance with the *Nuclear Non-Proliferation (Safeguards) Act 1987.*

13.53 **The Committee recommends that:**

- **the Government coordinate arrangements with State and Territory Governments for improved annual reporting of radioactive waste holdings to a central authority.**

Chapter 14

THE AUSTRALIAN INSTITUTE OF MARINE SCIENCE

Introduction

14.1 The Australian Institute of Marine Science (AIMS) was established by the *Australian Institute of Marine Science Act 1972* and is located at Cape Ferguson, 50km from Townsville. It is governed by a Council of the Institute, which is currently responsible to the Minister for Science and Technology and the Minister Assisting the Prime Minister for Science.

Functions and Mission

14.2 Under its Act, AIMS is required to carry out research in marine science and disseminate information derived from that research. AIMS's mission is:

> ... to enhance its standing nationally and internationally; to generate a constant flow of new knowledge; to stimulate the development of high value new uses, services, processes and technologies; and to contribute to the knowledge base required for the sustainable use of existing and new marine biological resources and for conservation issues.[1]

14.3 AIMS has as its objectives for research and communication:

- to put particular emphasis on tropical marine research in order to advance and apply scientific knowledge in response to national needs and priorities; and
- to demonstrate and communicate the results of research and the importance of marine science in the management, maintenance and development of resources based on marine ecosystems.

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1. Evidence, p. S1209.

Activities

14.4 The focus of AIMS's research effort is the coastal and continental shelf regions of tropical Australia rather than deep water oceanography, which is covered by other institutions. Since 1986-87, the Institute has pursued four major programs:

- coastal processes and resources, involving research into the marine coastal environment that will aid its conservation, development and management;
- reef studies, involving investigation of how and why reefs exist as they do now as a basis for the development of conservation and management strategies by users;
- environmental studies and biotechnology, being the analysis of:
  - the manner in which selected marine organisms respond to and record environmental conditions which contribute to an understanding of climatic and other environmental processes;
  - the potential of marine organisms to yield substances of benefit to humans; and
  - the genetic and associated environmental aspects of selected organisms related to their mariculture ; and
- tropical oceanography, relating to natural phenomena in the ocean at a systems level, especially on the tropical continental shelves.

14.5 The research may carried out in-house or undertaken under contract, cooperatively or by providing outsiders with facilities and assistance.

Organisation

14.6 AIMS *is governed by a Council, which sets the Institute's policy,* and managed by a Director who is assisted by three committees: a senior management committee, a management advisory committee and a research evaluation committee The Institute is structured around its four programs which are assisted by a technical support program and corporate services sections.

14.7 In 1990-91, the Institute had an average staff level of 155 persons, of whom 33 were funded from external sources. These numbers represent a slight increase over these for 1989-90; staffing levels have been more or less stable since 1988.

Resources

14.8 AIMS received $13.6m in appropriations in 1990-91 and $14.2m is budgeted for 1991-92. The Government has set AIMS the targets of earning 30% of its budget from external sources and spending 25% of its total budget on applied research by 1994-95. In 1990-91, AIMS obtained 24% of its budget from external sources, and 15% of its budget was spent on applied research.[2]

Issues

14.9 Australia has established a 200 nautical mile exclusive economic zone, which gives the nation the world's second largest maritime domain under international law. Australia's marine area is now 1.5 times larger than its land area. The Australian fishing industry, with exports worth over $350m, is the sixth highest export earner. Marine industries already earn more than $16 billion annually. Of this, some $4.5 billion is gross export income. Substantial growth in these figures can be expected if action is taken to exploit the full range of commercial possibilities.

14.10 The importance of marine science and technology will grow over the next 20 years as there will be:

- increased activity in offshore maritime engineering projects;
- greater exploitation of fish stocks;
- increasing human use through tourism and leisure activities; and consequently
- increasing strains on marine ecosystems.

14.11 Australia has the research capability and competitive advantages bestowed by its endowment in natural resources to establish market positions in

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2. Evidence, pp. 1166, 1189.; AIMS, Annual Report 1990-91, p. 9.

various ocean related technologies. Those related to rapidly developing mariculture industries and the maintenance of the coastal and offshore environment provide two examples.

14.12 It has only been in the last decade, however, that Australian governments have recognised the significance of the nation's marine resources, the possibilities of commercially exploiting them and the existence of a base on which to build. Starting from an extremely low level of research, activity in the fields of marine science and technology has doubled since 1979. The Commonwealth Government now spends over $70m annually on marine research and development. However, the rate of expenditure has remained fairly static since 1987-88, following a $5m cut in 1987.

14.13 A Review Committee on Marine Industries, Science and Technology, which was led by Professor K R McKinnon, reported in 1989 on:

- the achievements, strengths and advantages of Australia's research activities in marine science and technology;
- the industrial and commercial opportunities in Australian and international marine industries; and
- the actions which could enhance Australia's performance in those industries.[3]

14.14 The McKinnon Review concluded that Australian civil marine science and technology were world class in many areas, but the effort across the field was unbalanced. There was too much emphasis on marine biology and not enough on the physical sciences and technology. The Review set out a strong case for building on Australia's scientific capability in marine ecosystem management and paying increased attention to marine science issues and funding. Activities of importance that were singled out in the McKinnon Review included exploiting Australia's natural competitive advantages in aquaculture, an industry which is as yet immature in Australia, and monitoring the increasing impact of the tourism industry.

3. DITAC, Oceans of Wealth? A Report by the Review Committee on Marine Industries, Science and Technology, AGPS, Canberra, 1989.

14.15 The Review also identified a need for:

- a national strategic plan in the management of Australia's marine resources;
- better coordination between marine industries and funding/policy agencies;
- improved research infrastructure; and
- improved interaction between the scientific community and industry.

14.16 In the light of these considerations, the Committee examined AIMS as one of the main players in the arena of marine science and technology research. Research priority setting, funding and commercialisation were identified as issues meriting the Committee's particular attention.

Setting Priorities

Priorities for Marine Science and Technology

14.17 The Committee considered the process of setting priorities both for the funding of marine science and technology as a whole and for research activities within AIMS. Decisions about the funding of marine science and technology are made by the Minister for Science and Technology, in consultation with the Minister for Industry, Technology and Commerce and sometimes the Prime Minister. Input to ministerial decisions are provided by a number of sources, that include:

- reviews, such as the McKinnon Review;
- the Marine Industries, Science and Technology Section of DITAC; and
- organisations, such as the Heads of Marine Agencies (HOMA) and the Consultative Group on Marine Industries Science and Technology (CMIST).

14.18 HOMA, which comprises the heads of marine programs in Commonwealth agencies, was set up to coordinate their marine scientific work, especially as it relates to international programs. An additional responsibility given to HOMA in the then Prime Minister's 1989 Statement on Science and Technology for Australia, involves coordinating the work of government agencies and industry in marine science.

14.19 CMIST, which was established to encourage consultation and coordination between government agencies and marine industries, appears to have functions that overlap with those of HOMA. Its membership, however, is wider than HOMA's and covers research organisations, industry associations, State Governments and other Commonwealth agencies.

14.20 In May 1991, the Director of AIMS told the Committee that:

> ... everybody has been disappointed by CMIST, because in the meetings the great majority of people attending are not from industry. They are from government agencies and universities, and are all anxious to share development with industries, but the industries have not come.[4]

HOMA has responded to this situation by forming a small group that will go to selected industries and consult with them about their requirements; in other words, it is moving 'to a situation where the industries are telling us what they want, not us trying to tell them what they need'.[5] HOMA is also seeking ways to encourage industry representatives to attend CMIST meetings.

14.21 In summarising the operations of the decision-making process described above, the Director of AIMS told the Committee:

> I must admit that I am searching for a thread ... that suggests there is a consolidated mechanism for determining marine science and technology priorities.[6]

14.22 The Committee notes that the Government rejected the recommendation of the McKinnon Review that an Australian Marine Industries and Science Council (AMISC) be established. The Review envisaged that AMISC would:

4. Evidence, p. 1197.
5. Evidence, p. 1197.
6. Evidence, p. 1156.

- maintain an overview of marine science and technology priorities and marine industry opportunities;

- evaluate achievements, opportunities and economic prospects in marine industries;

- promote communication between industry and the scientific community, noting this may require appropriate cultural management change on both sides;

- take initiatives aimed at improving coordination within and between government agencies and industry bodies working in the marine sector;

- ensure that important areas of marine research and development of nation benefit and/or commercial opportunity are funded, directly or in liaison with other funding bodies;

- raise funds from marine industries, other than fisheries, and organise and contract out collaborative industry-funded research and development; and

- manage Australia's participation in international marine science and technology programs, and assist Australian institutions and companies to participate in overseas markets for research and development services.[7]

14.23 The Government's view was that:

> ... the formation of an Australian Marine Industries and Science Council is not warranted at this stage. ... increased use of existing structures. ... will enable a more practical and rapid response to the issues raised.[8]

HOMA, DITAC and the ARC are the organisations that currently carry out the functions envisaged for AMISC. DITAC has developed a Marine Industries Development Program that includes marine science and technology[9], and HOMA will advise on priorities in marine science and technology R & D and any needs for improved coordination in this field.

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7. Evidence, p. S1814.
8. Evidence, loc. cit.
9 DITAC. Marine Industries Development Program, AGPS, Canberra, 1992.

14.24 The Committee notes that the mechanisms for providing advice about marine science and technology to the Ministers, DITAC and individual research institutions are still evolving. It recommends that the effectiveness of these mechanisms be monitored and steps be taken to improve them, if they are found to be deficient.

14.25 **The Committee recommends that:**

- **the Department of Industry, Technology and Commerce scrutinise the effectiveness of the existing mechanisms for providing advice on funding and research priorities for marine R & D; and**

- **bearing in mind the recommendation of the McKinnon Review that an Australian Marine Industries and Sciences Council be established, the Department of Industry, Technology and Commerce consider whether new mechanisms are required to provide advice on funding and research priorities.**

Priorities for the Australian Institute of Marine Science

14.26 There are several factors that influence the setting of AIMS's research priorities. First, there are two particularly significant features of the field in which AIMS works. They are the enormous area and variety of Australia's tropical marine environment and the lack of detailed knowledge of its dynamics and the resources it contains. A second factor is the Government and public's concern that the environment be protected. Thirdly, the Government is placing great emphasis on the commercialisation of Australian research results. Taken together, these factors have shaped AIMS's research program, which includes:

- research to establish the basic characteristics and dynamics of tropical marine environments, that is, facts that must be known before any applications can be considered;

- research concentrating on environmental science and ecology; and

- research with an applied focus.

14.27 The Committee notes that the McKinnon Review Committee, reporting in 1989, endorsed the directions of AIMS's scientific program and urged AIMS to increase its applied and industry-oriented research activities.[10] This AIMS has done. It is the Committee's view that the mix of research pursued by AIMS is appropriate.

14.28 As discussed in Chapter 4, a prerequisite of maximising the applications and commercial potential of research is the existence of mechanisms for bringing relevant information to the attention of those who might be interested in it. The Director of AIMS told the Committee that:

> One of the great weaknesses of the Australian situation is that the results of research, irrespective of the type, are not made available to the widest possible audience of potential users. So much of our research results are effectively locked up without being exposed to see if they do have commercial benefit.[11]

His solution to this problem is to consider establishing an applications committee made up of business people and research workers who have demonstrated an ability to think laterally. The Committee believes this to be a useful approach.

14.29 The Director also brought to the Committee's attention an initiative to document AIMS's planned research and development activities and provide this to federal politicians, different industry groups and Australian embassies and high commissions. This was seen as a means of maximising awareness of AIMS's work. It is of particular importance that Pacific and Indian Ocean and Asian nations know of Australian research in marine science and technology. According to the Director of AIMS:

> If we are to benefit fully from the research that is being done, we have to look to those countries that are going to develop. They may need aid now, but by the very magnitude of their populations they will represent enormous markets in the future. ... Australia should ... be able to ride on the back of our research to enter the business markets of Asia and the Pacific and Indian Ocean regions as they develop. ... This is

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10 DITAC Oceans of Wealth? A Report by the Review Committee on Marine Industries, Science and Technology, AGPS, Canberra, 1989, p. 116.

11. Evidence, p. 1186.

> where ... Australia has to try to develop a long term policy.[12]

The Committee concurs with this point of view.

14.30 **The Committee recommends that:**

- **the Department of Industry, Technology and Commerce and the Heads of Marine Agencies develop effective processes to identify ways in which Australia's research capability in marine sciences and technology can be used, disseminated and marketed overseas, especially among semi-tropical nations.**

Funding

External Sources of Funds

14.31 Given the current state of knowledge in the field and the public good nature of much of the required research, the Committee recognises the need for considerable government assistance in funding Australian marine science research

14.32 Many facets of Australia's marine resources and ecosystems remain to be mapped and analysed. The basic research that is required in such areas will, in some cases, involve significant investments in research infrastructure. In Japan, such research has been conducted by consortiums of firms which have funds and long term vision. In Australia, however, there is a strong case for the Government to take a more active catalytic role in the encouragement of private sector investments in marine science and technology.

14.33 Evidence provided to the Committee suggests that there is little support from the private sector for marine research. This was attributed to:

- the absence of an Australian tradition for such activity;

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12. Evidence, p. 1164.

- the lack of confidence in investing in long term research on the part of Australian industries;
- the small number of successful businesses in the Australian marine industry with funds available for investment in research; and
- the high penetration of foreign ownership in Australian industry and the tendency for foreign owners to carry out research in their home countries.[13]

14.34 Beyond domestic firms, there are two other possible sources of external earnings: overseas sources and other government organisations. An advantage of funds provided by overseas organisations is that they tend to be provided for five-year terms, allowing for more effective use of resources than is possible when only short term funds are available. Furthermore, as the Director of AIMS pointed out to the Committee:

> In looking at the way to understand ... [Australia's marine] resources and to responsibly manage them, it is unrealistic to believe that Australia could do that alone within a period of decades. On that basis ... we should investigate the possibility of collaborative studies with other nations that have the technology to investigate these resources ...[14]

14.35 AIMS has received support from overseas in the past and is seeking funds from Japan, the Asia Development Bank and the World Bank. The Committee applauds AIMS's initiatives in pursuit of overseas funds and research opportunities

14.36 An important consideration in collaborative studies is the protection of Australia's interests in the outcome of the research and the use of the results. The Committee heard that:

> Most countries with high technologies such as Japan, Germany, France and the United States appear to have indicated a willingness to join in collaborative research where all the scientific results would be lodged in Australian

13. Evidence, pp. 1160-1, 1169.
14. Evidence, p. 1159.

> institutions and where we would ... be able to negotiate some commercial return to the country.[15]

AIMS already has commercial agreements of this kind with two Thai universities and the Pacific Institute of Bioorganic Chemistry in Vladivostock. The Committee understands that DITAC has experience in negotiating to ensure that, when Australia undertakes collaborative research with other countries, Australia is guaranteed a financial return on any developments to which that research leads.

14.37 As mentioned in paragraph 14.8, AIMS obtained 24% of its budget from external earnings in 1990-91. In 1991-92, however, as a result of its failure to secure an extension of its contract with the National Cancer Institute of the United States, AIMS expects the figure to fall to about 15%. Variations of this magnitude are not unexpected when a large proportion of external earnings derive from a single grant. Despite this setback, there are good prospects of AIMS reaching the target of 30% by 1995-96 as its commercial ventures become profitable.

Funding from Other Government Organisations

14.38 Funding from other government organisations for AIMS's work is largely provided on a contract basis. In carrying out such work, AIMS has encountered the problem that many of these organisations cannot afford to pay full commercial rates for the research. The Great Barrier Reef Marine Park Authority (GBRMPA) is one such organisation. In addition, local governments, in particular, do not have the funds to carry out full-scale surveys of their coastal resources. Yet with such knowledge, they might well be able to save enormous sums of money by preventing the degradation of their coastal environments and exploiting their resources in a sustainable manner.

14.39 The Director of AIMS pointed to:

> ... the problems on the east coast of the United States and the north-west coast of Europe where pollutants have so modified the marine environment that the living things there are often not edible. They are polluted themselves and are carrying high concentrations of heavy metals.[16]

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15. Evidence, p. 1160.
16. Evidence, pp. 1162-3.

A strong case can be made for learning from such situations elsewhere in the world and planning for development that will minimise adverse effects. While the execution of such plans may be costly, in the long term they are likely to be far less expensive than having to undertake the repair of environmental damage. Furthermore, in taking this course of action:

> ... you are preserving an ecosystem which internationally is recognised for its appeal. As other countries have their natural environment degraded, Australia could retain a very high quality of marine environment.[17]

14.40 Given the significance of environmental management for local governments in Australia, the requirement that AIMS charge commercial rates for work for other organisations may not be appropriate in every case. The Committee notes that the then Minister for Science and Technology, the Hon S F Crean, MP recognised that AIMS's research may be more useful in many cases to local authorities than it is to industry, and State and Federal Governments. For this reason, he undertook to review after three years AIMS's target of earning 30% of its budget from external sources. The Committee supports the Minister's approach here.

14.41 In view of the significance of Australia's coastal environment, the Committee believes that steps should be taken to increase the availability of appropriate information to organisations, such as GBRMPA, and local authorities which desire to manage their coastal environments in a sustainable manner. One way in which the provision of such information might be financed is by levying developments along the Australian coast. For example, the Director of AIMS claimed that:

> ... developers who develop tourist resources in coastal areas ... and within 12 months try to sell that resort have no commitment to the environment.[18]

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17. Evidence, p. 1163.
18. Evidence, p. 1190.

He suggested to the Committee a scheme in which:

> ... if a person develops a facility like a tourist resort and sells within a year, a certain percentage of the sale price should go to government for support of environmental research to understand the impact of such developments.[19]

14.42 The Committee concludes that a strong case can be made for support for research into the management of Australia's marine and coastal environments by both governments and the tourist industry. The Committee believes that DASET, DITAC and the Department of Tourism all have roles to play in this regard.

14.43 **The Committee recommends that:**

- **funds be provided to the Department of the Arts, Sport, the Environment and Territories to enable it to make grants to government organisations, which have responsibilities for environmental management and wish to commission research from the Australian Institute of Marine Science; and**

- **the Department of Industry, Technology and Commerce consider other ways, such as levies on the tourist industry, to finance research relating to environmental management and protection.**

Adequacy of Funding Levels

14.44 AIMS's greatest difficulties with funding relate to the purchase and maintenance of facilities. In 1989, the McKinnon Review Committee noted that the generally high standard of AIMS's facilities reflected the Institute's relatively recent foundation. Even then, some of its equipment had become obsolete and needed to be replaced. In a supplementary submission given to the Committee in May 1991, AIMS indicated equipment needs for its four research programs and support services totalling $3.76m. Expenditure of this order would 'bring the Institute to an effective and efficient operating unit able to compete internationally with other major marine research institutes'.[20] Although AIMS has received some additional funding for

19. Evidence, p. 1190.
20. Evidence, p. S1807.

capital infrastructure, it has not received adequate funds 'to maintain research equipment at the highest level - despite annual requests'.[21]

14.45 One of the Government's initiatives that has caused AIMS particular difficulty is the requirement, introduced in 1989, that any items of capital equipment costing less than $250,000 be treated as ordinary annual running costs rather than attracting specific funding as was the case before 1989.

14.46 The Institute incurs greater repair and maintenance costs than are experienced by the average research establishment, largely because:

- its isolated site adds to the cost of services supplied by municipal bodies;
- it has unique facilities, such as a harbour complex; and
- airborne salt contributes to erosion of facilities. AIMS estimates that it requires an additional $400,000 each year 'to ensure that the facilities are maintained at a standard which ensures operational efficiency and maximises conditions whereby human health and safety will be maintained in the workplace'.[22]

14.47 Under the current funding regime and with its current research commitments, AIMS is unable to offer its research scientists salaries at the same level as in comparable research institutes overseas and in Australia. This has led to the loss of staff and failure to attract the best people to fill some of the positions at the Institute.

14.48 The Committee notes that AIMS has taken initiatives to increase funds for equipment and maintenance from appropriations and by expressing interest in ASTEC's proposed national program of major national research facilities. It has also applied for exemption from the efficiency dividend except where it applies to administration on the grounds that 'the "efficiency dividend" is "hurting" and its application to research activity does not appear valid'.[23] The Committee believes that AIMS should receive additional funds for research staff salaries and for the purchase and maintenance of equipment to ensure that it remains a research centre of world class.

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21. Evidence, p. S1859.
22. Evidence, p. S1807.
23. Evidence, p. S1859.

14.49 **The Committee recommends that:**

- **additional funds be provided to the Australian Institute of Marine Science for research staff salaries and the purchase and maintenance of equipment to ensure that it remains a research centre of world class.**

Commercialisation

14.50 One of AIMS's most notable commercial activities is the production of synthetic analogues of natural sunscreen agents extracted form coral reefs. This work started as a joint venture with ICI Australia and was programmed to culminate in 1994-95 with the launch of a human sunscreen lotion into a market estimated to be worth $600m. The analogues also have potential applications as photostabilisers in the plastics and protective coating industries.

14.51 ICI Australia has now withdrawn from the joint venture, following the sale of the division that was working with AIMS. AIMS is continuing this work on its own with the evaluation of the ultraviolet blocker by three overseas companies.

14.52 Other examples of the Institute's commercial operations include:

- the analysis of the impact of sediment in the Gulf of Papua in collaboration with the Ok Tedi Mining Company;
- collaboration with a Japanese company to search for biologically active marine substances with potential applications in agriculture and the pharmaceutical industry; and
- the provision of coral core analysis to Japanese and Indian organisations, with an interest in understanding past climatic changes.

14.53 AIMS is currently trying to sell its skills and knowledge in areas, such as:

- modelling and forecasting of marine climatology, inter-tidal food chains, water circulation and hydrodynamics:

- such data is required for coastal and offshore planning and developments. It ha. diverse applications in areas such as pollution control, dredging and navigation problems, and fisheries management; and

. analysis of data gathered by remote sensing satellites to map the physical and biological environments of coastal waters, reefs and tropical oceans:

- there is some demand for this work in fisheries management and mariculture operations.

14.54 AIMS is collaborating with other organisations in two enterprises with commercial aims. The first enterprise involves James Cook University, GBRMPA and AIMS in pooling their expertise in research, teaching, training and management to offer assistance to developing countries on a fee-for-service basis. In the second undertaking, AIMS, the Queensland Government, and some of its agencies, and two universities are examining the possibility of setting up a pharmaceutical and fine chemicals industry.

14.55 Earlier sections of this Chapter have detailed the approach of AIMS and other bodies to disseminating information about their research to those who might be interested in its commercial exploitation. Turning now to the marketing of AIMS's research, the Committee notes that it has been carried out by the Director and program leaders. Because of the time lag involved in the commercialisation of research results, is not yet possible to gauge how successful they have been.

14.56 An external review conducted by Arthur Andersen in 1989 recommended the appointment of a business manager. This, however, has not been done as there were insufficient funds available for such an appointment. Instead, an existing finance position was upgraded and the Secretary replaced with a person with experience in business. Furthermore, a suggestion by the McKinnon Review Committee that AIMS set up a technology transfer company was not taken up. When AIMS surveyed university and public sector transfer companies two years ago, all were being subsidised from appropriations. The Committee supports the steps that AIMS is taking in commercialising its work and urges it to monitor closely what further developments it should take to maximise its effectiveness.

Chapter 15

OFFICE OF THE SUPERVISING SCIENTIST FOR THE ALLIGATOR RIVERS REGION

Introduction

15.1 The Office of the Supervising Scientist for the Alligator Rivers Region (OSS) was established in 1978 under the *Environment Protection (Alligator Rivers Region) Act 1978*. Working with the Coordinating Committee for the Alligator Rivers Region (CCARR) and the Alligator Rivers Research Institute (ARRI), the Supervising Scientist ensures the protection of the environment in the Alligator Rivers Region (ARR) in the NT from the effects of uranium mining operations. Since 1987, the OSS has also been responsible for the protection of the environment from other forms of mining in part of the AAR. However, the Government's decision in 1991 not to allow mining or exploration in the Kakadu Conservation Zone removed OSS's responsibility in relation to protecting the environment from general mining operations.

15.2 The activities of these bodies complement those of the NT authorities which carry out the day-to-day licensing and regulation of mining in the AAR. The Supervising Scientist reports to the Minister for the Arts, Sport, the Environment and Territories (DASET).

Objective

15.3 The objective of the OSS is:

> ... to ensure the adequacy of arrangements for protection of the environment in the Alligator Rivers Region of the Northern Territory from the effects of mining operations.[1]

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1. The Arts, Sport, the Environment, Tourism and Territories Portfolio. Program Performance Statements 1991-92, Budget-Related Paper No. 8.2, p. 216.

Activities

15.4 The prime charter of the OSS is to ensure the adequacy of the regulatory arrangements and the scientific and technical measures taken for the protection of the environment. This involves research, supervision and assessment, and coordination roles for the OSS, with 75% of its resources being expended on its research role.

15.5 The OSS's research function is carried out by the ARRI at Jabiru. Its objective is:

> ... to provide a scientific basis for developing standards and measures for the protection and restoration of the environment and for assessing the actual and potential short- and long-term effects of mining operations in the Alligator Rivers Region.

The basic aim of the research is:

> ... to acquire enough knowledge about the environment of the Region to enable control measures to be formulated that will ensure with the degree of confidence demanded by the community, that a high level of environmental protection can be attained.[2]

In pursuing these activities, the ARRI is unique in Australia.

15 6 The ARRI's research consists of collecting baseline data on ecosystems in the ARR, assessing the potential impact of mining during operational and rehabilitation phases and developing techniques for protecting the environment. Research is carried out into aquatic biology, plant ecology, geomorphology, environmental radioactivity, modelling and chemistry, and has led to the development of new techniques and a range of standards, practices and procedures.

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2. Evidence, p. S180.

15.7 The Supervising Scientist's supervisory role involves:

- promoting compliance with the Commonwealth's environmental requirements;

- advising on the degree of compliance by each mining operation with these requirements; and

- assessing whether the licensing and regulatory regime established by the NT supervising authorities and the operating practices followed by mining companies are adequate for the protection of the environment.

However, the Supervising Scientist has no powers of enforcement or means of ensuring that his technical advice is put into effect; he relies on consultation and persuasion both directly with the relevant parties and through the CCARR.

Organisation

15.8 There are four sections within the OSS that correspond to its roles in research, supervision and assessment, policy coordination and information, and corporate services. The staff of the ARRI form the largest group within the OSS; they consist largely of scientific professionals and technicians who operate as a multidisciplinary team.

15.9 The Coordinating Committee is comprised of the Supervising Scientist, the Director of National Parks and Wildlife, a representative of the NT Department of Mines and Energy and representatives of other bodies with an interest in mining, such as Commonwealth departments, mining companies, unions and conservationists. Its role is to provide a forum for consultation between various interest groups and to assist the Supervising Scientist in the performance of his statutory functions.

Resources

15.10 Although the OSS was established in 1978, a viable staffing level for the work required of it was not reached until funding was increased in 1982. The OSS has thus been fully operational for less than 10 years. Since 1982, staff levels have dropped. In 1990-91, the OSS had an average of 71 staff, of whom 46 were at the ARRI at Jabiru near the Ranger mine site, 22 in Sydney and two in Darwin.[3]

15.11 Funding for the OSS is provided from government appropriations. In the financial year ended 1989-90, OSS's expenditure was nearly $7.5m, of which $5.8m was spent on the research program.[4] In 1990-91, funding was reduced to $6.6m; $7.2m was budgeted for the 1991-92 financial year but reduced by 9% when the OSS ceased to be responsible for protecting the environment from the effects of general mining. A levy imposed on exports of uranium concentrate produced in the Alligator Rivers Region is collected by the Federal Government and partially offsets the costs of environmental monitoring and research activities in the ARR.

Issues

15.12 In the sections that follow a number of issues are examined by the Committee. They include matters raised in OSS's submission to the Inquiry and others that were brought up by recent reviews of the OSS. The two major reviews are an efficiency audit of OSS's research project administration by the ANAO and a review, commissioned by DASET from Professor G H Taylor, of the role, operations and research program of the OSS. The Industry Commission's report on mining and minerals processing in Australia also refers to the OSS.[5]

15.13 The Committee has paid particular attention to:

- the role of the OSS;
- the most efficient, cost-effective means for the OSS to carry out environmental research;

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3. Supervising Scientist for the Alligator Rivers Region. Annual Report 1990-91, p. 105.
4. Supervising Scientist for the Alligator Rivers Region. Annual Report 1989-90, pp. A59, A62.
5. The Auditor-General. Audit Report No. 10 1989-90 *Office of the Supervising* Scientist for the Alligator Rivers Region - Research Project Administration, AGPS, Canberra, 1989.
   Department of the Arts, Sport, the Environment, Tourism and Territories. *Review of the Office of the Supervising Scientist*, (Reviewer: Professor G H Taylor), AGPS, Canberra, 1989.
   Industry Commission. Mining and Minerals Processing in Australia, Vol. 3, Issues in Detail, AGPS, Canberra, February 1991.

- sources of funds; and
- the management of the OSS.

Is the Office of the Supervising Scientist Needed?

Supervision and Regulation

15.14 This question arose in relation to both the research and the supervisory and regulatory functions of the OSS. In its report on mining and minerals processing, the Industry Commission expressed its dissatisfaction with the OSS's regulatory function and suggested that the OSS be disbanded and its functions transferred to other organisations. The Commission argued that the responsibilities of the OSS and the NT Department of Mines and Energy overlap. It claimed that the OSS 'intrude[s] into the regulatory process by having views differing from those of the Supervisory Authorities on important aspects of environmental protection'.[6] The alleged absence of clear lines of authority was said to have placed the mining companies involved in an untenable position.

15.15 The Industry Commission suggested that the solution to these alleged difficulties was the transfer of OSS's functions to other agencies. The Industry Commission would transfer OSS's supervisory and regulatory responsibilities to the Australian National Parkes and Wildlife Service and its research functions to CSIRO or ANSTO.

15.16 Professor Taylor, on the other hand, did not recommend any changes to the basic role of the OSS. He commented that:

> The prime requirements are for the environmental supervising body to be independent, impartial and competent, and for this body to have public credibility. ... this Review believes that the OSS has a good and deserved reputation for objectivity and impartiality.[7]

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6. Industry Commission. Mining and Minerals Processing in Australia, Vol. 3, Issues in Detail, AGPS, Canberra, February, 1991, p. 597.
7. Department of the Arts, Sport, the Environment, Tourism and Territories. Review of the Office of the Supervising Scientist, (Reviewer: Professor G H Taylor), AGPS, Canberra, 1989, p. 17.

15.17 The Supervising Scientist commented that the Industry Commission's recommendations indicated that the commission had failed 'to grasp the scientific and philosophical requirements of a system of regulation that will guarantee ecosystem protection'.[8]

15.18 The Committee believes, like Professor Taylor, that independence and impartiality on the part of a body responsible for monitoring environmental standards in relation to uranium mining are of paramount importance. The Committee supports the separation of the monitoring role performed by the OSS from the licensing activities of the NT authorities. The Committee also notes that Professor Taylor found that there was no significant overlap or duplication in the work of the various arms of the OSS and other bodies.

15.19 The regulation of environmental standards falls outside the scope of the present Inquiry. However, the Committee is concerned to ensure that the results of the research carried out by the OSS are used to maximum advantage to protect the environment of the ARR. The Committee notes Professor Taylor's concerns that this is not happening, in particular the possibility under the present legislation that the OSS's advice may be overridden and that this has been increasingly so. In his Review, Professor Taylor pointed out that:

> While the OSS is charged with ensuring that the Commonwealth's ERs [Environmental Requirements] are enforced consistent with BPT [Best Practicable Technology], the NT Minister is only required to have "primary regard" to the ERs and to the advice of the OSS when issuing and authorisation under the UMEC *[NT Uranium Mining (Environmental Control)] Act*; the mining companies are required to observe the NT law where it is impossible or impracticable to comply with both the NT law and the ERs. In practice, "having primary regard to" may be indistinguishable from "disregarding".
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> ... The present situation where the NT can override the advice of the independent Commonwealth body with, in general, the greater scientific expertise is unacceptable. Since

8. Evidence, p. S1793.

the ERs were established by the Commonwealth, it is necessary for the views of its agency, the OSS, on what constitutes BPT, to prevail.[9]

15.20 Professor Taylor recommended that:

> The Commonwealth/Northern Territory working arrangements be amended to require the Northern Territory authorities to give effect to the advice of the Supervising Scientist in respect of adherence to the Environmental Requirements.[10]

The Committee supports this recommendation, as well as others designed to strengthen the OSS's supervisory and regulatory roles.

Research

15.21 The Committee questioned whether the type of research carried out by the OSS had to be performed by a public sector organisation; could it not be required of the mining companies working in the area? The Committee accepts that mining companies would be able to carry out the necessary research and notes that one of the companies that has operated in the ARR, Pancontinental, 'had a very, very fine and comprehensive environmental baseline study program going on for three or four years in the early 1980s'.[11]

15.22 However, the need remains for an independent body to monitor the quality and extent of the research carried out by the mining companies and the validity of the claims made by the mining companies' environmental scientists. Furthermore, in such research there is a need for long term studies which public sector research organisations are generally better placed to carry out and more interested in doing than the mining companies. Mining companies tend to find research with a shorter term mining or engineering orientation more appropriate to their needs.

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9. Department of the Arts, Sport, the Environment, Tourism and Territories. Review of the Office of the Supervising Scientist, (Reviewer: Professor G H Taylor), AGPS, Canberra, 1989, p. 54.
10. Department of the Arts, Sport, the Environment, Tourism and Territories. Review of the Office of the Supervising Scientist, (Reviewer: Professor G H Taylor), AGPS, Canberra, 1989, pp. 55-56.
11. Evidence, p. 964.

15.23 The Committee believes that it is essential that the basic research relating to the protection of the environment is carried out by the public sector. At the same time, it recognises that the mining companies can contribute usefully in carrying out research that complements that of the OSS.

15.24 The Committee notes that there are a number of research organisations in Australia that carry out research in some of the areas covered by the OSS. The OSS, however, is the only body in which all the skills required for the protection of the environment from the effects of mining are combined. As the OSS pointed out, splitting up its different research functions would:

> ... destroy the cohesion between the physical, chemical, biological, radiological and geomorphological knowledge needed to ensure successful long term stabilisation and rehabilitation of the mine site. There is no other single agency currently in Australia which commands this full range of expertise. ... The proposal also would seem to be lacking in any conceivable gains - in efficiency or savings in cost.[12]

The Committee concurs with this point of view and supports the retention within the OSS of a pool of expertise necessary to support the OSS's statutory functions.

Should the Role of the Office of the Supervising Scientist be Extended?

Advisory Capacity

15.25 As indicated in paragraph 15.1, the work of the OSS is confined to the Alligator Rivers Region. The OSS's original charter was to deal only with the effects of uranium mining, but was extended to other forms of mining in 1987. Given the expertise that the OSS has built up in relation to environmental monitoring and management, it is clear that it could contribute to research in other parts of Australia and in relation to other types of problems.

15.26 The OSS has already had experience in dealing with matters outside the Alligator Rivers Region, helping to develop national and international codes of practice and advising Western Australia on the handling of radioactive tailings However:

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12. Evidence, pp. 1774-5..

> The Minister is ... unable to draw upon the expertise of the Supervising Scientist, or seek his advice in relation to uranium exploration or mining operations elsewhere in Australia. The expertise available within the OSS could certainly enhance the quality and depth of advice in this general area and it is wasteful for the Government not to be able to draw upon it.[13]

15.27 The Committee notes that, in late 1991, the Minister for the Arts, Sport, the Environment and Territories, the Hon R J Kelly, MP, determined that the OSS should move its Sydney office to collocate with the proposed Commonwealth Environment Protection Agency (CEPA) in Canberra. This move will ensure that policy advice on issues for which the OSS has expertise and responsibility are readily available to the CEPA. However, the Committee believes that the OSS's role should be further extended, notwithstanding the fact that this would raise a number of contentious issues in relation to Commonwealth-State relations.

15.28 **The Committee recommends that:**

- **the *Environment Protection (Alligator Rivers Region) Act 1987* be amended to allow the Minister to request advice from the Office of the Supervising Scientist about any mining operation in Australia; and**
- **Commonwealth and State Ministers discuss the best use of the expertise of the Office of the Supervising Scientist in relation to Australian mining operations.**

15.29 The Committee also believes that the OSS's competence should be exploited further, through contracting out its skills on the open market, engaging in more cooperative enterprises with other bodies and, where possible, commercialising the techniques it has developed.

Research Role

15.30 Under its Act, the research activities of the OSS are restricted to the matters relevant to the protection of the environment from the impact of mining. Yet the OSS has expertise, particularly in relation to waterways, that could be

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13. Evidence, p. S1776.

applied usefully to other management problems in the Alligator Rivers Region. The Coordinating Committee for the Alligator Rivers Region has endorsed:

> ... the concept that the expertise and the competence and the facilities of the research institute should be used to assist in the environmental protection of the park [Kakadu National Park] in whatever way it was appropriate.[14]

The Committee believes that the restriction on the OSS's activities should be lifted so that it can apply its expertise to other problems.

15.31 The Committee also noted the recommendation of the Taylor Review that 'the OSS be empowered to conduct contract research for other bodies'.[15] The OSS indicated to the Committee that:

> ... as an institute we are interested in the concept. We do have facilities and [scientific] competence which is in some ways unique in Australia. We could perhaps ... sell some of our competence.[16]

The OSS is prevented from undertaking contract work by its Act, another restriction that the Committee would like to see removed.

15.32 **The Committee recommends that:**

- **the *Environment Protection (Alligator Rivers Region) Act 1987* be amended to allow the Office of the Supervising Scientist to undertake research in the general field of environmental monitoring and management, including contracting to carry out research or provide advice for other bodies.**

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14. Evidence, pp. 939-40.
15. Department of the Arts, Sport, the Environment, Tourism and Territories. Review of the Office of the Supervising Scientist, (Reviewer: Professor G H Taylor), AGPS, Canberra, 1989, p. 96.
16. Evidence, p. 936.

Funding

15.33 The Committee addressed these issues relating to the funding of the OSS:

- the sources of funds that contribute to the costs of environmental monitoring and research activities; and

- the size of the OSS's budgetary appropriation.

15.34 The OSS receives a one-line budgetary appropriation, part of the cost of which is offset by the Government's collection of a levy on uranium concentrate exports from the ARR. At present, only one company, ERA/Ranger, pays the levy and the possibility of a levy being placed on other organisations or individuals was raised. It was pointed out to the Committee that other companies besides ERA/Ranger benefit from the results of the OSS's work and the OSS contributes knowledge useful to the management of Kakadu National Park. It seems reasonable to expect the other beneficiaries of the OSS's work to contribute to its funding.

15.35 The Committee notes, however, that tourists already pay a park entrance fee and so contribute to the cost of park management. Furthermore:

> All the end users of this [the ARRI's] work would be impossible to identify and its value to them could not be quantified. Perhaps it could be acknowledged that some fraction of work of the Research Institute is a contribution to scientific knowledge and that the user pays principle in this case need not imply full cost recovery from the immediate and identifiable beneficiaries of the research.[17]

15.36 The Committee concurs with the view that it would be difficult to identify all the users of the OSS's work and to charge them at an appropriate level The Committee believes that it is reasonable that those bodies that benefit most from the OSS's work, that is the mining companies, should contribute to the cost of its work. However, the Committee also acknowledges that it is administratively simpler to charge them for the information provided to them and/or to impose a levy only on these companies than to extend the levy to the multitude of other lesser users of the work. Both the Senate Standing Committee on the Environment, Recreation and the Arts and Professor Taylor, in his review of the OSS, have also

17. Evidence, p. S1769.

queried current levy arrangements. Both have suggested that the levy could be applied more equitably as organisations other than uranium mining companies either utilise or benefit from the results of OSS research.[18]

15.37 The Committee concludes that:

- there are cases of widespread benefit to a large number of users who cannot be identified readily on every occasion - in such cases, the Committee supports the principle that public funds should be used to provide these benefits;
- the levy should not be restricted only to uranium concentrate but should be extended as well to any other forms of mining that are undertaken in the ARR; and
- where substantial information is provided to mining companies elsewhere the OSS should charge for the information.

15.38 **The Committee recommends that:**

- **all mining companies operating in the Alligator Rivers Region that benefit from the work of the Office of the Supervising Scientist be levied to help support that work; and**
- **where substantial information is made available to other mining concerns, a charge should be made.**

15.39 The Committee notes that 'the Government will be ... examining alternative means for collecting ... costs in a more effective and equitable manner'.[19]

15.40 The OSS brought to the Committee's attention a problem that arose from the use of the levy paid by the mining companies to offset the cost of the OSS's operations:

18. Evidence, p. S1768.
19. Evidence, p. S1768.

> ... the payer of the levy ... may come to believe that since it is ... clearly paying for the work of the Office, and more particularly of the Research Institute, this work should be directed towards the solution of those problems perceived by the mining company as important. ... A vigorous campaign along these lines has been mounted by ERA/Ranger.[20]

15.41 The Committee believes that it is imperative that the OSS's research program be determined by the need for both the long and short term protection of the environment. It is essential that the levy payers realise the importance of the OSS's independence in selecting its research priorities. They should also appreciate that their input into the process of setting the OSS's research priorities should take place through the OSS's advisory committees.

15.42 The OSS told the Committee that the size of its budget was sufficient for the staff and equipment needed for its current work, although there was useful work that it could do if more funds were available to it. The major funding problem facing the OSS is one that was flagged originally in ASTEC's 1982 review of the OSS and is still outstanding: the need for permanent laboratory buildings at Jabiru. While they are adequate for the present purposes of the ARRI, the core of the laboratories are made up of ex-Cyclone Tracey demountables which need to be replaced. It appears that a strong case exists for the replacement of the current, temporary, make-shift laboratory accommodation with purpose-built, permanent accommodation.

15.43 **The Committee recommends that:**

- **funds be provided for the construction of permanent laboratory accommodation at Jabiru.**

Management

Research

15.44 Most of the research carried out by the ARRI is conducted by its permanent staff; only about 0.5% of the OSS's research budget is spent on contract or collaborative research. The Committee considered whether the research might be

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20. Evidence, p. S1768.

pursued more cost-effectively with a smaller permanent staff and greater use of consultants. The OSS justified their present approach to managing their research thus:

> Our philosophy is that they [the research scientists] are the ones who are knowledgeable at the forefront of research in their particular areas - they know the people who are doing research; they know what research needs to be done - and they are the ones who can constructively oversee the expenditure of those contract dollars. We will let out a contract to do a certain amount of research but it is the responsibility of the particular research scientist to ensure that ... it is research which is going to provide the results which we want to make use of.[21]
>
> You do not get what you think you are going to get unless you are extremely careful. ... By definition, research should be something that is assessed all the way along the track so that the direction can change part way through the project ... That means that our staff have to supervise those [research projects] very carefully ... Normally we do it by ensuring that we do not just go to strict consultancy; we do it almost inevitably, almost always, as collaborative research involving not only an external scientist but our own scientist as well.[22]
>
> It is a very positive relationship that we develop with them [the consultants]. But you must have that kind of approach to the science. We cannot afford to just let a contract, get a report in and hand it over to the regulator or the company,
>
> and say, 'There it is'. Our scientists must be actively involved so we can pick up the nuances that might be missed by the consultant. He is not primarily concerned with the application of his data to the real world problems of regulation of mining, whereas we are ... .[23]

15.45 In other words, the intimate involvement of OSS scientists in consultancies and their supervision of the consultants produces more directed and

21. Evidence, p. 942.
22. Evidence, p. 944.
23. Evidence, p. 946.

relevant results than would less well-supervised consultancies. However, the demands of the level of involvement and supervision limits the number of consultancies that the OSS lets. As it pointed out:

> We do not believe there is point in letting out research contract money unless it can be properly supervised ... .[24]

15.46 The Committee is supportive of the OSS's approach to the use of consultants. It does, however, urge the OSS to maintain a close watch on the balance between the employment of permanent and contract staff with a view to obtaining the most cost-effective use of its research funds.

15.47 The Committee notes that many of the recommendations concerning research management that were made in the reviews of the OSS by the ANAO and Professor Taylor have been adopted.[25] They relate to:

- the preparation of an annual OSS research plan with research organised on the basis of objectives and applications;
- the appointment of a scientific advisory committee;
- the development and approval process for internal research projects;
- monitoring research results and reviewing ongoing projects;
- prompt publication of research results;
- a greater degree of communication of OSS's research results through the better distribution of publications and the holding of workshops; and
- more collaboration with other research institutions.

15.48 The Committee believes that the new arrangements for producing the OSS's research plan are particularly important in maximising the relevance and efficiency of the OSS's research. Annual revision of the research plan and the involvement of a wider range of interested persons than hitherto in contributing to the plan are positive developments, which the Committee supports.

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24. Evidence, p. 942.
25. Evidence, pp. S1769-70.

Administration

15.49 Professor Taylor recommended that the staff from the Sydney office of the OSS should move to Darwin and Jabiru. He saw the move as important in increasing senior management's familiarity and understanding of the local issues with which the OSS has to deal and a means of improving relationships with mining companies and NT regulatory bodies.

15.50 The OSS, on the other hand, claimed that:

> The present arrangement is efficient and cost-effective and the potential for improvement in relations between OSS and the NT and mining companies resulting from the move ... is likely to prove illusory.[26]

The OSS also pointed out that relocating staff from Sydney to the NT would cost $6m-$6.5m and add $300,000 to the OSS's annual operating costs. Furthermore, few of the Sydney staff would be willing to move.

15.51 While acknowledging the validity of Professor Taylor's argument, the Committee notes the Minister's decision that the OSS relocate to Canberra, as indicated in paragraph 15.27 . The Committee believes that, if the OSS's advisory and research roles are extended as recommended in paragraph 15.28 and 15.32, Canberra is probably a more appropriate location than Darwin for contact with mining companies and activities across Australia.

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26. Evidence, pp. S1777.

Chapter 16

BUREAU OF MINERAL RESOURCES

Introduction

16.1 The Bureau of Mineral Resources, Geology and Geophysics (BMR) is a research bureau of the Department of Primary Industries and Energy (DPIE). The BMR was established in 1946 and is engaged in geoscientific research and resource assessment.

16.2 The BMR's research focuses on petroleum, minerals, groundwater, and environmental impacts and hazards. The BMR is also engaged in international development assistance and cooperation and developing and coordinating databases. The BMR's clients are the Commonwealth Government and its agencies, State and Territory Governments and their agencies, the minerals and petroleum industry and the geoscience research community.

Functions

16.3 The BMR's major role is to improve the effectiveness of exploration for, and assessment of, Australia's petroleum, mineral and groundwater resources, and to contribute to land use planning.[1]

16.4 The BMR's principal strategies to meet its objectives are:

- to generate publicly accessible information necessary for the exploration and assessment of the nation's petroleum, mineral and groundwater resources;
- to participate in monitoring and developing an understanding of the natural environment;
- to participate in global and regional geoscientific programs of importance to Australia; and

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1 DPIE. Research, Innovation and Competitiveness, AGPS, Canberra, May 1989.

- to provide independent scientific advice to government, industry and the public for:
  - the management of Australia's resources;
  - development of multiple land use policies and environmental protection;
  - the mitigation of natural hazards; and
  - the detection of underground nuclear explosions.[2]

16.5 The publication Geoscience for Australia's Future 1990-1993 outlined the forward planning and activities for the BMR's geoscientific research and capabilities. The BMR's key strategic research programs are:

- the Continental Margins Program;
- the Onshore Fossil Fuels Program;
- the Onshore Scientific Profiling Program;
- the Minerals Geology Research Program;
- the Airborne Geophysical Program; and
- the Groundwater Program.[3]

Reviews of the Bureau Mineral Resources

16.6 A number of reviews of the BMR have been carried out in recent years. In 1988, an ASTEC report and a review of the BMR's activities by Mr A J Woods were submitted to the Government. The Government accepted all the major recommendations made in the Woods Review and approved revised roles and functions for the Bureau, together with improved management, coordination and oversighting of the BMR activities by the BMR Advisory Council. Implementation of the recommendations commenced in mid-1989.

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2. DPIE. Program Performance Statement, 1991-92, p. 193.
3 DPIE. Research, Innovation and Competitiveness, AGPS, Canberra, May 1989.

16.7 DPIE's 1989-90 annual report stated that all of Mr Woods' recommendations had either been implemented or were at an advanced stage of implementation. During 1990, the ANAO conducted an audit of the Bureau's Continental Margins Program during 1990. Its report advised that the BMR had taken the necessary action to implement the Woods Review recommendations.[4]

Major Findings of the Woods Review

16.8 The Woods Review stated that, whilst the BMR was 'well respected and has played an important role in Australia's development', submissions to the Review had provided a clear message that the emphasis of the BMR's research programs should be changed.

16.9 Important recommendations of the Woods Review referred to:

- the BMR's role and functions:
  - the development of a strategy for the provision of a comprehensive set of geoscience maps, through consultation with the State/NT Geological Surveys, industry and the academic community;
- planning:
  - the further development of review and evaluation procedures, including the assessment of projects against specified performance indicators on a regular basis;
  - improved program formulation through the preparation of a 3-5 year strategic plan by the Advisory Council in close consultation with the States/NT, industry and academic institutions; and
  - increased industry representation on the Advisory Council;

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4 The Auditor-General. Audit Report No. 5, 1990-91, Report on Ministerial Portfolios - Budget Sittings 1990, AGPS, Canberra, September 1990.

- liaison with external entities:

  - closer liaison with the CSIRO and the universities to coordinate their research programs and to maximise cooperation; and

  - improved communications with industry and responsiveness to its needs;

- administration:

  - rationalisation of the BMR structure and reduction in the scope of the BMR program and the number of individual projects, to allow available resources to be targeted closely around the new charter;

  - the appointment of external management consultants to advise on management and operational procedures appropriate to the BMR's new charter;

  - the introduction of merit promotion for all scientists, engineers and technical staff as a matter of urgency to increase efficiency and improve staff morale;

  - an increase in the proportion of work carried out by contract staff and emphasis on the recruitment of staff with relevant industry experience; and

  - the encouragement of greater cost recovery through joint projects, external funding, commercial pricing of publications, an increase in commercial consulting services and other mechanisms, and the capacity to retain revenue from the provision of products and services.

The Bureau's Research

16.10 The BMR's research was identified in evidence to the Committee as being:

- national interest research, the results of which must be publicly available;

- long-term and strategic rather than tactical, with strong emphasis on database development; and

- designed to maximise Australia's understanding of its mineral resources and their potential.

Geoscience Databases

16.11 The Woods Review highlighted that the BMR's basic knowledge base was decaying more rapidly than it was being replaced:

> For example 1:250,000 scale maps in Australia are generally only reconnaissance documents ... most are now many years out of date (53% were mapped more than 18 years ago).
>
> ... virtually none of these geological data bases are available in digital forms and therefore can not be used in combination with other geoscientific data sets (e.g. magnetics) in-state-of-the-art information technology systems.[5]

16.12 In its submission to the Committee, DPIE made reference to the significant findings of the Woods Review and the need for the Bureau to provide an adequate coverage in terms of geoscience maps and databases. DPIE stated that:

> It is clear, as explained in the Wood's review of BMR, that the national geoscientific databases are inadequate to meet the various national needs. Recommendations for major national programs are being developed and will require the allocation of substantial additional resources if these needs are to be met.[6]

16.13 Two of the BMR's major projects are:

- the Petroleum Mapping Program which will complete mapping the areas of potential petroleum basins, both onshore and offshore, in the vicinity of 12 million square kilometres; and

5. Evidence, p. S136.
6. Evidence, p. S127.

- the Minerals Mapping Program which will undertake to provide second generation geological maps and data sets to promote and aid mineral exploration in Australia.[7]

16.14 The Committee was advised that:

- there had been some minor redeployment of the BMR's resources to implement the National Mapping Accord, which had resulted in the slowing down of the BMR's previous plans to expand database development in the petroleum area; and

- it will take 40 years to undertake and complete the framework mapping for both the Petroleum Program and the Minerals Program based on the allocation of resources and the existing technology.[8]

16.15 The Committee notes that the ANAO audit of the BMR Continental Margins Program reviewed the National Petroleum database and stated:

> Petroleum data has been collected by the Bureau since its inception. However, the data is stored in a number of independent database systems which were not organised in a manner by which the data could be used most effectively.[9]

16.16 However, DPIE's annual report for 1990-91 advised that:

- action was being taken to obtain compatibility of the independent databases; and

- the existing database index software was expanded and new computer hardware for the National Petroleum Databases was expected to be received during July 1991.[10]

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7. Evidence, pp. 793-4, 796.
8. Evidence, pp. 793-4, 796.
9 ANAO Audit Report No. 5 1990-91, Report on Ministerial Portfolios - Budget Sittings 1990, AGPS, Canberra, pp. 100-1.
10. DPIE. Annual Report 1990-91, p. 268.

16.17 The BMR has undertaken further geoscience mapping, conducted aerial surveys and introduced some new technologies during 1990-91 to improve its ability to fulfil its role and functions. DPIE's annual report for 1990-91 outlined the enhanced BMR capabilities and provided details of work undertaken during the year.[11] These new developments include:

- new surveys:
  - an aerial survey of 87,000 kilometres of aeromagnetic and radiometric data, (scale was 1:250,000 mapping), which produced a consistent magnetic database for approximately 60% of the continent; and
  - National Geographic Mapping Accord field programs conducted in conjunction with State and Territory geological surveys in six mineral areas;
- new technology:
  - development and application of new technology to the collection, integration and presentation of geoscience data under the National Geoscience Mapping Accord;
  - installation of state-of-the-art geophysical and navigational equipment on the new Aero Commander geophysical survey aircraft; and
  - acquisition of a vector-based Geographic Information System which produced the first 1:100,000 map sheet for an area in Western Australia;
- updating BMR databases:
  - expansion of the MINLOC/MINDEF database to cover 30% of all mineral occurrences and deposits in Australia; and
  - enhancement of the BMR's database of petroleum drilling and geophysical information, the first copy of which was sold to a commercial company.

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11. DPIE. Annual Report 1990-91, pp. 159-61.

16.18 The DPIE Program Performance Statements for 1991-92 provided further information regarding the actions being taken to remedy and improve the information stored and the usefulness of the BMR Geoscience databases. The Program Performance Statements stated:

> As a support to petroleum exploration companies, both onshore and offshore, BMR is developing an integrated national petroleum database using modern information technology. BMR is also generating a range of databases for the mineral exploration industry. BMR will be making these databases increasingly accessible to government, industry and the public to improve government decision making and industry exploration effectiveness.[12]

16 19 On the basis of the evidence presented to it, the Committee concludes that the BMR's strategic research is essential to the Australian economy. The use of the BMR's research and geoscience data by private industry has contributed to the development of Australia's petroleum and mineral deposits. This has resulted in the national self sufficiency for many petroleum products and the export of resources. Both of these features have assisted Australia's balance of payments and brought other economic benefits to the Australian economy.

16.20 The Committee believes that the BMR's strategic research should continue to be funded by the Commonwealth, with assistance from the States for some areas of the National Mapping Accord. The Committee is, however, concerned that the BMR allocates only 3% of its budget for the National Geoscience Database Program. The Committee regards this level of funding as inadequate.

16.21 **The Committee recommends that:**

- **the Department of Primary Industries and Energy allocate additional resources to the National Geoscience Database Program as a matter of high priority.**

16 22 The Committee notes the 40-year timeframe that has been projected for completing the collection and analysis of data, updating Geoscience databases and producing maps. The Committee believes that this timeframe is too long and needs to be significantly decreased.

12. DPIE. Program Performance Statement, 1991-92, p. 204.

16.23 **The Committee recommends that:**

- **the Bureau of Mineral Resources review the 40-year timeframe for the completion of the Minerals and Petroleum Programs and identify the measures to be taken to decrease the long lead time; and**

- **the Government allocate additional resources to the Bureau of Mineral Resources to enable it to accelerate the collection and analysis of data needed for the Minerals and Petroleum Programs.**

16.24 The Committee notes that the BMR provided information to the Senate Estimates Committee F during 1991 concerning funds that were included in the 1991-92 budget for the initial design studies for a purpose-built office and laboratory. This measure was necessary to overcome 'serious occupational health, safety and fire issues'. The Committee is concerned that adequate premises are not available for the Bureau to fulfil its role in the coming years.

16.25 **The Committee recommends that:**

- **the Government accelerate the design and construction of the new building for the Bureau of Mineral Resources.**

Resources

16.26 In 1990-91, the BMR received \$59.7m in appropriations and \$54m is budgeted for in 1991-92. This made the BMR the fifth largest Commonwealth research organisation. The BMR 1990-91 budget provided for 550 staff years and the 1991-92 budget for 539.

16.27 Information provided to the Committee highlighted that approximately 86% of the BMR's 1991-92 budget of \$54m was allocated to the following programs:

Program	$M	% of Budget
Petroleum	31.6	59
Minerals	12.9	24
National Geoscience Databases	1.7	3
Total	46.2	86

Other research programs included in the BMR's 1991-92 budget were:

Program	$M	% of Budget
National Geophysical Observatories	4.2	8
Environmental Geoscience Groundwater	3.3	6
International	0.1	<1

16.28 One of the high priority areas of the Bureau's operations is the National Geoscience Mapping Accord. Thirty per cent of the BMR's 1991-92 budget and 157 staff were allocated to the direct support of the onshore Mapping Accord activities.

Funding of Research Programs

16.29 There are two features of the BMR's funding that are presenting it with problems. One is the funding of its programs as recurrent expenditures from the annual Appropriation Acts No. 1 and No. 3. The second is the cutback in funds that it has experienced in recent years.

16.30 One of the BMR's difficulties stems from the annual funding of research programs that extend over several years. The short time scale of the funding relative to the duration of these projects injects a degree of uncertainty into the projects' future. It also makes planning and management over the long term very difficult. The BMR suggested that funding on a triennial basis would be more appropriate to the efficient and cost-effective conduct of its national interest strategic research.[13] Such a move would bring the Bureau in line with CSIRO.

16.31 The BMR also pointed out that the salaries and administrative expenses incurred in the process of carrying out its research are regarded as running costs, to which the efficiency dividend applies. The Bureau shares the view of several of the research organisations examined by the Committee that it is inappropriate for the efficiency dividend to apply to research activities.

16.32 Furthermore, continued funding cuts combined with the pressure to obtain additional revenues from the sale of the BMR's services were flagged as likely to result in the Bureau emphasising short term commercial activities at the expense of its longer term national interest research.

16.33 The Committee accepts that the BMR's flexibility to manage its strategic longer term research is being impeded by the above factors. The Committee considers that the BMR should revise the form of its estimates so that such research as salaries, administrative expenses and minor capital equipment items would not be aggregated as running costs, but would be subject to an additional item within the Appropriation Act No. 1. The Committee recognises the existing uncertainty which annual funding via the budget imposes on longer term management of research programs The Committee's view of the imposition of the efficiency dividend was outlined at paragraphs 11.39 and 11.40.

16.34 **The Committee recommends that:**

- **the Bureau of Mineral Resources restructure the form of its estimates so that the costs of research programs are separately appropriated in the annual Appropriation Acts and will not be aggregated as running costs;**

- **the research costs of the Bureau of Mineral Resources' programs be exempt from the application of the efficiency dividend; and**

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13. Evidence, p. S1888.

- **the Bureau of Mineral Resources' funding be based on the triennium principle similar to that approved for other government-funded research agencies.**

The Hon G F Punch, MP
Chairman
24 June 1992

APPENDIX A

SUBMISSIONS RECEIVED

Listed below are organisations and individuals that provided the Committee with submissions to the Inquiry. Some departments and agencies made more than one submission to the Inquiry.

Organisations

Agricultural Research Development Education and Planning
Attorney-General's Department
Australian Trade Commission
Australian Academy of Science
Australian Bureau of Agricultural and Resource Economics
Australian Consumers' Association (joint submission with the Australian Federation of Consumer Organisations)
Australian Federation of Consumer Organisations Inc.
Australian Government Analytical Laboratories
Australian Industrial Research Group
Australian Institute of Aboriginal Studies
Australian Institute of Health
Australian Institute of Marine Science
Australian Medical Devices and Diagnostics Inc. (joint submission with the Medical Engineering Research Association)
Australian National Rail
Australian Nuclear Science and Technology Organisation
Australian Pharmaceutical Manufacturers Association Inc.
Australian Sugar Milling Council
Australian Wine Research Institute
Best Knowledge Systems Pty Ltd
Betatene Limited
Broken Hill Proprietary Co. Ltd
Bureau of Immigration Research
Bureau of Sugar Experiment Stations
Business Council of Australia
Cattleman's Union
Codan Pty Ltd
Commonwealth Industrial Gases Limited
Commonwealth Serum Laboratories
Crocker Research
CSIRO Australia
CSIRO Corporate Services Department
CSIRO Division of Tropical Animal Production

CSIRO Division of Geomechanics
CSIRO Division of Fuel Technology
CSIRO Officers Association
D B Sugden Consulting Engineers Pty Ltd
Department of Aboriginal Affairs
Department of the Arts, Sport, the Environment and Territories
Department of the Arts, Sport, the Environment, Tourism and Territories
Department of Community Services and Health
Department of Defence
Department of Finance
Department of Foreign Affairs and Trade
Department of Industrial Relations
Department of Industry, Technology & Commerce
Department of Primary Industries and Energy
Department of the Prime Minister and Cabinet
Department of Social Security
Department of Transport and Communications
Department of the Treasury
Department of Veterans' Affairs
Export & Commercial Research Services Pty Ltd
Great Barrier Reef Marine Park Authority
Greenwoods & Freehills Pty Ltd
Harry Sebel Consultancy
Horticultural Research & Development Corporation
Incitec Ltd
Industry Research and Development Board
Institute of Engineers Australia
Joint Coal Board
Montech Pty Ltd
National Board of Employment, Education and Training
NSW Agriculture & Fisheries
New South Wales Coal Association
New South Wales Nurses Research Interest Group
New South Wales Science and Technology Council
NSWIC Pty Ltd
Nucleus Limited
OTC Limited
Pacific Biotechnology Ltd
Peptide Technology Limited
Public Service Commissioner
Royal College of Nursing, Australia
Sheddon Technology Management Ltd
State Chemistry Laboratories
Supervising Scientist for the Alligator Rivers Region
Sydney Business & Technology Centre
Technology and Innovation Management Pty Ltd

University of Melbourne
  Centre for Manufacturing Management
  Department of Mechanical and Manufacturing Engineering
University of Sydney
University of Western Australia
University of Wollongong
Urban Water Research Association of Australia
Viewnex Pty Limited
Western Australian Product Innovation Centre Pty Ltd

Individuals

Mr R Butler
Mr Leung Chen
Mr Kevin Davies
Mr J A Godwin
Dr Richard Hartley
Mr M Mueller
Mr M A Nettleton
Miss M C Peake
Ms P A Williams

APPENDIX B

PUBLIC HEARINGS AND WITNESSES TO THE INQUIRY

Date of Hearing	Witnesses
21 September 1990	**Commonwealth Scientific and Industrial Research Organisation**
	Dr A D Donald Director, Institute of Animal Production and Processing
	Dr R M Green Director Institute of Natural Resources and Environment
	Dr W Hewertson Acting Director Institute of Plant Production and Processing
	Mr P H Langhorne Director, Corporate Services
	Dr M J Murray Acting Director Institute of Industrial Technologies
	Dr A F Reid Director Institute of Minerals, Energy & Construction
	Dr R L Sandland Acting Director Institute of Information Science & Engineering
	Dr J W Stocker Chief Executive
	Dr M J Whitten Chief Division of Entomology

22 October 1990	**Institution of Engineers**

Dr J B Allen
Research Officer

Rear Admiral W J Rourke
Chief Executive

Department of the Arts, Sport, the Environment, Tourism and Territories

Dr P Bridgewater
Director
Australian National Parkes and Wildlife Service

Mr P Kennedy
Deputy Secretary

Mr R L Moncur
Director
Antarctic Division

Mr R J Pegler
Assistant Secretary
Environment Planning Branch

Mr N J Quinn
First Assistant Secretary
Environment Protection Division

CSIRO Officers Association

Mr P M Fleming
President

Mr J F Stephens
Vice-President and Chairman of the Science Policy Committee

Mr M Willoughby-Thomas
General Secretary

Bureau of Meteorology

Mr J Zillman
Director

23 October 1990	**Australian Nuclear Science and Technology Organisation**
	Dr D J Cook Executive Director
	Mr D R Davy General Manager, Scientific
	Mr D E Wilson General Manager Corporate
	Mr P Wright Acting Director Occupational Health and Safety Program
16 November 1990	**Sirotech Ltd**
	Dr C M Adam Director
	Mr P D Francis Legal Manager
	Dr J Stocker Board Chairman
	Bureau of Industry Economics Department of Industry, Technology and Commerce
	Mr G Hollander Assistant Director
	Mr T Moleta Senior Economist
22 November 1990	**Australian Industrial Research Group**
	Mr H C Coe Member
	Dr P J Harvey Vice-Chairman Southern Division
	Dr A R Kjar Vice-President

University of Melbourne

Professor D A Samson
Director
Centre for Manufacturing Management

8 March 1991

Department of Defence

Mr J S Allison
Acting Chief Defence Scientist
Defence Science and Technology Organisation

Dr G F Ashton
Assistant Secretary
Development Projects Branch
Defence Science and Technology Organisation

Mr T Carthigaser
Director
Industry Involvement and Offsets

Mr F R Harvey
Inspector-General

Mr P J Lush
Assistant Secretary
Science Corporate Management Branch
Defence Science and Technology Organisation

Dr O J Raymond
First Assistant Secretary
Science Policy Division
Defence Science and Technology Organisation

Mr A R Taylor
Director-General
Science Policy Development Branch
Defence Science and Technology Organisation

19 March 1991

Australian Bureau of Agricultural and Resource Economics

Dr B Curran
Senior Economist

Dr B Johnston
Senior Economist

Dr L P O'Mara
Assistant Director

Land and Water Resources R & D Corporation

Mr F Meere
Acting Assistant Secretary

Rural and Industries R & D Corporation

Professor B W Davis
Chairperson

Mr K W Hyde
Managing Director

Bureau of Mineral Resources

Dr N Williams
Associate Director
Minerals and the Environment

Dr D Falvey
Associate Director
Petroleum and Marine Geoscience

Department of Primary Industries and Energy

Mr A J Glenn
Assistant Secretary
Crops Division

Mr B J Hill
Executive Director
Agriculture and Forestry Group

Mr S W Lack
Acting Director
R & D Corporations

Mr W W Leitch
Acting Manager
Levies Management Unit

Ms A G Quinn
Director
Research and Development Policy

Mr J Rhodes
Rural Access

Bureau of Rural Resources

Dr R T Williams
Corporate Planning Office

Dr M Williams
Acting Executive Director

3 April 1991

Metal Trades Industry Association

Mr P G Boland
Member

Mr B Cox
Member

Mr R K Harris
Member

Mr R A Matheson
Member

Mr I D McArthur
Member

Mr P J Morris
Manager
Industry Policy Projects

Mr L Purnell
Director
Trade and Commercial Services

Mr K Rankin
Member

Mr R Wiseman
Member

Office of the Supervising Scientist

Mr D Cottam
Manager
Corporate Services

Mr R M Fry
Supervising Scientist
Alligator Rivers Region

Dr A Johnston
Director
Alligator Rivers Region Research Institute

Dr G H Riley
Deputy Supervising Scientist

19 April 1991

Department of Industry, Technology and Commerce

Mr D J Ashmore
Deputy General Manager
National Industry Extension Services (NIES)

Dr J D Bell
Deputy Secretary

Mr R C Bourke
Director

Mr A F Caddy
Assistant Secretary

Mr K L Croker
Assistant Secretary, R and D Grants Branch

Mr G A Hallinan
First Assistant Secretary
Light Industries Division

Mr M J Holley
Assistant Director
Construction Industry

Mr J Williams
Manager
Manufacturing Technologies Section

Dr D H Williamson
Assistant Secretary
Science and Technology Policy Branch

15 May 1991	***Australian Institute of Marine Science***	

Dr J T Baker
Director

16 May 1991	**University of Canberra**	

Professor D A Aitkin
Vice-Chancellor

Industry Research and Development Board

Mr D Hanley
Member

Mr W A Kricker
Chairman

Dr P O Miller
Member

Mr R Sauer
Member

Observers

Australian National Audit Office

Mr R Alfredson
Mr B Boland
Mr J Bowden
Mr P Farrelly
Mr M Gillespie
Mr D Lennie
Mr J Marton
Mr D McKean
Mr M Ryan

Department of Finance

Ms S Gillett
Mr B Forner

APPENDIX C

MAJOR COMMONWEALTH COMPETITIVE RESEARCH GRANT AND RESEARCH FELLOWSHIP SCHEMES BY PORTFOLIO[1]

Arts, Sport, Environment, Tourism and Territories

- 'Greenhouse' Research Grants
- Australian National Parks and Wildlife Service (ANPWS)
    - Australian Biological Resources Study Grants (ABRS Participatory Program)
- Great Barrier Reef Marine Park Authority
- Antarctic Science Advisory Committee
- Australia Council

Attorney-General

- Criminology Research Council

Community Services and Health

- AIDS Research Grants Program
- Health and Community Services Research and Development Grants
- Research into Drug Abuse Advisory Committee
- National Health and Medical Research Council (NH&MRC)
    - Project Grants (including Special Initiative Grants and Priming Grants)
    - Development Grants (for commercial development work)
    - Program Grants
    - Research Fellowships
    - Other Fellowships and Awards
    - Equipment Grants
- NH&MRC Public Health Research and Development Committee
    - Project Grants
    - Public Health Research Fellowships
    - Seeding Grants
    - Development Program Grants

Employment, Education and Training

1. *Grants for postgraduate training (eg. research scholarships), research funds which are not awarded in open competition, and grants for R&D solely within business enterprises are excluded.*

- Australian Research Council
  - Project Grants
  - Special Research Centre Grants
  - Key Centre of Teaching and Research Grants
  - Australian Research Fellowships

The ARC also provides competitive research infrastructure support grants through the Large Equipment Program and Research Infrastructure Funding scheme (competitive component).

- *Australian Institute of Aboriginal and Torres Strait Islander Studies*

Foreign Affairs and Trade

- Australian Centre for International Agricultural Research

Industrial Relations

- National Occupational Health and Safety Commission

Industry, Technology and Commerce

- Industry, Research and Development Board
  - Generic Technology Grants
- Artificial Intelligence Research Scheme
- International Science and Technology Program
- Bilateral Science and Technology Program

Primary Industry and Energy

- Energy Research and Development Corporation (ERDC)
  - *Research, Development and Demonstration Grants (formerly* National Energy Research, Development and Demonstration program - NERDDP)
- Land and Water Resources Research and Development Corporation
- Australian Meat and Live-stock Research and Development Corporation (AMLRDC)
- Australian Horticultural Research and Development Corporation
- Dairy Research and Development Corporation
- Pig Research and Development Corporation
- Rural Industries Research and Development Corporation
  - Honeybee Research and Development Council
  - Egg Industry Research and Development Council
  - Chicken Meat Research and Development Council
  - Tobacco Research and Development Council
  - Dried Fruits Research and Development Council
- Cotton Research and Development Corporation
- Sugar Research and Development Corporation

- Grains Research and Development Corporation
- Grape and Wine Research and Development Corporation
- Wool Research and Development Council
- Fishing Industry Research and Development Trust Fund

Prime Minister and Cabinet

- Office of the Chief Scientist
    - Cooperative Research Centres Program

Source: ASTEC. Funding the Fabric: Should Commonwealth Government Competitive Research Granting Schemes Contribute More to Research Infrastructure Costs?, ASTEC Occasional Paper No. 14, AGPS, Canberra, February 1991, pp. 32-34, with modifications.