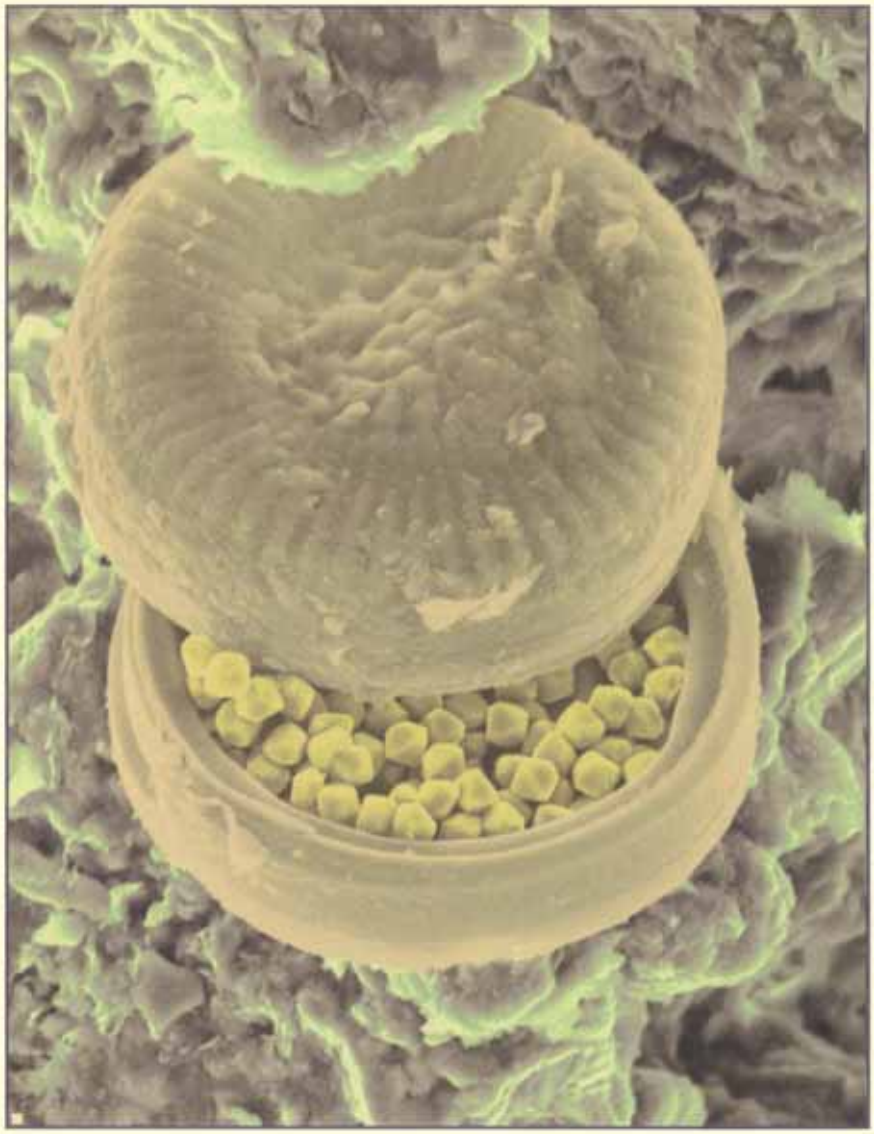
Science and Technology Budget Statement 1997-98



The Honourable Peter McGauran, MP
Minister for Science and Technology

SCIENCE AND TECHNOLOGY BUDGET STATEMENT 1997-98

CIRCULATED BY
THE HONOURABLE PETER McGAURAN MP
MINISTER FOR SCIENCE AND TECHNOLOGY

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HIGHLIGHTS

Commonwealth support for major programs of science and innovation in 1997-98 is estimated to be $3.55 billion, an increase in dollar terms of $43 million. Within the total, there is a real increase in direct Commonwealth support of 0.8%.

Other financial highlights include real increases of:

- 5% in total budget funding for the CSIRO, to $473 million;
- 5% in targeted funding for university research, to $427 million; and
- 5% in funds for specific purpose R&D grant schemes, to $338 million.

Increases such as these are a substantial achievement in a period of tight fiscal restraint.

Outcomes from Australia's publicly funded research continue to be impressive, and of value to Australia and the wider world:

- New technology developed by CSIRO which enables the extraction of magnesium from ore has evolved into a major commercial venture aimed at establishing a world-class magnesium plant in Australia. Ford has already undertaken to buy up to 45,000 tonnes per year of the magnesium produced by this plant.
- A researcher from the University of Melbourne has found that the parasitic organism responsible for malaria is a plant rather than an animal.
- Scientists from CSIRO and Sydney's Prince of Wales Hospital have found a viral agent that can be used to transport therapeutic genes into cancer cells.
- A new device, developed by the Photonics Cooperative Research Centre, dramatically increases the capacity of optical fibre networks.
- Researchers at the University of Sydney have developed a new vacuum double glazing technique which has been licensed for manufacture in Japan. The new technique enables windows to be double glazed without having to modify the existing frames.
- A study undertaken in the University of Melbourne has suggested that trends in height data for populations might be used as an alternative to per capita income as a measure of changes in living standards.
- A study funded through the National Strategic Research Program in road transport has demonstrated that optimisation of measures to manage the design, construction and continuous maintenance of roads can potentially save around $800 million per year.

SUMMARY NOTES

SUPPORT FOR SCIENCE AND INNOVATION IN 1997-98

- In 1997-98, Commonwealth support for major science and innovation programs is expected to rise to $3551m from $3508m in 1996-97, a dollar increase of $43m. Within the total, direct Commonwealth support rises to $3265m, a real increase of 0.8%. Including indirect support through the industrial R&D tax concession (where the change in the rate to 125% comes fully into effect in 1997-98), gives a real decrease of 1.3% overall.

- Targeted research in universities (mostly funded on the advice of the Australian Research Council) will receive $427m, a real increase of 5% ($396m in 1996-97). Total funds for university R&D are estimated to remain steady in real terms.

- Total support for industrial R&D and innovation, including both direct support through appropriations and the estimated effects of tax revenue forgone, is expected to be $487m in 1997-98. This is a real decrease of 5%, resulting from changes in the rate and application of the industrial R&D tax incentive. These changes, which had a partial effect in 1996-97, become fully effective in 1997-98.

- Support for R&D through the Cooperative Research Centres Program, aimed at promoting more effective interaction between researchers in industry, government agencies and universities, is steady in real terms at $146m.

- Funds for specific purpose R&D grant schemes (rural R&D, National Health and Medical Research Council grants, other health R&D and some smaller R&D grant schemes) together rise to $338m (up 5% in real terms).

- A total of $970m will be provided to the major research agencies in 1997-98 ($988m in 1995-96), which includes $238m on defence R&D ($267m in 1996-97). Budget support for CSIRO will be $473m (a real increase of 5%), and the Organisation's external earnings will bring its total income to around $741m. Relative to GDP, appropriations for research in Government agencies in Australia are among the highest in the OECD.

- In common with trends in many countries with high levels of Government R&D, policy in recent years has sought to encourage greater reliance on external earnings, particularly those resulting from productive interactions with industry.

- Budget support is provided in the expectation of useful outcomes and applications, including the development of the national skills base. The *Science and Technology Budget Statement* provides many impressive examples of the discoveries, advances in understanding and steps in commercialisation resulting from Government support for science and technology.

SUMMARY TABLE

COMMONWEALTH SUPPORT FOR MAJOR PROGRAMS OF SCIENCE & INNOVATION

	1996-97 $m est	1997-98 $m est	Real change
TARGETED HIGHER EDUCATION R&D[1]	396.2	427.0	+ 5%
OTHER HIGHER EDUC. R&D	1175.8	1182.4	- 2%
CO-OPERATIVE RESEARCH CENTRES	141.9	146.2	0%
INDUSTRY R&D & INCENTIVES[2]	492.6	486.9	- 4%
RURAL R&D	135.8	145.4	+ 4%
NH&MRC	150.3	156.4	+ 2%
OTHER HEALTH R&D	13.7	19.4	+ 38%
OTHER R&D GRANTS[3]	13.4	16.8	+ 23%
CSIRO[4]	439.1	472.9	+ 5%
DSTO[5]	266.9	237.8	- 13%
OTHER R&D AGENCIES	282.0	259.3	- 10%
TOTAL	**3508**	**3551**	**- 1.3%**

NOTE: Estimated outlays and expenditure are at current prices, the real changes shown are based on constant price estimates.

1 Represents the total of Budget and HEF Act funding and incorporates funds allocated on the advice of the Australian Research Council (ARC). In 1997-98, $321 million will be allocated on the advice of the ARC.

2 R&D Start Program plus the estimated effect of revenue forgone via the IR&D tax concession scheme.

3 Australian Biological Resources Study, Greenhouse research grants, Energy R&D and Australian Road Research Board.

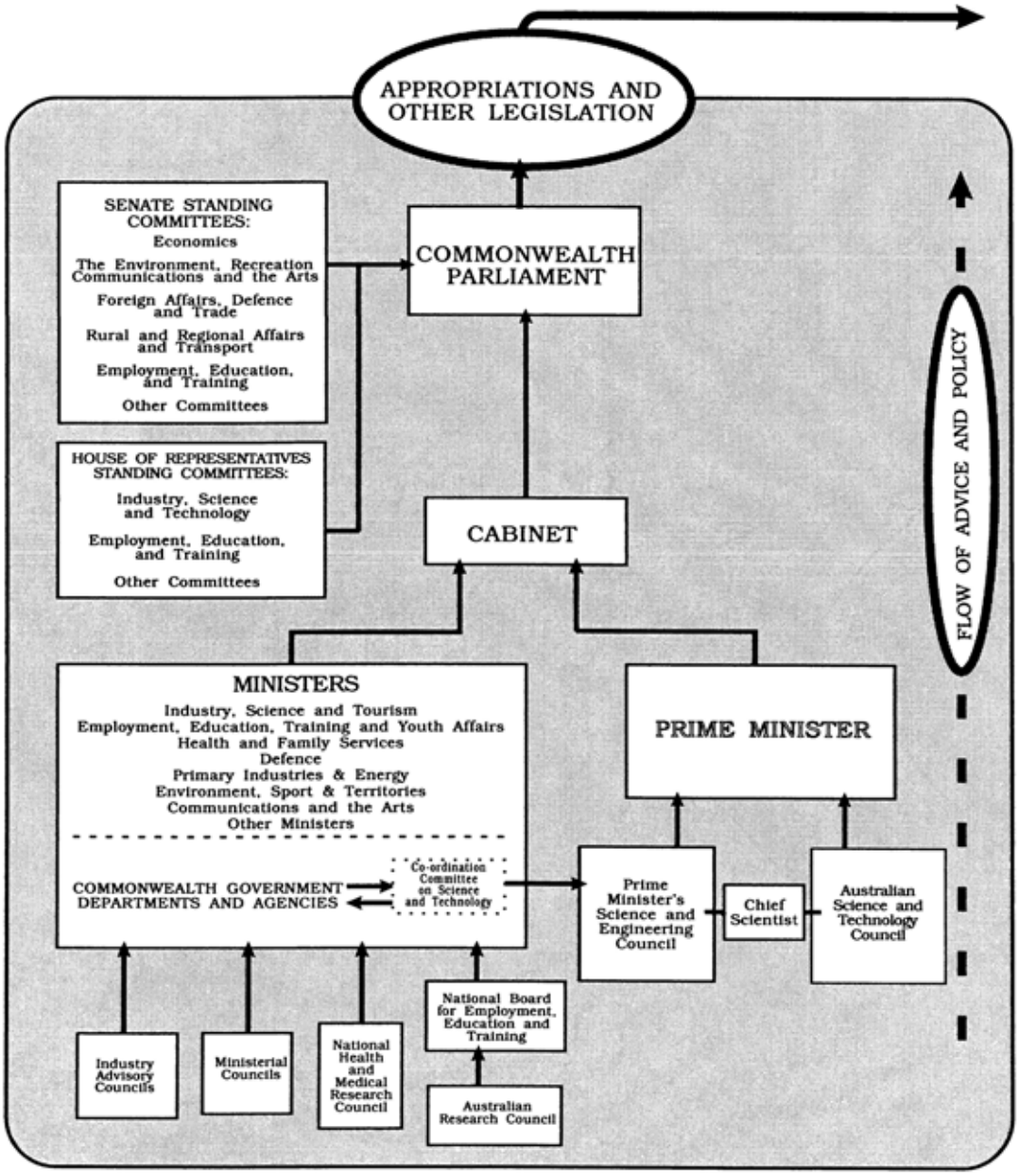
4 Includes funding through DPIE for the Australian Animal Health Laboratories. In addition to the budget funding shown, CSIRO expects to earn over $268 million from external sources in 1997-98.

5 These figures include DSTO overheads that are funded through appropriations to other parts of the Defence Portfolio. (See note 1 to Table 4.) They also include capital works appropriations principally attributable to DSTO.

For more detailed information see Tables 2 to 6

Figure 1

MAIN CHANNELS OF ADVICE
FOR POLICY FORMULATION IN SCIENCE AND TECHNOLOGY

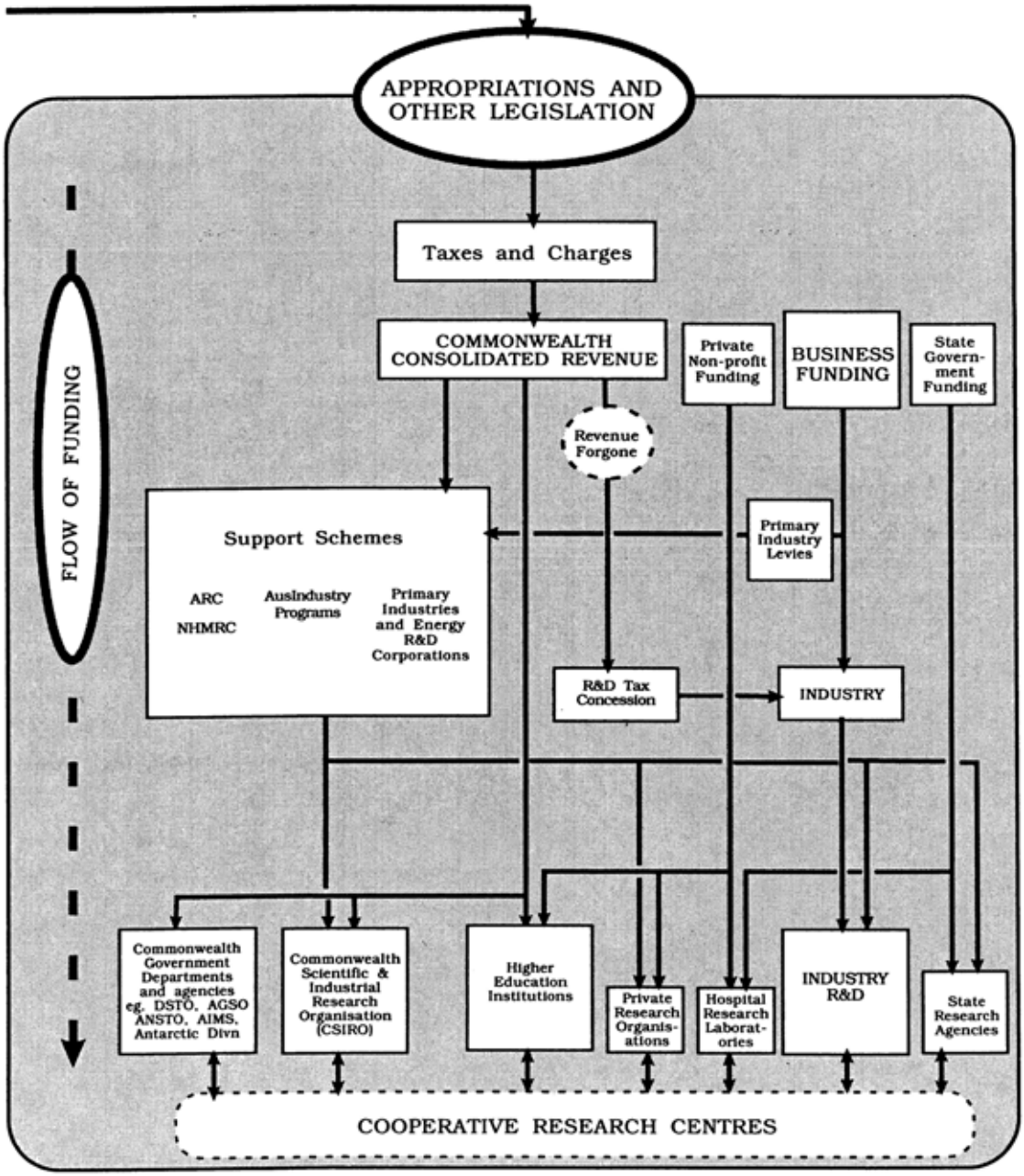


The figure is indicative of major bodies and principal channels for the flow of policy advice leading to Parliamentary and Cabinet decisions on science and technology issues. It does not purport to be other than illustrative.

Of course, there are a host of influential forces, including professional organisations and other non-government groups, and there are many cross-links and productive interactions between them.

Figure 2

FLOW OF FUNDING SUPPORT FOR R&D



The figure illustrates the main channels of funding to R&D performers. Funds originate primarily with the taxpayer and private business. The Commonwealth Government is the major funding source. For simplicity, minor funding flows are omitted.

Setting Priorities for Expenditure on Science and Technology

This section discusses the current framework within which priorities for expenditure on science and technology are determined

Introduction

The 1997-98 Budget involves the expenditure of $3551 million on programs supporting science and innovation. These programs, as described in this *Science and Technology Budget Statement,* extend across an extensive range of activities and contribute in a multitude of ways to the advancement of knowledge, to a better quality of life for Australians, and to national economic prosperity. As foreshadowed in the Government's policy statement *Investing in Tomorrow,* determining the most appropriate way to allocate Budget funds to these endeavours is now being addressed through placing an increased emphasis on national priorities.

The first step in this process is to provide a description of the underlying framework within which science and technology priorities are currently set, and a clearer articulation of present priorities. This first Section of the *Statement* undertakes the former task, and Section 5 - for the first time in the publication of the *Science and Technology Budget Statement* - undertakes the latter.

As a further step, the Prime Minister has asked the Chief Scientist, Professor John Stocker, to include within his current review of science and technology arrangements, a review of mechanisms through which national priorities for science and technology can be set. Professor Stocker will shortly report his findings.

Advice, priorities and pluralism

Increasingly over this century, especially from the 1960s and 1970s, it has become clear that governments need advice on science and technology matters and a range of information against which that advice can be considered. Science and technology have come to dominate many aspects of life, and this points to a need for proper advice and appropriate mechanisms to establish clear priorities and a sense of direction at national and other levels.

A difficulty in meeting this requirement has been the inherently sectoral nature of much of the science and technology system, and the decentralisation of responsibilities that this inevitably leads to. Science and technology are appreciated as an essential and substantial component of Australia's overall culture and identity, but in many respects it has always been clear that they constitute means to ends, and not ends in themselves. Much government support for scientific and technological activities is provided in the expectation that practical problems in specific sectors will be solved - in sectors such as agriculture, health and defence, for example.

There is a very substantial presence of such sector-based activities within Australia's science and technology system, and arrangements for those science and technology activities are substantially linked with other arrangements within the relevant sectors. These linkages between science and technology and other activities within sectors are in many respects stronger than linkages between science and technology activities in

unrelated sectors. This is typical of the situation in most advanced countries and it has therefore been well recognised for a long time that there are many advantages in each sector determining its own priorities for science and technology in competition with priorities for non-S&T activities.

It makes sense for those dealing with defence needs to make decisions between defence priorities that involve R&D, and those that do not; and for those responsible for health issues to decide, for example, funding relativities between support for public health measures and research on particular health problems. This approach also encourages scientists and scientific institutions to be responsive to market signals from the users and beneficiaries of their activities. As there are many sectors, this approach is known as ***pluralism***.

The effects of pluralism

The strength of pluralism is the inherent coupling of science and technology activity particularly R&D to the goals and needs of the sector. This coupling has led to the socalled 'customer/contractor' principle that has aimed at encouraging the development of market forces between the customers and beneficiaries of R&D and the researchers. This has usually been effected by putting the customers and beneficiaries into positions where they have a substantial role in determining the directions of research and the levels of R&D expenditure in areas of interest to them.

This principle has had a significant influence in several aspects of the institutional arrangements adopted in Australian science and technology policy - for example, in the establishment of the various rural R&D corporations within the Department of Primary Industries and Energy. The rural R&D corporations, which are mostly concerned with the needs for research within particular rural sub-sectors, do not conduct their own R&D but make grants to research agencies - to CSIRO, State Government agencies and universities, for example. In terms of the customer/contractor principle, the latter establishments are the *contractors* for the R&D while the corporations are the *customers* (or, more correctly, agents for the ultimate customers - the primary producers).

Pluralism is a dominant feature of the science and technology systems in all large advanced countries. A 1991 OECD study on the subject noted that priority setting is mostly decentralised and pluralistic in OECD countries, and (in addition to the advantages already noted above) this had the further advantage of involving substantial input from scientific and technological communities. However, it also noted that a purely pluralistic approach did pose some problems in coordination and determining tradeoffs among priorities.

Limitations to a pluralist approach

While the customer/contractor principle, and more general issues of pluralism, have had a substantial influence on many arrangements adopted within the science and technology systems of many OECD countries,

including Australia, there are also a number of matters that limit their full application. For example, pluralism and the customer/contractor principle make an implicit assumption that customers in the sector are fully informed as to the possible benefits of various research directions. Yet, rational choices between different directions in research and different levels of financial support often require sophisticated and far-sighted scientific understanding that few customers are likely to possess. There is also a need, in any sizeable country, to maintain an adequate base of disciplinary competence that is not always readily provided through a purely sectoral approach.

In addition, Australia's particular circumstances have many implications. Australia's dilemma is that it exhibits many of the features of scale of the world's largest countries, but couples them with a relatively small population and a middle-sized income. Our physical size and length of coastline, the arid nature of our country, its dry but highly variable climate, its vast biological diversity, its extensive mineral resources, and geographical location, together raise a great number of scientific problems and opportunities, most of which are not duplicated in other parts of the world.

While the characteristics of diversity and scale have led to a great deal of sector-based activity, this in turn implies a need for the development and maintenance of a base of expertise, capabilities and training across a range of scientific and technological disciplines. The nature of many issues also points to a need for the existence of some support measures and institutions of a cross-sectoral and cross-disciplinary kind, to complement sector-based activity. Science and technology activities of this nature are needed to facilitate the conduct of multi-disciplinary work and to utilise the capabilities of various scientific disciplines in changing combinations to meet large-scale objectives that may need to shift over time. Such cross-sectoral effort also carries the advantage of increasing opportunities for crossfertilisation of ideas, by enabling ready consultation and collaboration between scientists of differing expertise but working within the proximity of a single program or organisation. Where activities of this nature are supported or encouraged by government programs, purely pluralistic considerations cannot be applied as there is no single sector within which funds and priorities can be determined.

The combination of a broad range of sector-based activity stimulated by the scale of the country and the uniqueness of many of its problems, together with complementary cross-sectoral effort and an historical concern to maintain a basic research capability across many disciplines, have led to a substantial scientific effort of internationally recognised quality. Relative to Australia's GDP, our expenditure on scientific research outside the business sector is the fifth largest in the world. But even the scale of our effort is relatively large - in absolute terms we are thirteenth among all countries and one or two places higher if purely engineering R&D is excluded. Moreover, the diversity of our scientific effort and the evenness of its high quality is unusual in world terms.

The scope of the Federal Government's role and influence in the overall national system is very extensive. Essentially, it is summarised by the list of

organisations and programs listed in Tables 4, 5 and 6 in Section 3 of this *Statement.* Collectively these constitute a complex system, and the distribution between nine Ministerial portfolios indicates the prevalence of sector-based considerations. This situation typifies that of all sizeable OECD countries. Simpler arrangements are generally found only in smaller countries, with scientific efforts of small scale and low stature, and/or facing problems and exploring opportunities on only a few clearly defined fronts. In summary, the nature of the system arises from:

- a preponderance of sector-based needs;
- a need for complementary cross-sectoral effort; and
- a consequent necessity to maintain national capabilities across a broad range of disciplines.

Thus, while many issues of priorities and funding are appropriately considered within a sectoral context, other issues need to be dealt with in a strategic cross-sectoral way.

Priority-setting, and the underpinning advisory mechanisms

Australia has developed a range of advisory and other mechanisms to support priority-setting in its science and technology system. These have evolved with regard to the needs described above. In essence, priority-setting in Australia's science and technology system supports four levels of decision making:

- broad decisions and decisions of national significance, normally taken by Federal Cabinet;
- sectoral decisions, usually taken by Ministers or mechanisms established within particular portfolios;
- decisions within major science and technology organisations; and
- micro-level decisions preferring one project to another.

Each level of decision-making or priority-setting relies on different kinds of information and advice. This produces a need for a wide variety of quite specific advisory arrangements within the system, as well as needs for policy advice in relation to the system as a whole. There is a particular need for awareness and information at peak government levels (and sometimes an 'early warning' service) on problems and opportunities relating to important scientific and technological developments - including their likely impact in non-S&T areas - as well as well-researched strategic advice on such matters. There are also needs for monitoring trends in the system and the Government's role in it, and for identifying gaps. Finally, specific advisory functions arise in relation to many activities, including needs to ensure that science and technology aspects are adequately considered within policy advice relating to broader issues in particular sectors or portfolios.

In broad terms, the peak level advisory arrangements that have been developed to guide priority-setting and decision making are as follows:

- ***Prime Minister's Science and Engineering Council (PMSEC)****:* - PMSEC is a high level discussion forum in which the Prime Minister and other ministers with interests in science and technology hear expert presentations on current issues of national importance involving science and technology and engage in discussion on these issues with leaders from industry and the science, technology and engineering communities.
- ***Australian Science and Technology Council (ASTEC)****:* - ASTEC provides the Government with carefully considered advice and recommendations, based on policy research and analysis and extensive consultation. ASTEC deals principally with issues where government decisions have to be based on a full examination of all relevant facts. ASTEC's advice represents the outcome of deliberation by experts, both on the Council and co-opted to ASTEC working parties.
- ***Chief Scientist****:* - the Chief Scientist provides advice to the Prime Minister and the Minister for Science and Technology on such matters affecting science, technology and engineering as the Prime Minister or the Minister request, and on other issues to which science and technology are relevant. The Chief Scientist chairs ASTEC.

In summary, PMSEC is a high level discussion forum, while ASTEC is a policy research and analysis body. The two bodies deal with the same subject matter, but in quite different ways. Their roles are complementary and together they form a powerful mechanism for ensuring that government decisions on matters involving science and technology are technically well-informed (based on ASTEC's research and analysis) and that relevant ministers have had the opportunity to debate the issues with leading experts (in PMSEC).

Combination of the positions of Chief Scientist and ASTEC Chairman aims to ensure that the Government's sources of advice on science and technology are well coordinated, that the work of ASTEC is linked closely with that of PMSEC and that both address the most urgent needs of government.

More specialised advisory roles are provided at other levels in the system - often such a role complements another purpose, taking the opportunity afforded by a gathering of specialised expertise. For example, the Australian Research Council, the National Health and Medical Research Council, and the Industrial Research and Development Board - having roles as grant-giving bodies - also have advisory roles in their different spheres.

To complement the advisory arrangements discussed above, there are also needs to promote consultation within the system and needs for mechanisms that will effect coordination between different parts, when that is needed. In this regard, the **Coordination Committee on Science and Technology (CCST)** exists to complement the work of the Prime Minister's Science and Engineering Council by bringing together heads of agencies and senior representatives of departments with an interest in science and technology to share information about their programs and policies and to address common problems and opportunities. The main purposes of the Committee are to:

- enable departments and agencies with responsibilities in science and technology to share information about their policies and programs;
- ensure coherency and consistency in the implementation of Government policy for science and technology;
- allow an overview of policy;
- stimulate coordinated responses to science and technology policy issues;
- keep a watching brief on the development of specific proposals for national research facilities, particularly those that cross departmental boundaries; and
- report to Government on the mechanisms used to set science and technology priorities, and to address the adequacy of these mechanisms and the resulting priorities.

As part of their advisory and priority-setting roles, the mechanisms established through PMSEC, ASTEC, the Chief Scientist's position, and the CCST, aim to promote awareness, communication, substantial consultation, and a degree of coordination across portfolios - while recognising pluralism as a dominant feature of the science and technology system. An appropriate descriptive title might well be ***consultative pluralism.***

Priorities at the program and organisational level

Australia has a very diverse set of science and technology bodies - a diversity that was supported by the Industry Commission in its 1995 review of R&D activity in Australia. However, they have one common feature: they are the bodies in which the goals set through government policies, the aspirations of the scientific and technological communities, and the constraints set by financial and other resource limitations, all interact to produce concrete priorities. This individual effort by bodies at framing strategic priorities is a cornerstone of the science and technology system in Australia.

Increasingly in recent years, science and technology bodies have generally adopted quite rigorous internal priority-setting processes, of which the best known is the feasibility/benefits approach that has now been established for several years in CSIRO. In 1995, the CCST undertook a review of the priority-setting and planning processes within government science and technology organisations at the program and organisational level. While the criteria adopted varied with the circumstances and missions of the agencies, this review found that the following broad considerations were generally taken into account:

- the potential benefits of S&T activities, including
  - the needs of end-users being met;
  - the suitability and timeliness of the expected results;
  - the acceptance by key customers of activities and their likely outcomes;

- the ability of Australia to capture benefits of activities, and the impacts on beneficiaries;
- the capacity to attract joint venturers and / or external funding;
- the scientific or technological potential of the activities, and estimates of the probability of success;
- the agency's ability to conduct the activity, including the likely quality of its scientific contribution and its access to appropriate skills and technology;
- the contribution in strengthening international linkages in science, and international industrial technology collaboration;
- the relationship of activities to expected future directions in science and technology; and
- the value of activities in improving the operations and capabilities of the agency.

It is generally acknowledged that key aspects of any priority setting process should be openness of process, and a commitment or ownership of the decisions by stakeholders and those who must put the priorities into effect. This commitment is best achieved when decisions between competing priorities are seen to be supported by the best available information and advice.

At a broader level than programs and organisations, ASTEC has recently been investigating another strategic approach, seeking to identify emerging issues that will place demands on science and technology. This approach is based on 'technology foresight', a generic term for a range of techniques that can be used to identify possible, likely and preferred futures and to explore the conditions that might bring each of them about. It has been used for many years by the Japanese Science and Technology Agency and more recently by the governments of the United States, the United Kingdom and Germany as a guide to priority areas of science and technology. Foresighting of this kind is still in its infancy, but it has the potential to make an important contribution to planning and priority-setting.

Public scrutiny of priorities - accountability

The openness of Australia's political system has increasingly ensured that decisions are placed under public scrutiny, and increasingly demands that proper means of accountability be put in place. In response, Australia's science and technology priorities have come to be set in ways that are open to public scrutiny through a variety of mechanisms. Many general arrangements and practices, and several particular features of the science and technology system, combine to provide opportunities for public comment and the assessment of outcomes. These include:

- The publicly available *Portfolio Budget Statements* produced annually by *all* Departments and containing information on *all* programs and sub-programs including science and technology agencies. Apart from providing budgetary information, these statements set out

performance outcomes from the previous financial year and performance forecasts for the current year.

- The process of examination of details of the Budget by Senate Committees. The Senate Committee hearings which are normally conducted twice in each financial year provide an opportunity for representatives of the Australian people to ask highly detailed questions, based on the Department budget statements and relevant annual reports, on the nature and performance of S&T within Department funding programs and agencies.
- The Annual Reports produced by all government departments and research agencies, by science and technology institutions receiving funding, and the reports provided by grant recipients to bodies such as the Australian Research Council (ARC) and the National Health and Medical Research Council. In the case of CSIRO, many of the Divisions also produce annual reports. Guidelines on the production of government annual reports specifically require information on program objectives, performance indicators and outcomes.
- The situation, in the case of CSIRO, Australian Nuclear Science and Technology Organisation (ANSTO) and Australian Institute of Marine Science (AIMS), in which performance indicators are specified as an important component of the Triennium Resource Agreement signed between each agency and the Government. The agencies are required to report against these indicators in their annual reports.
- The formal Evaluation Program conducted by ARC and the Department of Employment, Education, Training and Youth Affairs through which the outcomes of research funded under ARC programs are evaluated by expert panels.
- This annual *Science and Technology Budget Statement* which, amongst other things, has for many years reported on the achievements of each Commonwealth science agency over the previous year - thus providing accountability to the Australian people for the outcomes of the Federal science and technology system *as a whole*.

This year, to enhance the role of the *Science and Technology Budget Statement* in providing an overview of science and technology activities and priorities, relevant material has been drawn together from the separate *Portfolio Budget Statements* and incorporated in Section 5. This includes the major performance forecasts for 1997-98 that relate to science and technology.

An evolving system

Australia's processes of priority setting in science and technology have a much greater degree of coherence than is sometimes perceived. Nevertheless, no system is ever perfect, or stays perfect for long. There are always possibilities for productive change. Furthermore, not only is Australia's science and technology system evolving, but many ideas on how science and technology issues can be best addressed are still being developed. Continuous improvement in small ways is clearly achievable and must be facilitated. And major changes cannot be ruled out, if backed by the outcomes of appropriate investigation. Complacency would be a poor strategy, especially in such a rapidly changing world.

Recent Major Developments

This section outlines the major developments of the past year and initiatives to be taken in science and technology across all Government portfolios

Science and Technology Advice

Appointment of new Chief Scientist

The Chief Scientist, Professor John Stocker, was appointed in December 1996, to advise the Government on science and technology issues and to undertake high level tasks at the request of the Minister for Science and Technology. The Chief Scientist is also Chair of the Australian Science and Technology Council (ASTEC), and an *ex officio* member of the Prime Minister's Science and Engineering Council (PMSEC) and the Government's Coordination Committee on Science and Technology (CCST). In these latter roles, the Chief Scientist is responsible for maintaining and further developing links between PMSEC and ASTEC, and for ensuring that issues of major national importance in science and technology are brought to PMSEC's attention.

Prior to this appointment Professor Stocker had been the Chief Executive of the CSIRO. This followed a period as Managing Director of AMRAD Australia and some years with Hoffman-La Roche, where he became Director of Pharmaceutical Research. He is also a Director of Telstra and a number of small, high-technology firms, and is Chair of the Grape and Wine R&D Corporation.

Review of Science and Technology Arrangements

Professor Stocker's first major task as Chief Scientist is to investigate and report on arrangements for Australian science and technology. This follows comments by the National Commission of Audit on these arrangements, and the scope for more efficiency. The Chief Scientist will investigate gaps and overlaps in science and technology arrangements, mechanisms for identifying national priorities for science and technology, and arrangements for provision of science and technology policy advice to Government.

Prime Minister's Science and Engineering Council (PMSEC)

The Prime Minister's Science and Engineering Council, which includes Ministers whose portfolios have major science, engineering and technology interests, met in September 1996 and will meet next in May 1997.

At the September meeting, a major agenda item was a series of presentations, followed by discussion, on the role of science in the management of water in the Murray-Darling Basin and the Great Artesian Basin. Particular issues were:

- water allocation in the two basins, including the conservation of water in the Great Artesian Basin through better maintenance and repair of bores; and
- concerns about water quality, including both current (salinity) and emerging (agricultural chemicals and algal toxins) problems.

Another important agenda item discussed key issues in Australian science, technology and engineering. This was presented by Australia's four peak professional organisations in science and technology: the Australian Academy of Science; the Australian Academy of Technological Sciences and Engineering; the Institution of Engineers, Australia; and the Federation of Australian Scientific and Technological Societies.

Other topics in presentations to the Council included biological control of rabbits, genetic engineering applied to floriculture, and on science and technology teaching in primary schools.

In March 1997 the Government announced it would develop an oceans policy, in fulfillment of one of its key election promises (see p. 2.12). The importance of the need for such a policy had been highlighted by the December 1995 PMSEC Paper, *Australia's Ocean Age: Science & Technology for Managing Australia's Ocean Territory*. The Paper also recommended the development of an integrated marine science plan. A Marine Science and Technology Plan is now being developed under the guidance of the Minister for Science and Technology.

The Council continues its practice of publishing papers arising from its major sessions, and making these available to the scientific, engineering and wider communities. Papers on managing inland waters and key science, technology and engineering issues were published following the September meeting. PMSEC papers are now available on the World Wide Web (see http://www.dist.gov.au/sandt.html).

Australian Science and Technology Council (ASTEC)

A notable development was the decision by the Minister for Science and Technology that the Chair of ASTEC should be held by the Chief Scientist. This coincided with the appointment of Professor John Stocker to that position (see page 2.3).

ASTEC's work during the year included the completion of two studies and a public discussion paper, as well as input to the Chief Scientist's review of Australian science and technology (see page 2.3).

Matching Science and Technology to Future Needs 2010
Released in October 1996, this report details all the elements of ASTEC's foresight work. The report's aim is to build skills in foresight, to disseminate the outcomes of such exercises, and is intended to help those who are considering undertaking them. Subsequent to the report's publication, ASTEC initiated a number of forums around the nation to make individuals and organisations aware of the value of foresight. These events were held in conjunction with ASTEC's counterparts in all mainland States and the Northern Territory. In addition, ASTEC is assisting a number of organisations to undertake their own foresight exercises.

Shipping Partnership report
ASTEC's Shipping Partnership, a self-funded 17 member group comprising industry, government, research, defence and learned society representatives, was one of five ASTEC partnerships that applied foresight processes to explore and evaluate the Australian future science and technology requirements to the year 2010. It used Delphi techniques to investigate likely trends in the Australian maritime industries.

The Partnership's report on the Maritime Industries priorities in science and technology was launched in September 1996. The report focuses on three priority areas where Australia is considered to have strengths that have considerable potential to contribute to economic well-being and quality of life:

- fast ship transportation for passengers and cargo;
- maritime defence opportunities; and
- resources and management of our exclusive economic zone.

Within these broad areas, 36 individual priorities for research and development and skills development were identified. These cover issues such as design, construction, safety, environmental impact, infrastructure, and export opportunities.

ASTEC subsequently published an evaluation of its experience of Delphi surveys.

Science and technology in primary schools
Against a background of earlier studies relating to science and technology education, ASTEC has initiated a study of science and technology teaching in Australian primary schools. The interim findings of its working group have revealed that while the situation has improved over the last decade, much still remains to be done. In particular, means need to be found to improve the confidence and capacity of many primary teachers to teach science and technology. The interim findings of the working group were discussed at the September 1996 meeting of the Prime Minister's Science and Engineering Council (PMSEC) and subsequently released in a public discussion paper. It is expected that the final ASTEC report will be discussed at the May 1997 meeting of PMSEC and released publicly soon after.

International Science Advisory Arrangements
An international comparison of science, technology and engineering policy advisory mechanisms has been prepared as an input to the Chief Scientist's review of Australian science and technology (see p. 2.3). The comparison details variations in the functions, structure and processes of science and technology advisory arrangements in several overseas countries, spanning both the developed countries and the emerging economies.

Coordination Committee on Science and Technology (CCST)

The Committee's major role as a forum for exchange of information among departments and agencies continued. In its recent activities, the Committee has:

- provided a forum for consideration of issues related to the management of research in publicly funded research agencies and of the funding programs of the major Commonwealth Government research funding agencies;
- considered comments by the National Commission of Audit on science and technology arrangements and contributed to the Stocker review of arrangements for publicly funded science and technology;
- discussed the implications for research of the proposed World Intellectual Property Organisation (WIPO) Database Treaty;
- discussed and responded to the views of the major science, technology and engineering representative bodies in their paper on Key Issues in Australian Science, Technology and Engineering as presented to the 13 September meeting of PMSEC;
- commenced an investigation of the adequacy of coordination arrangements for Australia's international science and technology activities;
- discussed the issue of international comparability of statistics on higher education sector research and development;
- discussed the application of State and Territory animal welfare laws to Commonwealth employees engaged in research involving animal experimentation;
- discussed possible topics for the PMSEC agenda;
- commenced consideration of a response to the ASTEC report *Developing Long-term Strategies for Science and Technology in Australia.*

Subgroups of the CCST met to discuss issues related to the management of research in publicly funded research agencies, and issues related to the management of the funding programs of the major Commonwealth Government research funding agencies.

Innovation in Industry

Development of the R&D Start Program

Much work has been done to develop the **R&D Start** Program since its announcement in the 1996 Budget. This has included defining the scope of projects that will be considered for support to those which:

- demonstrate a clear commercial focus with high potential rates of return;

- link leading industrial research with management and financial capability;
- would not otherwise be undertaken by firms without government support;
- provide net national economic benefits; and
- are performed in Australia.

Funding for up to three years is provided for expenditure of up to 50 per cent of the cost of a project.

Round One applications for support under **R&D Start** were divided into two phases. The first phase results were announced in December 1996, and saw $23.4 million in funding offered to five projects. The aims of these projects include the development of a unique braille printing technology, an oral vaccine for respiratory and middle ear infection in infants, and a more environmentally friendly copper refining process. In the second phase, announced in March 1997, $44 million has been offered to sixteen projects in a variety of industry areas, including mining, energy, automotive, health, sawmilling and electronics.

Small Business Innovation Fund

As part of the March 1997 Small Business Statement, the Prime Minister announced the **Small Business Innovation Fund** (SBIF), a scheme to help small, technology-based companies gain access to equity finance (venture capital). Generally, such companies find it extremely difficult to attract early-stage capital, with this problem being particularly severe in the $500,000 to $2 million investment range. The SBIF will improve the commercialisation of outcomes of Australia's strong R&D capabilities.

The Fund constitutes a key element of the Government's R&D Start Program. It will provide $130 million on a 2:1 basis with private-sector capital, thereby creating potential funding of $195 million. This funding will allow for the creation of up to six early-stage investment funds in the range of $30 million-$50 million. These funds will be managed by expert private sector fund managers, who will be required to pass a rigorous assessment process before being registered with the scheme. The funds will be restricted to investing in technology companies with an annual revenue of $4 million or less, averaged over the previous two years. These companies offer a dynamic source of economic growth/ employment, the development of highly innovative products and services, and exports.

It is expected that expressions of interest from potential fund managers will be called for by June 1997.

Pharmaceuticals Industry Investment Program (PIIP)

$300 million is being provided over five years for a new Pharmaceuticals Industry Investment Program to follow the existing Factor (f) scheme for the pharmaceuticals industry. This demonstrates the Government's commitment to maintaining an internationally competitive operating environment for the pharmaceuticals industry into the 21st Century, and will encourage international investment in Australia. PIIP is forecast to generate $1.5 billion in additional value-added production and in expenditure on research and development.

The Government will also be seeking amendments to patents legislation to provide an extension of up to five years for existing pharmaceutical patents. Under associated amendments, companies will be allowed to undertake preparatory work on generic drugs so that they can enter the market as soon as the relevant patents expire.

Review of Business Programs

In November 1996 the Government commissioned the Managing Director of TNT, Mr David Mortimer, to head a Review of Business Programs. The Review forms part of the Government's broader agenda to refine its industry policy framework and provide business with a coherent, stable and productive operating environment. Mr Mortimer is assessing business programs from a range of Commonwealth portfolios, including: Industry, Science and Tourism; Foreign Affairs and Trade; Primary Industries and Energy; Education, Employment, Training and Youth Affairs; and Communications and the Arts. A wide range of R&D support, including the *R&D Start* program, Cooperative Research Centres and R&D Corporations, is under consideration. Mr Mortimer will present his findings in June 1997.

Higher Education Research

Review of higher education financing and policy

In the *1996 Higher Education Budget Statement*, the Government announced a major review of the broad policy objectives in higher education. A review committee was appointed in January 1997, chaired by Mr Roderick West. The committee is undertaking a broad ranging review of the state of Australia's higher education sector, the effectiveness of the sector in meeting Australia's social, economic, scientific and cultural needs, and the developments which are likely to shape the provision of higher education in the next two decades. Higher education research policy will be a significant focus of the review.

The review committee will identify options for the financing of higher education teaching and research, and for providing Commonwealth funding to higher education institutions for these purposes. The review committee is

expected to examine long term developments, and their implications for higher education teaching and research in areas including the following:

- the internationalisation of higher education;
- sources of finance for higher education;
- the level and nature of industry demand for higher education graduates and higher education research, and the contribution that graduates and research conducted within higher education institutions makes to the competitiveness of Australian industry;
- the role of research conducted in higher education institutions in the national research and innovation system, and the increasing importance of international links for research conducted in higher education institutions in Australia; and
- the use of advanced communications technologies in teaching, and in libraries and other teaching and research infrastructure.

Program Reviews of Higher Education Targeted Research

During 1996 and 1997 the Department of Employment, Education, Training and Youth Affairs (DEETYA) and the Australian Research Council (ARC) began implementing a more strategically focused evaluation and monitoring program for the Higher Education Targeted Research Program, to extend to scope of previous evaluation work. This approach is intended to improve accountability and produce more strategic, policy oriented information. It involves reviewing the Program to determine how effectively it has fulfilled specific Government objectives for research and research training and the needs and expectations of particular research disciplines and communities.

In the initial phase of the strategy, the Department and the ARC are reviewing targeted support for biological sciences and industry-linked research.

Evaluation of Industry-Linked Research
This evaluation will assess how well ARC/DEETYA Industry-linked schemes are meeting the Government's objective of developing strategic interactions between higher education research and research users. It is being conducted by the Centre for Research Policy, University of Wollongong, who are expected to report their findings in January 1998. The evaluation will focus primarily on three ARC schemes: the Collaborative Research Grants Scheme, the Key Centres of Teaching and Research Program and the Australian Postgraduate Awards (Industry) Scheme.

Evaluation of Biological Sciences Research
This evaluation will assess the effectiveness of targeted research funding in relation to research in the biological sciences, in particular the extent to which this support has enabled the discipline to achieve the Government's objectives in relation to research and research training. It is expected to begin in May 1997, with the consultants to report their findings in March 1998. The outcomes of the evaluation will provide input to a proposed Discipline Research Strategy for the Biological Sciences scheduled to commence in late 1997 or early 1998.

Review of the Institute of Advanced Studies of the Australian National University

The *1996-97 Science and Technology Budget Statement* reported that a comprehensive review of the Schools and Centres of the Institute of Advanced Studies (IAS) of the Australian National University was conducted in 1995. In response to the Review, the Government has made a number of decisions, including an allocation to the Australian National University, for the IAS, of $0.5 million from the Research Infrastructure Block Grants Program in 1997 and $2 million in both 1998 and 1999 from the Research Infrastructure (Equipment and Facilities) Program (RIEF). The Government has also given approval for the IAS to compete for funds under the RIEF program.

As a result of the Review, the Government has also decided to transfer funding for the John Curtin School of Medical Research from the Health portfolio back to the Employment, Education, Training and Youth Affairs portfolio. In addition, the IAS will be reviewed at intervals of not less than five years, with the next review in 2001 to be conducted by a Government appointed committee of national and international experts with representatives from the ARC and ANU. From 1997, the Government will no longer set a specific target for the percentage of the budgets of the schools and centres of the I AS to be spent on collaborative activities with other Australian universities. Rather, collaborative activities will be reported annually to the ANU Council and considered in all future reviews.

Special Research Centres Program, 1996 Selection Round

The Special Research Centres (SRC) Program funds special units of concentration of research workers and resources in Australian higher education institutions, aimed at encouraging the pursuit of excellence in research, as measured at both national and international levels. Other objectives of the program are to establish Centres that will act as major linkages to international centres and programs, provide for postgraduate education and postdoctoral training, and serve as points of interaction between universities, government, industry and the private sector.

Government funding for individual SRCs is generally provided for six years, with a maximum of nine years, subject to a successful review every three years. The most recent selection round of SRCs was completed in 1996. On the advice of the ARC, the Minister for Employment, Education, Training and Youth Affairs announced that eight new centres would be funded beginning in 1997, as follows:

- Centre for Integrated Dynamics and Control (University of Newcastle);
- Centre for Multiphase Processes (University of Newcastle);
- Centre for Ecological Impact of Coastal Cities (University of Sydney);
- Tectonics Research Centre (University of Western Australia);

- Centre for Offshore Foundations Systems (University of Western Australia);
- Centre for Subatomic Structure of Matter (University of Adelaide);
- Centre for Ore Deposit Research (University of Tasmania); and
- SRC for Cross Cultural Research (Australian National University).

Australian Research Council Innovative Projects

Patterns of research activity in Australian universities
The findings of this study, which involved an analysis of national data sets on research funding as well as interviews with a selection of universities, were published in *Patterns of research activity in Australian universities*, in July 1996. A significant observation was the heavy concentration of research activity in just a few institutions, with five universities accounting for nearly half of higher education research expenditure. This pattern prevails whether grant funding, institutional funding, or total research funding is considered. Despite this concentration of research activity, the study also shows that important research activities are being undertaken across the whole higher education sector and that the pattern of institutional concentration varies considerably with the research field. As a result minor research institutions in terms of overall figures achieved prominence in some disciplines.

A follow-up study is planned to examine in more detail the specific role of higher education institutions in research funding. Phase 2 of the study is expected to focus on discretionary resources applying to research, how those resources are determined and how they are distributed.

Support for early career researchers
In September 1996, the ARC released the final report of a study aimed at examining the needs and experiences of those within an academic setting who show promise as researchers. The study defined early career researchers, identified the means by which they obtain research funding, considered the impact of their not receiving funding, and determined whether some identifiable groups face particular obstacles in obtaining funding for their research. It involved surveys of PhD graduates and early career researchers, established researchers and heads of departments.

The study found three major stages in the development of an academic research path. Having graduated with a PhD, the first major challenge is to secure an academic appointment. The next is the need to build up a research profile and the final critical development occurs at the point when the researcher wins competitive external funding in their own right. The final report outlines the barriers which need to be overcome at each stage on this path - by the researcher, by the researcher's institution, and by the ARC. The Council is currently developing its response to those recommendations relating to the operation of its programs.

Federal Sector Science

Major geophysical initiatives

Australian Ocean Territory (AOT) Mapping Program
The Government announced in the 1996 August Budget provision of $16.7 million over two years to supplement existing funding for the Australian Geological Survey Organisation (AGSO) to undertake an AOT Mapping Program. This program is collecting, processing and analysing marine technical data necessary to document Australia's claims under the United Nations Convention on the Law of the Sea (UNCLOS) and has important implications for Australia's sovereignty over its ocean territory. AGSO is also to carry out seabed mapping to gain new insights into the effects on the seafloor environment of human settlement, particularly in areas adjacent to urban populations. A further element of the program is to encourage investment in petroleum exploration through improving understanding of offshore petroleum prospectivity.

Geological Hazards Impact Study
A major national study of the vulnerability to geohazards of urban communities, the *Cities Project*, was launched by AGSO in November 1996. It is designed to assess the likely impact of earthquakes, landslides, tsunami, shrinking soils, geochemical and radon contamination and mine subsidence, should they occur, on communities from Cairns to the Gold Coast. Work is also scheduled to address specific geological hazard issues in a number of centres in other States, including in Adelaide and Newcastle.

Strategic Plan in nuclear science and technology

Following a two year review of its capabilities, activities, performance and structures, the Australian Nuclear Science and Technology Organisation (ANSTO) has implemented a Strategic Plan for the period 1997 to 2000. The Plan is based on the views of ANSTO's stakeholders and provides Australia with the capacity to benefit from the peaceful uses of nuclear science and technology into the 21st century.

The Strategic Plan outlines significant research outcomes planned for the three years, and in 1997-98 includes:

- further development of regionally accepted radiation safety standards;
- development of new instruments and enhanced methods for environmental monitoring applied to international safeguards, climate change and pollution, together with the development of instruments for applications in advanced materials and biosciences;
- development of improved tracer technology application techniques for environmental studies, trace element analysis, and dating;

- further development of processes for use in uranium processing, mineral sands extraction, and in radioactive waste and hazardous waste treatment;
- further development of risk assessment techniques and remaining life assessment techniques; and
- completion of the preclinical evaluation of radiopharmaceuticals developed by ANSTO.

Marine research and strategic planning

The Government announced in March 1997 that it was developing a comprehensive Oceans Policy. The policy will balance the needs of the environment with the needs of resource security and jobs. It will recognise environmental and conservation needs, and promote sustainable resource development and use. Research aspects of the new policy will include increased attention to the study of introduced marine pests and diseases.

In parallel with the Oceans Policy, and integrated with it, the Government is developing a Marine Science & Technology Plan. The Plan will provide a strategy for the application of marine science, technology and engineering to the exploration and ecologically sustainable development of our marine resources, and to the development of sustainable maritime industries.

A Scoping Paper for the Plan was released on 9 May 1997 and has invited comment and submissions from the general public and professional groups.

Radiofrequency Electromagnetic Energy Program

In October 1996, the Government announced a $4.5 million research and information program over 4.5 years to address community concerns about exposure to electromagnetic energy (EME) occurring in the radiofrequency (RF) range of the spectrum. This includes exposure to mobile phones, mobile phone towers, broadcast towers etc.

The program consists of:

- a public information dissemination strategy;
- continuing participation in the World Health Organisation's project to assess the health and environmental effects of EME exposure; and
- an independent Australian research program to be managed by the National Health and Medical Research Council.

Weather forecasting

High Performance Computing Centre

The Bureau of Meteorology and CSIRO have concluded agreements for the establishment and operation of a joint High Performance Computing Centre. Formal tenders have been let and the centre commences operation in mid 1997. The centre, supported by a core group of expert staff, will provide

facilities for advanced computation, interactive modelling and visualisation, large volume data archiving and high-speed communications access. The centre is designed to:

- service the operational and research requirements for high performance computing in the Bureau of Meteorology, and the scientific and industrial research requirements for high performance computing in CSIRO;
- provide a capability to service needs for high performance computing in other environmental sciences organisations;
- improve online environmental information services to the community;
- maintain and strengthen Australia's contribution to the international science community; and
- provide a leading capability for education and training in high performance computing.

Australian Integrated Forecast System

The Bureau of Meteorology has commenced implementation of the Australian Integrated Forecast System (AIFS), a decision support system which automates the more routine aspects of meteorological data analysis and processing, and allows weather forecasters to concentrate on the more scientific aspects of forecasting. The system is operating in the Bureau's Victorian and New South Wales Regional Offices. Further installations, in the Queensland Regional Office and in the National Meteorological Centre, will be completed by mid 1997. The AIFS is designed to integrate and enhance the overall functionality of existing diverse support systems, which serve a wide range of data access, display, manipulation and processing purposes, into a single system.

The overall objective of AIFS is to introduce into the Bureau's distributed operational environment an improved ability to deliver services of greater quality and timeliness. It will also provide increased flexibility and efficiency in meeting changing user requirements whilst taking advantage of advanced technology. The design of AIFS is based on modern 'open systems' technical standards, a relational database management system, commercial off-the-shelf products wherever possible, and advanced graphics.

Aerosonde Pilotless Weather Reconnaissance

The Aerosonde development program at Melbourne's Sencon Environmental Systems Pty Ltd has become fully established, with the continuing strong collaboration of the Bureau of Meteorology and the US-based Insitu Group. The Aerosonde is a small pilotless weather reconnaissance aircraft, designed to transmit real-time data from over oceans and remote areas at a fraction of the cost of other available systems. System performance was improved in local test flights near Geelong and in the USA, and in field trials off the Oregon and Canadian west coasts and off the northwest coast of Australia. Aerosondes have undertaken sustained flights of up to 24 hours, to 3.4 km altitude, and up to 280 km from base. Test transmissions have been made into the Aircraft Meteorological Data Relay (AMDAR) System for reporting aircraft observations in flight. A

developmental version of the aircraft has been purchased by the US Navy and is being subject to rigorous testing and trials aimed at producing the first operational-level aircraft in early 1998. It is expected that this aircraft will operate for more than 30 hours at ranges up to 3000 km and altitudes of 5 km. The design stage for the supercharged engine required to take the Aerosonde to high altitude has been completed and development work has commenced.

International Science and Technology Links

APEC

- The second **Ministers' Conference on Regional Science and Technology Cooperation** was held in Seoul in November 1996 and attended by the Minister for Science and Technology. It focused on ways to stimulate mobility and interchange of scientists and technologies in the APEC region. The Conference supported initiatives to encourage young people to take up science and technology as a profession and to facilitate the movement of scientists and engineers across the region by removing barriers and by creating systems for sharing information, programs and facilities.
- The **APEC Working Group on Industrial Science and Technology** (WGIST) is a major focus of interest. The 11th Meeting was held in Canberra in September 1996. The Meeting discussed projects and new proposals on the environment, information networks, technology flow, joint research, researcher exchange, policy and regulations. At this Meeting, Australia demonstrated its prototype for the APEC Science and Technology Web (ASTWeb) on the Internet. There was keen interest by APEC member economies to support this project and to combine it with other proposals from Japan and Korea. (The prototype Web Site can be accessed at http://www.iacom.au/apec/).

  The 12th WGIST Meeting was held in Vancouver in March 1997. The meeting developed a draft of the APEC Cleaner Production Strategy as requested by APEC Sustainable Development Ministers and established a Task Force for the implementation of that Strategy. This project will be a major priority for the Working Group over the next year. The meeting also gave highest priority for APEC Central Funding to Australia's ASTWeb project (see above).

  WGIST made considerable progress during the year, especially in improving its own procedures for focusing and prioritising activities. Australia played a major role in this work. The Working Group's activities provide many excellent opportunities for the Australian research community to build strategic links with counterparts in the rapidly expanding research communities of the region.

China

- Discussions on **science and technology indicators and their analysis**, where Australia is recognised as having particular expertise, were facilitated through a visit to Beijing anal Wuhan by an expert from the University of Wollongong in Aprill997. There will be a reciprocal visit to Australia by Chinese experts later in 1997 to further develop collaborative studies in this area. These are being undertaken as a bilateral project under the Australia-China Science and Technology Agreement. A joint workshop is planned for 1998.

Europe

- The '***new*Images' campaign** developed by the British Council jointly with Australia officially commenced on 5 February, but one of the first events, an astronomy exhibition entitled 'Night Skies' was launched at the Australian High Commission in London on 30 January. The S&T aspects of '*new*Images' focus on collaboration in Biosciences, Biodiversity and Astronomy. A high level science policy colloquium was held at Sydney University in April at which science leaders from both countries discussed future change, challenges and the part that S&T can play in advancing the economic and societal interests of both nations.
- The 1994 **EU-Australia S&T Agreement** has increased scientific collaboration with Europe. From 11 collaborative projects established under the EU's 4th Framework Program in 1995, the European Commission (EC) has approved a similar number in 1996, and another 30 proposals are at discussion or lodgement stages. A particular focus has been on 'Technology for Business Processes' building networks of SMEs and research organisations.
- A revised 'arrangement' of the **French-Australian Industrial Research (FAIR) program** has been agreed and is expected to be formally signed by the Minister for Science and Technology and the French Minister for Research later in 1997. A major workshop involving a 25 member French delegation on 'Mineral Extraction and Processing' was held in Australia in March 1997.

India

- As part of the Department of Foreign Affairs and Trade promotion - '**Australia-India New Horizons**' - held in India, the Department of Industry, Science and Tourism (DIST) contributed $100,000 for a Science and Technology Colloquium in New Delhi in November 1996. High ranking research scientists in India held discussions with visiting Australian researchers in the fields of medical science, human nutrition, environment and energy. A Memorandum of Understanding was signed between the DIST and the Indian Department of Science and Technology during the Colloquium. Both Departments have agreed to fund an exploratory visits exchange program for Australian and Indian research scientists, commencing in 1997. The exchanges are to initiate the development of collaborative research.

Indonesia

- The **Collaboration on Science and Technology - Australia and Indonesia (COSTAI)** Joint Steering Committee now reports to the Australia-Indonesia Ministerial Forum as 'The Working Group on Science and Technology/COSTAI'. Under the auspices of COSTAI, the CSIRO Institute of Natural Resources and Environment introduced airborne environmental monitoring sofware into Indonesia. These applications were proved in a number of commercial projects in Indonesia focusing on forestry, land use, coastal zone and marine/reef environmental management. The CSIRO has recently licensed its technology to an Australian company which has in turn entered into a joint-venture arrangement with an Indonesian company. The arrangement is expected to return US $7 million to the CSIRO during the life of the licence.
- **A collaborative exercise** between the CSIRO Forestry and Forest Products and an Indonesian institute, aimed at collecting *Melaleuca cajuputi* seed in both countries, as the basis for a future tree breeding program will significantly broaden the field of collaborative research. The arrangement holds potential for CSIRO to provide services that would be paid for out of a multi-million dollar forestry fund in Indonesia.
- CSIRO has been awarded a US$6.1 million World Bank contract to provide **Management Systems Strengthening services to the Indonesian Institute of Sciences (LIPI)**. Although this arrangement did not arise out of any particular project, in making the announcement the Chairman of LIPI attributed the CSIRO's success to linkages forged under COSTAI.
- Other COSTAI activities involving Indonesia included support to **Indonesian scientists to visit Australian Antarctica**, and support for a seminar on the science and technology of low-rank coal. There have also been workshops on sustainable housing and urban development.

OECD

Over three decades, the OECD has had a substantial focus in studying and discussing policy issues in science, technology and innovation. These activities, through the OECD Committee for Scientific and Technological Policy (CSTP) and its various working groups, have greatly facilitated the exchange of policy experience between member countries. The activities of the CSTP over the years have had a major influence on the directions of science and technology policy in all developed economies.

Australia has been very active within the CSTP and its subgroups since it first joined the OECD in 1973. Over the past few months, Australia has continued a high level of involvement and has taken a leading role in some areas. The recent focus of the CSTP has included work in the following areas:

- **Science and technology indicators and their analysis**, focusing on a consistent international approach to the measurement of science and technology activity - inputs such as R&D and human resources, and outputs such as patents and high technology exports. Australia has

recently made a substantial contribution to new guidelines on the measurement of innovative activity in the business sector.

- **Innovation and technology policy**, which includes studies on technology, productivity and job creation, national innovation systems, and issues such as the promotion of technology diffusion.
- **The science system**, which focuses on areas such as trends affecting university research and education, public understanding of science and technology and how results of the science system contribute to economic growth and employment and technology transfer mechanisms.
- **International cooperation in relation to large facilities and projects,** focusing on areas such as radio astronomy, neutron sources, removing obstacles to international megascience cooperation, biological informatics and nuclear physics with a clear desire to deliver practical policy outcomes for the countries involved. A notable event in this area was a series of meetings on bioinformatics that were hosted by Australia in Canberra during April 1997.
- **Biotechnology studies** related to human health, intellectual property, technology transfer and genetic resources, water use and conservation, and food safety.

Other initiatives in support of science and technology

- in industry, science and technology

- **Scoreboard 96**, the second in a series of reports on business expenditure on R&D at the firm level, was released by the IR&D Board and AusIndustry. The *Scoreboard* aims to raise awareness of the importance and benefits of R&D. It will also assist the financial community in assessing the potential of companies and encouraging leading firms to maintain their position at the forefront of developing technology.
- **CSIRO, ANSTO and AIMS triennium appropriations** for 1997-98 to 1999-2000 were determined in the context of the 1996-97 Budget. With this stable framework in place, the Science Agencies during 1996-97 formulated their strategic directions and research plans for the next triennium. Agreements are under negotiation to formalise the arrangements for the next triennium and provide performance measures for the Science Agencies.
- Since switching to project-based planning in 1995, **AIMS has further refined its research effort** through the finalisation of strategic areas for the next triennium. Research will focus on five areas critical to the sustainable development of Australia's EEZ. These areas are:
  - The ocean environment - understanding the circulation of water, nutrients and the genetic diversity of ocean species.
  - Marine biodiversity - characterising species richness and genetic variety.

  - Marine living resources - identifying valuable marine plants and animals.
  - Ecologically sustainable development - understanding and documenting natural changes and human impacts.
  - Technological innovation - developing advanced instruments and techniques.
- The momentum established by changes to CSIRO's management and structure in March 1996 has continued with the establishment of **twenty-two new Sector Advisory Committees and the** conduct in February 1997 of a second **CSIRO-Government workshop**. These consultative processes have assisted CSIRO in establishing research priorities and preparing Sector Plans for the triennium commencing on 1 July 1997. They wifl continue to provide an important source of informed advice to ensure that CSIRO's efforts are focused on the research challenges and opportunities offering greatest benefit to Australia.
  - To increase the proportion of resources available for research, a significant downsizing of corporate support areas has been achieved. Several Divisional amalgamations also have been implemented - both to streamline management and to capitalise on opportunities for synergistic inter-disciplinary research and development.
  - Recognising that CSIRO must be able to attract and retain the highest calibre people, a major review of its remuneration system was undertaken by a joint CSIRO/Union working group in 1996. Recommendations agreed by the Chief Executive will be implemented in 1997 to address anomalies in the present system and improve classification procedures.
- **The Cooperative Research Centres (CRC) Program** completed its fifth selection round in December 1996 with the announcement of funding for 15 successful proposals, including 10 from existing Centres, as well as an extension of one existing Centre. (See Section 5 for further details.)
- Final agreements have been negotiated with the seven **major national research facilities** announced in December 1995. The facilities have completed their business planning phase and are progressively implementing the research infrastructure that is to be made available to Australian researchers.
- The Government is to undertake a review of Cooperative Research Centres that will focus on identifying means to improve the **commercialisation of CRC research activities** and achieve a higher degree of self funding.
- **A Probabilistic Safety Assessment (PSA) and Remaining Life Study** (RLS) are being undertaken of the HIFAR Research Reactor at Lucas Heights. HIFAR is a 39 year old, major national research facility which is expected to reach the end of its operational life in about 2003 unless a significant safety upgrade is undertaken. The PSA will determine the probability or internal and external events that might cause damage to the reactor's fuel. The RLS provides a conservative

assessment of the remaining useful life of the reactor's components. Both studies will be concluded in 1997.

- The Government has provided funding to the Australian Nuclear Science and Technology Organisation to provide **interim storage relief for spent fuel**. ANSTO presently holds some 1600 spent fuel rods arising from the past 39 years of operation of the HIFAR research reactor. The storage facilities at Lucas Heights will reach capacity in 1998. The Government is considering its options for the balance of ANSTO's spent fuel holdings.
- The refocusing of ANSTO's strategic research on **priority nuclear science and technology areas** has advanced during 1996-97 with the identification of seven topic areas. These are:
  - Ecological sustainability and competitiveness of the mining and minerals industries
  - Designer materials
  - Safety of and safeguards for nuclear materials
  - Environmental dynamics
  - Global climate change - application of nuclear techniques
  - Radioactive waste management
  - Radionuclides/radiopharmaceuticals for the 21st Century

  Twelve strategic R & D projects have commenced in these topic areas during 1996-97.
- Within the Australian Government Analytical Laboratories (AGAL), a **National Analytical Reference Laboratory** (NARL) is being set up to provide Australia and the Asia-Pacific region with a primary centre of reference for the accuracy and validity of chemical measurements. Under the umbrella of NARL, current activities undertaken through the Curator of Standards and the Australian Chemical Standards Laboratory (ACSL) will be enhanced to provide a centre for chemical metrology. In another activity within AGAL, the Australian Sports Drug Testing Laboratory (ASDTL) is commissioning a high resolution mass spectrometer (HRMS), the first of five such instruments to be used for drug testing at the Sydney 2000 Olympics. HRMS has improved the capability for detecting drugs in sport.
- From the 1998 funding round, the Collaborative Research Grants Program and the Australian Postgraduate Awards (Industry) Scheme will be integrated into a single scheme called the **Strategic Partnerships with Industry-Research and Training Scheme** (SPIRT). This new scheme will combine the best elements of the previous schemes and give universities and their collaborators greater flexibility to undertake research projects.
- Through the Research Evaluation Program (REP), the Department of Employment, Education, Training and Youth Affairs (DEETYA) and the Australian Research Council (ARC) have undertaken a number of **Reviews of ARC Large Grant Outcomes**. The Reviews evaluate the effectiveness of the Large Grants Scheme in supporting research in a discipline by examining the output and impact of research carried out by individual researchers and teams. The aim is to ensure that the

Scheme is supporting high quality research in the discipline, that research output is commensurate with funding input and that administrative processes are efficient and fair. The evaluations completed since July 1996 or nearing completion are: Plant Physiology, Education, Marine Biology and Atmospheric and Oceanographic Science. These four Reviews are the last in a series of 24 Reviews undertaken since 1990.

- Beginning with the 1997 grants round, DEETYA and the ARC have begun implementing an **electronic grants processing platform** to assist in the allocation of targeted research grants to universities, researchers and other bodies. Utilising the Internet, the platform allows university research offices to electronically submit key parts of research grants applications via on-screen forms. It also gives the Panels and Committees of the ARC access to a large database of peer review assessors and the ability to establish electronic links to them. The platform is allowing a large reduction in paper-based processing and handling, resulting is significant time and cost savings and quality improvements. Through a phased approach to implementation, it is expected that all aspects of the process will be handled electronically by the 1999 grants round.

- in science and technology awareness:

- **The 1997 Australia Prize** was awarded in the field of telecommunication to three scientists - Australians Professor Allan Snyder and Professor Rodney Tucker, and an Austrian, Dr Gottfried Ungerboeck - for their contributions to the advent of the information superhighway.
- **The 1996 Daley Awards for Science, Engineering and Technology Journalism** in ten categories were announced in September 1996. The overall best entry award went to Mr Bob Beale, Ms Leigh Dayton and Mr James Woodrord for their news reports on the rabbit calici virus published in the Sydney Morning Herald.
- In late 1996, CSIRO initiated a series of **National Science Briefings** for parliamentarians and their staff in Parliament House, Canberra. Hosted by the Minister for Science and Technology, Mr Peter McGauran, these briefings aim to provide information to help form better public.policy. They receive support from the Australian Academy of Science, the Australian Academy of Technological Sciences and Engineering, the Australian Research Council, the CRC Association, the National Health and Medical Research Council and the Federation of Australian Scientific and Technological Societies. Topics covered so far include Greenhouse and alternative energy, gene mapping, protective food, marine resources and wine science.
- In February, up to 170 business people attended **MANUfesto** '97, held in Melbourne. MANUfesto '97 was a CSIRO initiative, co-sponsored by Business Victoria. It involved seminars, workshops and an exposition of 46 examples of the latest CSIRO science and technologies in the automotive, food, environmental management, telecommunications, chemical, aerospace, healthcare and other industries.
- 1997 has been designated the **Year of Youth in Science.** To this end, the Science and Technology Awareness Program will be providing

financial support totalling $1.18 million over three years to some forty projects that aim to enhance young Australians' awareness of the role of S&T in national development. Projects supported include school resource materials as well as support for science fairs, competitions and games.

- The Government is funding a **major science broadcasting development** project at the Australian Broadcasting Corporation (ABC). Over three years, $1.8 million will be provided for a range of activities including the development of an on-line science service for secondary schools.
- The Department of Communication and the Arts' **Australia on CD program** will showcase Australia's cultural heritage through the production of 10 interactive CD ROM titles which will be distributed to all Australian schools, public libraries, Austrade offices, overseas missions and Federal politicians. Two titles cover science and its place in Australian culture. *Tales from the Kangaroo's Crypt: 4 billion years of extraordinary Australia* investigates the prehistoric fossil heritage or Australia while describing how our land and wildlife originated. *Ingenious* enables the user to study some of the current scientific topics in Australia and to solve the problems faced. (See www.dca.gov.au/pubs/creative_nation/auscd.htm).
- The Government will continue to be a major sponsor of the **Australian Science Olympiads** and will provide funding of $750,000 over the next three years.

- in international science and technology collaboration

- CSIRO has been awarded a contract to provide **R&D assistance to the Indonesian national research agency LIPI**. CSIRO was selected by the Indonesian Government after a process of international competitive tendering by the research agencies of a number of countries, including Germany, Korea, and the Netherlands. The five-year contract, backed by the World Bank and worth more than $7 million, will involve Indonesian and Australian research managers in a close two-way process on the best ways to plan and manage scientific research through to its ultimate adoption or commercialisation by private industry.
- There are continuing efforts to strengthen **collaborative research ties between Australia and Japan** evidenced in two areas of research. In late 1996 the first Australian/Japanese Collaborative Cardiovascular Research Forum was held. This forum received support from the NHMRC. Additional funding was also provided to further support cancer research between Japanese and Australian researchers, following the joint workshop held in late 1995.
- In 1996-97, $5.6 million was allocated under the International Science and Technology Program (ISTP) to develop and strengthen **relationships between Australian and overseas researchers** through a variety of funded programs, including under ten collaboration treaties. Assistance was provided to around 500 Australian scientists, technologists and engineers for overseas travel for research collaboration and access to major research facilities. In the same period, ISTP helped sponsor 24 major international scientific, technology and engineering conferences in Australia.

- Adding to previously signed Memoranda of Understanding (MOU), the Australian Research Council has, since June 1996, signed MOU on **research collaboration with the Grant Agency of the Czech Republic and the University Research Council of Indonesia**.
- The Australian Research Council has undertaken a **joint exercise with the Japan Society for the Promotion of Science** under the Memorandum of Understanding between the two agencies to fund collaborative research between researchers from Australia and Japan. Funding was provided for eleven projects in January 1997.
- **Eligibility provisions for the ARC's Large Research Grants Scheme** were changed in 1997 to allow the involvement in projects of partner chief investigators from overseas. Of the 640 successful applications in the 1997 granting round, fifty-four (54) included partner chief investigators from overseas. The investigators were spread across thirteen (13) countries in all, with the largest number residing in the United States (50%) and the United Kingdom (20%).

- in environment

- CSIRO has launched a $3 million **Tourism Research program** designed to give Australia's $47 billion-a-year tourism industry a world lead in environmental sustainability. The program will develop innovative ways to plan and locate sustainable resorts, dispose of effluent and waste, enhance nature tourism and evaluate its impact, protect against the increase in storm surges and cyclones expected under Global Warming, and better integrate tourism with aboriginal, pastoral and local communities.
- In late 1996, the **National Wetlands Research and Development Program** was established as a joint initiative between the Biodiversity Group of Environment Australia and the Land and Water Resources Research and Development Corporation (LWRRDC). One of the key components of the Program is funding support for management oriented research designed to encourage application of the wise use of wetland principles championed by the Ramsar Convention on Wetlands. The priorities for projects were developed in 1996 in a scoping study involving some of Australia's leading wetland scientists. The study identified a number of issues for attention under the Program including water regimes, habitat modification, weeds and feral animals, monitoring, wetland valuation and technology transfer. In its first year the program is expected to have around $400,000 for administration and projects. The National Wetlands Research and Development Program Management Agreement covers a three year period, from 1996-97 to 1999-2000, which will enable funding to be provided for projects where meaningful results can only be achieved by ongoing research over several consecutive years.
- The Biodiversity Group continued to provide **funding for native vegetation research** as part of a program funded by Environment Australia and the LWRRDC, and managed by LWRRDC. The aim of the program is to assist government agencies, community groups and landholders to better manage and protect remnant native vegetation through the application of improved knowledge and understanding gained from research. The program has two main thrusts:
  - increased understanding of the ecology of native vegetation; and

- identification and understanding of socio-economic factors and values influencing the protection and management of remnant native vegetation.

- **The Environmental Indicators Program** is designed to develop scientifically credible indicators for State of the Environment reporting. The indicators will be a vital tool to track changes in Australia's environment and human activities that affect it. They will also help communicate these findings to decision makers. The program is a collaborative effort between the Commonwealth and States through the ANZECC State of the Environment Reporting Taskforce and with the Australian Local Government Association.

- **Research projects on the impacts and science of climate change** funded by the Environment Protection Group of Environment Australia, and carried out by a variety of institutions include:-
  - The economic and social consequences of climate change induced reduction in snow cover in the Victorian Alps;
  - Formulation of a methodology which assists coastal management planning in the context of climate change;
  - Managing the water resources of the Macquarie River in a changing climate;
  - Potential impacts of defoliating insects in rural tree decline under climate change;
  - Impacts of climate change on Australian grain production;
  - Methodology, case studies and policy input relating to studies of urban flooding;
  - Carbon: Nitrogen (C:N) ration and tissue quality of temperate grasses and trees under greenhouse - implications for atmospheric composition and impacts;
  - Physiological changes in rangeland species with rising CO_2 levels: impact on carbon and nutrient distribution and turnover in soil/ plant systems;
  - Patterns of excess mortality in relation to temperature extremes;
  - Development of baseline geographical vector-borne disease and survey of current state disease networks;
  - Applying Frameworks for assessing agricultural adaptation to climate change to the Australia and Oceania regions;
  - Climate change and pollen allergens;
  - Antarctic influences on global warming, sea level and CO_2;
  - Determination of the age and age-spread of air in ice cores;
  - Modelling of Australia's past climate to allow better modelling of future climate;
  - The enhanced emission of greenhouse gases from soil following prescribed burning in a southern eucalypt forest;
  - Measurement of methane and nitrogen dioxide emissions from sugarcane soils in tropical Australia and the use of management

practices to reduce their impact on atmospheric trace gas concentrations; and

- Modelling the El Nino Southern Oscillation.

- Following its work on a vulnerability assessment of the Alligator Rivers Region to the possible effects of sea level rise due to climate change, the Environmental Research Institute of the Supervising Scientist has established a **Coastal Monitoring Node for the Alligator Rivers Region** to develop a regional capacity to measure and assess change on the floodplains and coast. The objective is to increase Australia's capacity in the monitoring of coastal change through establishment of a coordinated monitoring program which can function as a benchmark for monitoring in the wet-dry tropic
- Achievements in environmental information, through the Department of Environment, Sport and Territories, included the completion of the **National Pollutant Inventory database.**
- The Bureau of Meteorology publication ***The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method*** (Bulletin 53) is a basic reference used by consulting engineers in the design of hydrological structures in small catchments. An amendment was published during the year using an improved methodology for determining the spatial distribution of rainfall.
- The Bureau of Meteorology, in cooperation with the Cooperative Research Centre for Catchment Hydrology at Monash University, has completed a project on the development of an **improved real-time flood forecasting model.** The project used data from 14 catchments in Victoria, New South Wales, Queensland, Tasmania and South Australia to compare the relative performance of forecasting models. A series of reports detailing the performance of each model is currently being reviewed before publication. The recommended models provide increased warning time and greater accuracy for flood warning predictions, leading to higher potential savings (reduced damage) in flood events.
- The **Bureau of Meteorology has established a World Wide Web Internet site** (http:/ / www.bom.gov.au/) to provide direct electronic access by the public and other users to a wide range of textual and graphical meteorological and hydrological information and products. Forecasts, warnings, satellite images, current weather charts, current observations and analysed maps are available to support risk management and inter-disciplinary research.
- Following acceptance by government of the recommendations of the 1996 *Review of the Operation of the Bureau of Meteorology,* additional funds were appropriated to the Bureau to continue the program commenced in 1996 to **restore meteorological observing networks to accepted benchmark levels.** In particular:

  - rainfall networks are being strengthened to improve national drought monitoring;
  - a 180 station National Benchmark Network for Agrometeorology is being completed to ensure fundamental meteorological information is available for agricultural research and operational decision making; and

  - a 100 site Reference Climate Station network providing long-term homogeneous data is being maintained into the future as the basis for regional climate change detection.
- Originally established for a three-year period concluding in October 1996, the **Pacific Meteorological Services Project** has been extended for a year by its funding agency, AusAID. The project is being implemented by the Bureau of Meteorology in ten countries of the south west Pacific, and was designed to improve the collection of meteorological data primarily for the purpose of the climate record, and thus improve the ability to observe and predict climate change. The key components are the upgrade of basic meteorological instrumentation and training in the methods of observation, maintenance and inspection of equipment, and reliable methods of data collection and storage. The emphasis of the extended program will be on technical training for staff of the National Meteorological Services of the developing countries of the southwest Pacific.

- in defence

- Construction of a **new laboratory complex for the Defence Science and Technology Organisation** (DSTO) at Salisbury, SA is close to completion. The building will house some 600 staff and will provide state of the art facilities for research into Defence electronic systems.
- Construction of a **new Helicopter Transmission Test Facility** at the Aeronautical and Maritime Research Laboratory at Fishermens Bend, Victoria is nearing completion. The facility will provide a greatly enhanced capability for experimental development and testing of advanced condition-monitoring technologies for highly loaded transmission systems.
- A **Sonar Research Projector** has been acquired to conduct investigations in advanced concepts for active sonar. The projector will be used to study reverberation in the ocean, to explore optimal sonar pulse shapes, and to study techniques to classify underwater objects.
- Four scientists have been posted to US government laboratories to work on **guidance and control, simulation, and hardware evaluation** for the next generation of ship defence missiles.
- DSTO has initiated a **new approach for interacting with Australian industry** by linking a licence agreement with an industry alliance and a Defence procurement project to provide a foundation for the building of a sustainable information security capability in Australia. The wider commercial opportunities from the intellectual property, rather than just the more limited Defence applications, were used as key drivers.
- DSTO has signed agreements with four of Australia's universities to establish **Centres of Expertise in airframe technology** in the focus areas of structural mechanics, vibration analysis, aerodynamic loading and damage mechanics. These agreements provide financial support to participating universities over a four year period, and so encourage them to invest in developing expertise in their particular focus area.

- The most important multilateral defence science forum continues to be **The Technical Cooperation Program** (TTCP) between the United States, the United Kingdom, Canada, Australia and New Zealand. Over the last 12 months the management structure of TTCP has been substantially reviewed and enhanced.
- The defence science relationships with South East Asian countries have been strengthened by the formation of **defence science cooperation working groups** with Indonesia and Thailand and the revitalisation of the defence science and industry working group with Malaysia. These groups have encouraged a well-directed approach to bilateral activities between the member nations.

- in health

- An initiative aimed at **strengthening the health and medical research workforce** has been announced in the 1997-98 Budget with a funding program in excess of $10 million over a seven-year period.

  One of the initiative's aims is to encourage young Australians working in overseas research institutions to return to a research career in Australia. Although Australia is a leader in health and medical research, some of our best young researchers move to overseas research institutions immediately after completing their doctorates rather than seek postdoctoral training in Australia. Once they have completed their overseas training it is often difficult for them to secure research support in Australia.

  The package has three elements:

  – a program of research fellowships which will encourage bright young researchers to return from overseas after gaining valuable international experience;

  – scholarships and fellowships in areas of health and medical research identified as areas of research weakness but health priority; and

  – a review of Australia's health and medical research workforce to develop a strategy for strengthening Australia's research capacity.
- In a collaborative effort, the NHMRC has joined the Juvenile Diabetes Foundation Australia (JDFA) and the Juvenile Diabetes Foundation International (JDFI) to provide up to $5 million per annum for 5 years to support research into insulin dependent diabetes in Australia. The program will be known as **the Diabetes Interdisciplinary Research Program**, and will work towards a cure for diabetes. The funds will also be used to find ways of minimising the serious complications people with diabetes face, such as blindness, kidney disease, heart disease, stroke and amputation.
- The Menzies Foundation will be providing $50,000 per annum towards the **award of NHMRC/R G Menzies Fellowships** to be held in the UK and Australia.
- The **Australian Breast Cancer Family Study**, originally established through funding from the NHMRC and other local agencies, has now received funding for 1996-99 of over $3m from the National Institute of Health (USA). The study found the likelihood of increased risk of

early onset breast cancer, for first and second degree relatives of women diagnosed with breast cancer before the age of 40, to be 2.5 times. The international funding, part of an international Cooperative Family Registry for Breast Cancer Studies, will enlarge the study to consider breast cancer of all ages.

- To match increased Commonwealth funding provided through the NHMRC's research grants system, the **Wellcome Trust of the UK has increased its contribution to Australian medical research** from $4 million to $10 million in 1997. This funding will provide for the purchase of major items of equipment and a range of awards including collaborative biomedical research in the Asia Pacific region. Australian researchers will also now have access to Wellcome Trust grants in the area of population and reproductive health studies.

Australian medical researchers have attracted substantial recognition both locally and internationally:

- **The 1996 Nobel Prize in Physiology or Medicine** was awarded jointly to Peter Doherty (Australia) and Rolf Zinkernagel (Switzerland). The prize was awarded for their discovery of how the immune system recognises virus infected cells. Professors Doherty and Zinkernagel carried out the work when research fellows at the John Curtin School of Medical Research, Canberra, in 1973-75.
- **The 1997 King Faisal International Prize for Medicine,** awarded in Saudi Arabia for research on Degenerative Diseases of the Nervous System, was shared by Professor Colin Masters (Australia) and two other researchers from Canada and Germany. Professor Masters is Head of the Pathology Department at the University of Melbourne and Chair of the Network for Brain Research into Mental Disorders, and has received significant funding support from the NHMRC over the years.
- Associate Professor Brandon Wainwright, of the University of Queensland Centre for Molecular and Cellular Biology and Biochemistry Department, has won the **Gottschalk Medal** for his contribution to biomedical research. The Gottschalk Medal is awarded to younger Australian researchers by the Australian Academy or Science. Dr Wainwright has received significant funding support from the NHMRC over the years for his work on the genetic components of skin cancer and cystic fibrosis.
- Dr Vasso Apostolopoulos was named the **Herald Sun/Network Ten Young Achiever or the year** in December 1996. Dr Apostolopoulos, who works at the Austin Research Institute, received the award for her ground breaking research which helped develop a vaccine for breast cancer which is now being trialled. Dr Apostolopoulos also won the Eastern Energy Science and Technology award and the Premier's Award for Medical Research.
- Dr Michael Berndt, Associate Director at the Baker Medical Research Institute, has won the **1996 Glaxo Wellcome Australia Medal** for identifying the structure and function of receptors that mediate platelet and neutrophil interactions with blood vessels. The Glaxo Wellcome Australia Medal is awarded to scientists for distinguished discovery and its demonstrated or potential use in the field of human

health. Dr Berndt has received significant funding support from the NHMRC.

There have been significant research findings:

- A pilot study undertaken at the Brisbane's Mater Mothers' Hospital, by researchers from the University of Queensland (Dr Bruce Carles and Mr Toong Lee), has proven for the first time **caffeine's effectiveness in treating apnoea in very premature babies**.
  - Apnoea, or temporary cessation of breathing, is a common problem for premature babies, affecting over 75% of those with a birth weight of less than 1.5kg. The major existing treatment, aminophylline, can cause side effects such as gastro-intestinal irritation, nausea, very fast heart rate and central nervous system damage in some babies. Dr Charles and Mr Lee used special non-invasive methods for monitoring the tiny babies, who weighed between 500g and 1.5kg. The study's findings could mean that caffeine could replace aminophyline in neonatal facilities throughout the world before next century. NHMRC has provided funding to continue this research.

Advances in understanding or techniques have included:

- Last year's report included an item relating to the **identification of the gene responsible for common skin cancer**. Further research at the University of Queensland and the Queensland Institute of Medical Research indicates that the same gene is likely to be responsible for many other forms of cancer, including the commonest brain tumor in children, medulloblastoma.
- The Australian Health Technology Advisory Committee(AHTAC), a committee of the NHMRC, evaluates health technologies and highly specialised services looking at safety, efficacy, effectiveness, cost, equity, access and social impact and provides advice to government, the health professions and the community on these issues. It has recently reported on **treatment for sleep apnoea and screening for prostate cancer:**
  - Sleep apnoea is estimated to affect up to 5% of the adult population. The research project on The Effectiveness and Cost-Effectiveness of Nasal Obstructive Sleep Apnoea in Adults identified nasal Continuous Positive Airways Pressure(CPAP) as an effective treatment for adults with moderate to severe sleep apnoea.
  - AHTAC's review of the evidence on benefits, risks and costs of screening for prostate cancer recommended against prostate cancer screening of asymptomatic men and advocated strengthened research efforts.
- The Australian Radiation Laboratory (ARL) has developed instrumentation and a protocol for the **measurement of environmental radiofrequency(RF) radiation** arising from communications (ie radio and television transmissions, mobile phones and pagers etc).

- ARL has developed very sensitive and sophisticated equipment for the **detection of residual environmental radioactivity.** This equipment is currently being deployed in the clean-up of Maralinga.
- ARL has extended its capabilities for **calibrating radiation measurement instruments** into the high radiation energies range now used in cancer therapy treatments.
- The development and installation of a **solar ultraviolet radiation (UVR) measuring station** in Singapore now extends our coverage from Antarctica to the equator, including 13 stations around Australia.
- ARL invented a **device for assessing radiation dose of radon decay products** for which a provisional patent has been obtained.
- Many modern, **computerised hearing aids** permit the user to choose different kinds of amplification to suit different listening conditions. For example, speech may be understood best when sounds of all frequencies are heard equally well but it may be preferable to reduce low-frequency traffic noise when out in a busy street. Recently completed studies have defined which types of amplification are best for which conditions, for listeners with particular types of hearing problems. This knowledge will enable many hearing-impaired people to be aided more effectively.
- In general, understanding of speech depends on how well we hear the many sounds that comprise the speech signal. Recent National Accoustics Laboratory research has found that this is not always true for people with severe hearing impairments. When sounds of certain frequencies are amplified to audible levels, this may not improve speech understanding as much as would be expected and, for some people, it may even reduce speech understanding. This finding is very important for deciding how to design and fit **hearing aids for severely hearing-impaired people.** It is of special significance for the fitting of hearing aids to hearing-impaired children, many of whom have hearing losses that are severe at some or all frequencies in the range that is important for understanding speech.

- in space

- An international consortium of mining companies and Government Geological Surveys has been formed to investigate the feasibility of **launching the world's first satellite-based imaging spectrometer,** ARIES-1. The project is a joint effort between CSIRO, Auspace Ltd, and the Australian Centre for Remote Sensing with support from Earth Resource Mapping Pty Ltd, Geoimage Pty Ltd and Technical and Field Surveys Pty Ltd.

Significant statements, reviews and reports

Over the past year, a number of statements, reviews and reports dealing with major issues relating to innovation, science and technology have been published. These are listed below. Annual reports are not included in the list.

Industry, Science and Tourism Portfolio

- Minister for Industry, Science and Technology
  - *Science and Technology Budget Statements* 1996-97 and 1997-98
- Prime Minister's Science and Engineering Council
  - *Managing Australia's Inland Waters,* September 1996
  - *Key Issues in Australian Science, Technology and Engineering,* September 1996
- Australian Science and Technology Council
  - *Developing long-term Strategies for Science and Technology in Australia,* October 1996.
  - *Australian Maritime Industries: Priorities in Science and Technology,* September 1996.
  - *Technology Foresight: The ASTEC's Shipping Partnership Experience with the Delphi Survey,* Lance Schultz, ASTEC Occasional Paper No. 29, February 1997.
  - *Discussion Paper: Study on Primary School Science and Technology,* November 1996.
- Department of Industry, Science and Tourism
  - *Australian Science and Technology at a Glance 1997.*
- Commonwealth Scientific and Industrial Research Organisation (CSIRO)
  - *CSIRO Operational Plan 1996-97.*
  - *CSIRO Data Book 1997.*
  - *Strategic Research Directions for the Funding Triennium 1997-98 to 1999-2000.*
  - *Technology Transfer Through Spinoff Companies:* CSIRO - 1985 to 1995.
- Australian Institute of Marine Science
  - *1996-1997 Research Plan.*
  - *Western Australian Research Activities 1994-1996.*
  - *— Strategic Directions.*
- Genetic Manipulation Advisory Committee (GMAC)
  - *Guidelines for the Planned Release of Genetically Manipulated Organisms.*
  - *Safety Practices in PC2 Laboratories.*
  - *Biotechnology Information Series,* reprint of series produced by Iowa State University of Science and Technology.

Employment, Education, Training and Youth Affairs Portfolio

- Department of Employment, Education, Training and Youth Affairs
  - *Higher Education Funding Report for the 1997-98 Triennium,* January 1997
  - *Report on Research Funding Programs 1996 Volume 1 - Introduction and Summary Tables, 1996*
  - *Report on Research Funding-Programs 1996 Volume 2 - Grants and Fellowships Awarded, 1996*

- M. Baker, F. Robertson and H. Toguchi, *The Australian Postgraduate Research Awards Scheme: An Evaluation of the 1990 Cohort*, AGPS, May 1997
- E. Deane, L. Johnson, G.Jones and N. Lengkeek, *Women, Research and Research Productivity in the Post-1987 Universities: Opportunities and Constraints*, December 1996

- National Board of Employment, Education and Training
  - *Patterns of Research Activity in Australian Universities: Phase 1: Final Report, Commissioned Report No.74*
  - *Determining Measures of the Quality and Impact of Journals*, Commissioned Report No.49, July 1996
  - *ARC News*, August 1996
  - *Waiting in the Wings: A Study of Early Career Academic Researchers in Australia*, Commissioned Report No.50, September 1996
  - *Performance-based Funding of Universities*, Commissioned Report No.51, November 1996
  - *The Peer Review Process*, Commissioned report No.54, January 1997

Environment, Sport and Territories Portfolio

- Bureau of Meteorology
  - *Capturing Opportunities in the Provision of Meteorological Services*, January 1997.
  - *Research in BMRC*, July 1996.
  - *A Symposium on Climate Prediction and Predictability: papers presented at the Eighth Modelling Workshop*, February 1997.

- Great Barrier Reef Marine Park Authority
  - *Review of the Crown-of-thorns Starfish Research Committee Program, 1996.* Research Publication No. 39.1996, B. Lassig, P. Moran, T. Ayukai, U. Engelhardt, GBRMPA, Townsville. ISBN 0 642 23000 5.
  - *Historical nutrient usage in coastal Queensland river catchments adjacent to the Great Barrier Reef Marine Park, 1996.* Research Publication No. 40.
  - *The Status of the Dugong in the Southern Great Barrier Reef Marine Park,* Research Publication No. 41.
  - *Standard Operational Procedure: Video-monitoring of sessile benthic communities,* D. Wachenfeld, Research Publication No. 42.
  - *Cyclone Sadie Flood Plumes in the Great Barrier Reef Lagoon: Composition and Consequences:* Proceedings of a workshop held in Townsville, Australia, 10 November, 1994, Workshop Series No. 22.
  - *The Great Barrier Reef: Science, Use and Management, A National Conference Proceedings*, Volume 1. Proceedings of the conference held on 25-29 November 1996 at James Cook University of North Queensland.
  - *Trace Metals in Sediments, Indicator Organisms and Traditional Seafoods of the Torres Strait, 1996*, Commonwealth Coastal Action Program Report Series 5a.

- Environment Protection Group
  - *Foundations for the Future II: Australia's National Greenhouse Research Program - A Strategy for Action 1996 - 2001*, National Greenhouse Advisory Committee, March 1996.

- Biodiversity Group
  - *Reimbursing the Future - an evaluation of motivational, voluntary, price-based, property-right, and regulatory incentives for the conservation of biodiversity (Parts 1 and 2)*, Paper No. 9 in the Biodiversity Series.

- *Approaches to Bioregional Planning (Parts 1 and 2)*, Paper No. 10 in the Biodiversity Series.

- National Greenhouse Research Program
  - *National Greenhouse Gas Inventories*, 1988-1994.
  - *Workbooks for the National Greenhouse Gas Inventory.*
  - *National Greenhouse Gas Inventory Summary and Analysis of Trends.*
  - *Future Change in Australia's Rangelands*, Joint DEST, CSIRO and GCTE publication.

Primary Industries and Energy Portfolio

- Bureau of Resource Sciences
  - *National Forest Inventory. 'National Plantation Inventory of Australia' 1997.*
  - *Vegetation Classification and Mapping Systems for Australian Forest Management.* Bureau of Resource Sciences/ Australian Nature Conservation Agency, Canberra. 1996.
  - *Indicators of Drought Exceptional Circumstances 1997*
  - *Projections of Greenhouse Gas Emissions from the Australian Agriculture Sector to the Year 2020*. Report to the Department of the Environment, Sports and Territories, 1997.
  - *Projections of Greenhouse Gas Emissions from the Australian Agriculture Sector to the Year 2020. Combinations and Permutations.* Report to the Department of the Environment, Sports and Territories, 1997.
  - *Projections of Greenhouse Gas Emissions from the Australian Forest Sector to the Year 2020*. Report to the Department of the Environment, Sports and Territories 1997.

Health and Family Services Portfolio

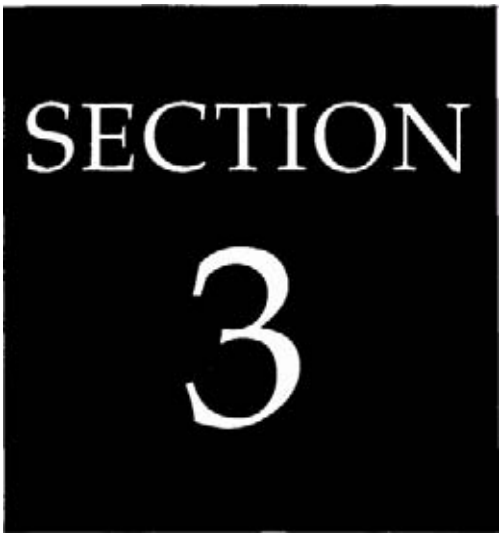
- Australian Radiation Laboratory
  - *ARL Technical Report into radon levels in Australian tourist caves.*

- National Health and Medical Research Council
  - *NHMRC Grants 1996, Accompanies NHMRC Annual Report 1995.*
  - *Researching for health 1996: Advancing Australian health and medical research into the 21st century, 1996.*
  - *Report of the 1996 Evaluation of NHMRC, December 1996.*
  - *Research Infrastructure and Capital Works for Health and Medical Research*, September 1996(discussion document).
  - *Primary Prevention of Skin Cancer in Australia.*

- Australian Health Technology Advisory Committee (AHTAC)
  - *Superspeciality service guidelines for adult heart transplant.*

Treasury Portfolio

- Australian Bureau of Statistics (ABS)
  - *Research and Experimental Development, Higher Education, Australia 1994*, Bulletin 8111.0,28 October, 1996
  - *Research and Experimental Development, All-Sector Summary, Australia 1994-95*, Bulletin 8112.0,12 November, 1996
  - *Research and Experimental Development, Higher Education, Australia 1995*, Bulletin 8111.0,2 May 1997



Science and Innovation in the Budget

Australia's national R&D expenditure

Table 1 provides a broad outline of recent data on R&D expenditure in Australia, based on surveys by the Australian Bureau of Statistics (ABS). The most recent data showed that Australia's gross expenditure on R&D (GERD) stood at $7321 million in 1994-95, corresponding to 1.61 per cent of gross domestic product (GDP). Broadly, about 46 per cent of Australia's R&D expenditure, corresponding to 0.74 per cent of GDP, was undertaken within business enterprises in that year.

TABLE 1 Australia's expenditure on R&D, *by* sector *of* performance, 1990-91 to 1994-95

	1990-91			1991-92			1992-93			1993-94			1994-95		
Sector of performance	$m	%GDP	%real annual increase	$m	%GDP	%real annual increase	$m	%GDP	% real annual increase	$m	%GDP	% real annual increase	$m	%GDP	%real annual increase
Business	2100	0.55	0.6	2360	0.61	9.9	2855	0.70	17.4	3069	0.72	5.0	3383	0.74	9.6
- private	1896	0.50	0.5	2144	0.55	10.5	2610	0.64	18.0	2836	0.66	6.0	3051	0.67	6.8
- public	204	0.05	2.0	216	0.06	3.8	245	0.06	11.4	233	0.05	-5.8	332	0.07	43.7
Government	1704	0.45	6.6	na	na		1819	0.45	-0.9	na	na		1965	0.43	2.7
- Cwlth	1034	0.27	4.0	na	na		1151	0.28	0.6	na	na		1178	0.26	0.0
- State	670	0.18	11.0	na	na		668	0.16	-3.3	na	na		786	0.17	7.3
Higher educ.	1333	0.35	6.1	na	na		1695	0.43	10.7	na	na		1830	0.41	1.3
Priv non prof.	85	0.02	18.8	na	na		101	0.02	5.0	na	na		144	0.03	18.7
TOTAL	5222	1.38	4.5	na	na		6470	1.59	8.2	na	na		7321	1.61	4.6

Source: DIST based on ABS data.

**New data are expected by October 1996*

The other principal R&D sectors include higher education, where 25 per cent of R&D expenditure (0.41 per cent of GDP) was undertaken, and Commonwealth agencies, which accounted for 16 per cent of R&D expenditure and 0.26 per cent of GDP.

At 1.61 per cent of GDP, GERD in 1994-95 stood at an all time high and had increased dramatically from 1.38 per cent in 1990-91 and 1.26 per cent in 1988-89. The substantial increases in GERD since 1988-89 reflect substantial increases in the level of R&D in the business sector. The other component of the increases in GERD has been an increase in R&D expenditure in universities. This has been funded through a range of measures over the years, including increased support for postgraduate research awards and other research in the higher education sector and establishment of the Cooperative Research Centres Program. There has also been additional funding for medical R&D.

Further background on Australian science and technology is provided in the box of 'key facts' on page 4.2.

Commonwealth support for R&D in a national perspective

As is seen from Table 1, Commonwealth agencies are significant performers of R&D, but undertake only 16 per cent of total R&D expenditure. As a funding source, however, the Commonwealth Government provides about 40 per cent of R&D funds directly, and has provided another 12 per cent through the indirect means of the R&D tax concession. Derived from ABS survey data, Figure 3 provides a schematic picture of the Commonwealth's activity in the national R&D context and its relative size and interactions compared with other elements of the system.

While the ABS surveys provide the definitive data on Australian R&D expenditure, they cannot be directly related to Government programs. However, a data series has been derived which draws on Budget and other information relating to major Commonwealth research agencies and programs supporting research-related activities. These 'science and innovation' data (named so as to distinguish them from ABS R&D data) are described below.

Commonwealth support for science and innovation through major programs

Commonwealth support for major science and innovation programs has increased from $3508 million in 1996-97 to an estimated $3551 million in 1997-98, a decrease in real terms of 1.3 per cent. Broadly, support generally increased over the period from 1986-87 to 1995-96, with revenue forgone from the Industrial R&D Tax Concession Scheme providing particular stimulus from the mid-1980s. Omitting this, the rise in total Commonwealth support results from increased R&D support to the higher education sector coupled with a steady rise in amounts disbursed through the various granting schemes, including the introduction of the Cooperative Research Centres Program.

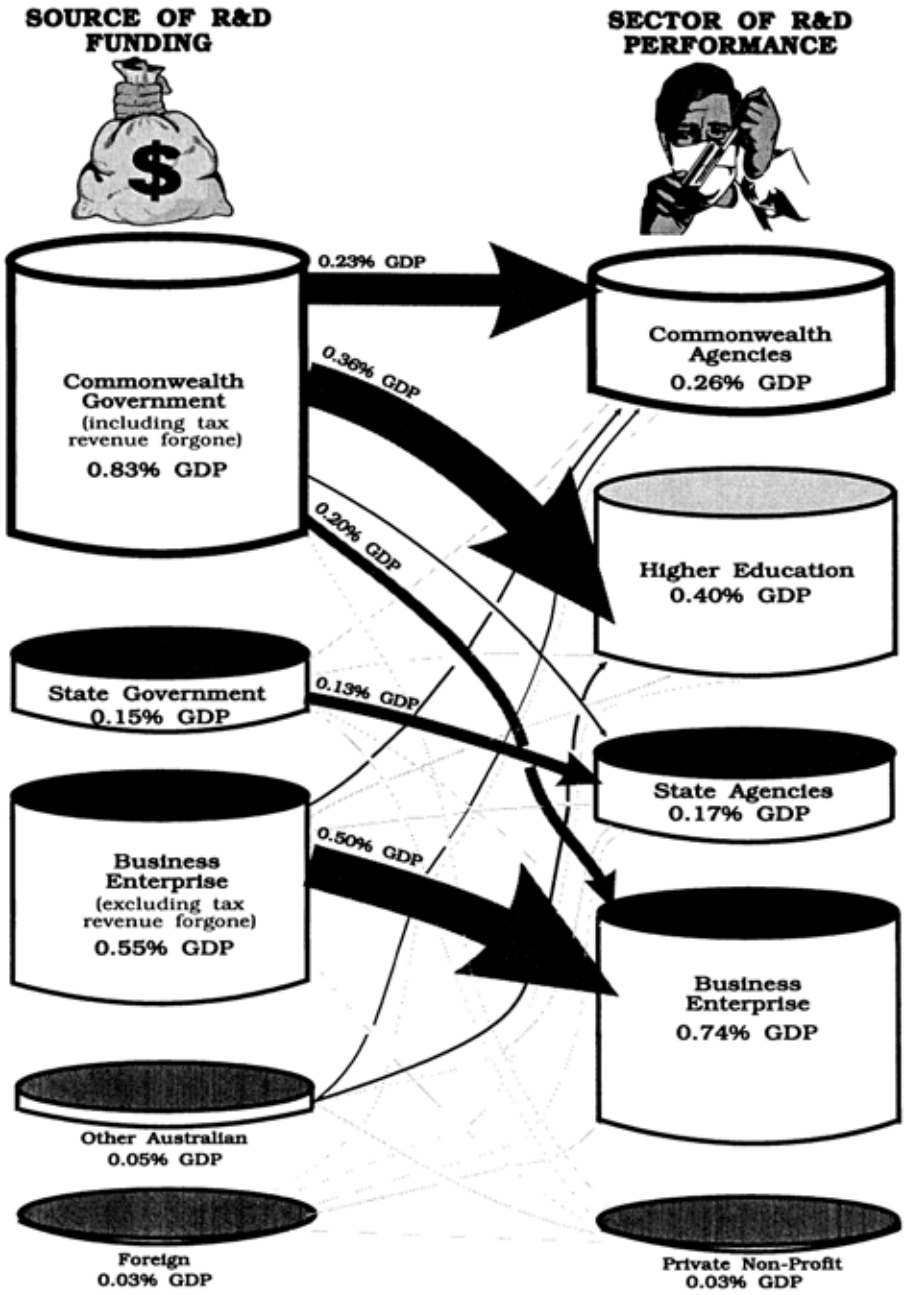
The small real decrease in 1997-98 results from the full year effect of the reduction in the rate of the Tax Concession Scheme, from 150 to 125 per cent, and some other changes in the application of the scheme that were outlined in last year's *Statement.* If the indirect support through the Tax Concession Scheme is omitted, direct Commonwealth support for major programs of science and innovation can be seen to have increased in 1997-98 by 0.8 per cent in real terms to $3265 million.

Figure 4 and Table 2 present a summary of Commonwealth support for science and innovation at constant price values. They provide a four-way breakdown of the data as follows :

- higher education research
- R&D in Commonwealth agencies
- special purpose or directed research grant schemes
- industry incentives through tax concessions.

Figure 3

COMMONWEALTH R&D SUPPORT IN A NATIONAL PERSPECTIVE



The figure illustrates major flows of funding support between sectors, based on updated 1994-95 data. It places Commonwealth funding of R&D in a national perspective.

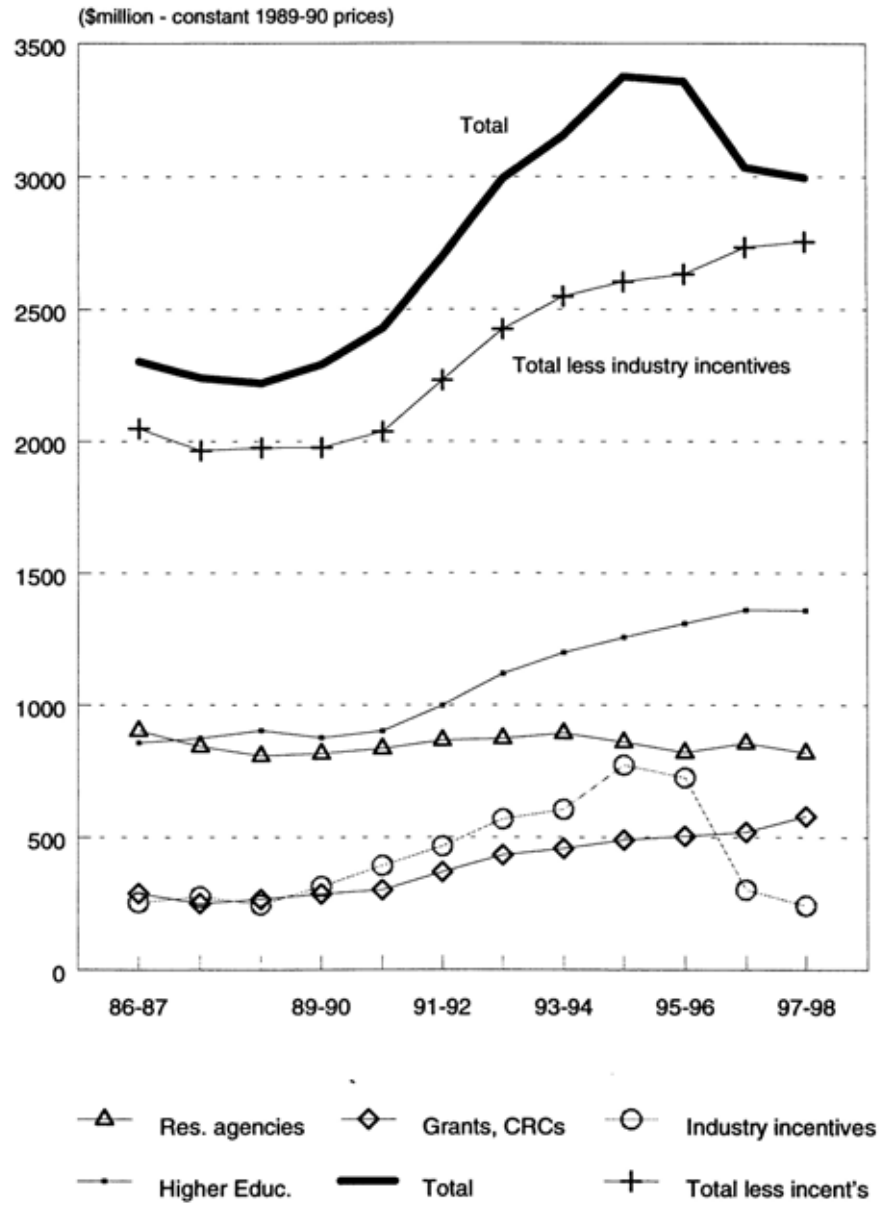
TABLE 2 Constant Price Summary *of* Major Commonwealth Support for Science and Innovation, through the Budget and Other Measures ($m at constant 1989-90 prices)

	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	(est) 1996-97	(est) 1997-98
MAJOR SCIENTIFIC RESEARCH AGENCIES												
• Defence	235.7	225.3	232.9	235.0	227.6	228.5	224.9	247.7	225.0	236.6	230.8	200.7
• Civil	667.1	616.8	573.9	580.7	607.2	637.4	647.9	645.5	634.4	583.4	623.8	617.9
SUB-TOTAL	902.8	842.1	806.8	815.7	834.7	865.8	872.8	893.2	859.4	819.9	854.6	818.6
SCIENCE AND INNOVATION GRANTS												
• Health and Medical	79.7	80.5	81.8	89.9	104.2	118.7	123.6	131.3	138.0	144.2	141.9	148.4
• Industry and space	109.5	90.6	91.4	92.8	94.2	122.1	143.3	114.2	118.8	111.0	125.1	169.5
• Cooperative Research Centres	-	-	-	-	-	17.2	42.2	83.6	94.3	117.4	122.8	123.4
• Rural	78.6	62.7	77.6	82.0	78.9	89.0	102.9	107.9	118.7	111.9	117.5	122.7
• Energy and environment	17.6	13.0	12.4	18.5	21.8	18.8	18.5	17.6	17.3	17.4	9.8	12.5
• Transport	2.5	2.3	2.1	2.0	2.1	2.1	2.0	2.0	2.0	1.9	1.7	1.7
SUB-TOTAL	287.9	249.1	265.4	285.2	301.3	367.9	432.5	456.7	489.1	503.7	518.8	578.2
COSTS OF IR&D & RELATED INCENTIVES	253.7	274.8	244.7	314.0	392.5	465.6	568.0	605.2	771.8	725.0	301.0	241.4
HIGHER EDUCATION RESEARCH												
• ARC and related grant schemes	80.1	83.2	89.9	124.4	175.1	230.3	245.0	272.5	281.6	308.9	345.0	363.2
• Specific R&D support	119.5	115.5	114.9	122.0	128.6	133.1	134.8	134.9	134.2	132.5	131.6	129.1
• Est. general research support	657.6	674.4	697.9	629.0	596.9	634.3	739.3	791.5	840.0	867.4	883.2	865.8
SUB-TOTAL	857.2	873.0	902.7	875.4	900.7	997.7	1119.1	1198.9	1255.8	1308.8	1359.8	1358.1
TOTAL COMMONWEALTH SUPPORT AT ESTIMATED 89-90 PRICES	**2302**	**2239**	**2220**	**2290**	**2429**	**2697**	**2992**	**3154**	**3376**	**3357**	**3034**	**2996**
EST. REAL % INCREASE/DECREASE		-2.7	-0.9	3.2	6.1	11.0	11.0	5.4	7.0	-0.6	-9.6	-1.3

SOURCE Based on data in Table 3 and using GDP non-farm deflators.

Figure 4

MAJOR COMMONWEALTH SUPPORT FOR SCIENCE AND INNOVATION



Source: see Table 2

– *Higher Education Research*

Support for research in the higher education sector (excluding support from special purpose grant schemes) is estimated to increase to $1609 million in 1997-98 from $1572 million in 1996-97, effectively constant in real terms.

The higher education sector is supported through general or nondirected research funds (in fact, the research component of funds which are provided for both teaching and research purposes), funds provided specifically for research, and research funds under the control of the Australian Research Council (ARC). Only funds provided specifically for higher education are considered here. (A significant proportion of the funds provided under special purpose grant schemes also flow to higher education).

The natural sciences and engineering represent about 70 per cent of all higher education research activity supported through all the above means, with the balance being research in the social sciences and humanities.

– *Research in Commonwealth Agencies*

The largest Commonwealth research agencies are CSIRO, DSTO, ANSTO, AGSO, Antarctic Division and AIMS. Support through Budget appropriations to these agencies, and some smaller ones, is expected to be $970 million in 1997-98, compared with $988 million in 1996-97, a decrease of 4 per cent mostly due to the completion of capital works associated with major stages of a new building for AGSO.

It is important to note that the research agencies receive funds in addition to those appropriated directly and that these sums are not included in the amounts referred to above. Such external funding has increased significantly in recent years. For example, CSIRO receives business funding, funds from earned revenue (from licencing fees, disposal of assets etc.) and additional Commonwealth support won competitively via the special purpose grant schemes. To encourage improved links with industry, the Government has set a target for external earnings (ie, funds from other than its direct Budget appropriations) of 30 per cent of total funding. Direct appropriations to CSIRO for 1997-98 are expected to amount to $467 million (with a further $6 million through DPIE, see Table 4), but the total income of the Organisation is expected to be in the region of $740 million.

– *Special Purpose Research Grant Schemes*

Support for R&D through the special purpose research grant schemes is estimated to increase to $685 million in 1997-98 from $600 million in 1996-97, representing a real increase of 11 per cent.

The Commonwealth has established a number of research grant schemes which are directed to special areas of interest - health and medical research (NH&MRC), rural research (RIRFs and other rural), industrial R&D (R&D Start and its predecessors), energy R&D, and some smaller ones. The Cooperative Research Centres, established for the purpose of promoting linkages, are also included in this category.

– *Tax Incentive Scheme - Industrial R&D and Innovation*

Estimated support for R&D and innovation in the business sector through the industrial R&D tax concession is estimated be $286 million in 1997-98 ($348 million in 1996-97), down 20 per cent in real terms. This is an estimated outcome from the change in the rate of the tax concession, from 150 per cent to 125 per cent, part way through 1996-97 and some other changes in the application of the concession.

The industrial component of special purpose grants will increase substantially to $201 million from $145 million in 1996-97, a real increase of 35 per cent in direct support for R&D and innovation in the business sector.

Changes in the balance of funding

Figure 5, expressed as a percentage of GDP, provides an alternative view to Figure 4. In addition, funding of both civil and defence research agencies is shown and higher education funding is split between specific R&D funding and the research and research training component of the general operating grant for universities (GOG).

Looking at the broad changes apparent in Figures 4 and 5, Budget funding for the research agencies has remained approximately static in real terms over the period from 1986-87 to 1997-98. Over the same period, the special purpose schemes have increased significantly.

The significant increases in funding in the higher education sector have been accompanied by a substantial change in arrangements so that the proportion of funds allocated on the advice of the ARC is now much higher than in the mid-1980s. Total funds have increased overall in parallel with this substantial change in the funding mechanisms.

The 1988-89 dip in total funding levels is traceable mainly to a real fall in the level of Budget funding for Commonwealth research agencies, since offset by increases in external funding. Such non-Commonwealth funding is not shown in Figures 4 and 5. The fall in 1993-94, visible in Figure 5, was due to the one-off payment in 1992-93 to initiate the Australian Technology Group Pty Ltd, and the decrease in the corporate tax rate (from 39 to 33 cents in the dollar) which reduced the tax revenue forgone from the industrial R&D tax concession. The decline after 1995-96 has been due to the change in the rate of the tax concession from 150 to 125 per cent and the other changes referred to above.

Detailed data

Table 3 is the current price summary corresponding to Table 2. It summarises the data from Tables 4,5 and 6.

For the most part, the data series in Tables 4 and 5 comprise well-defined expenditures which can be readily identified from the Budget Papers. However, Table 6 presents a less clear-cut situation for the two largest items. The first of these is the estimated research component of the general Commonwealth funding for universities. This includes support for teaching activities as well as for research and the research component can only be estimated on the basis of the ABS R&D surveys. Since there were no ABS surveys in some earlier years, and survey results will not be available for some time in relation to the latest years shown, the effect of adding this series to others, as in Table 3, is to blur the assessment of overall trends. See the footnotes to Table 6.

A further blurring results from the inclusion of the estimated costs of Commonwealth revenue forgone through the taxation concession scheme for industrial R&D. As already indicated, the amounts shown are *estimates* only. (See footnote (5) to Table 6.) There are significant revisions to some historical data in this table. These may be subject to further revision as better estimates of claims against the concession in past years become available, and as outcomes of the very recent changes to the concession are seen.

Budget-based science and innovation data and ABS R&D

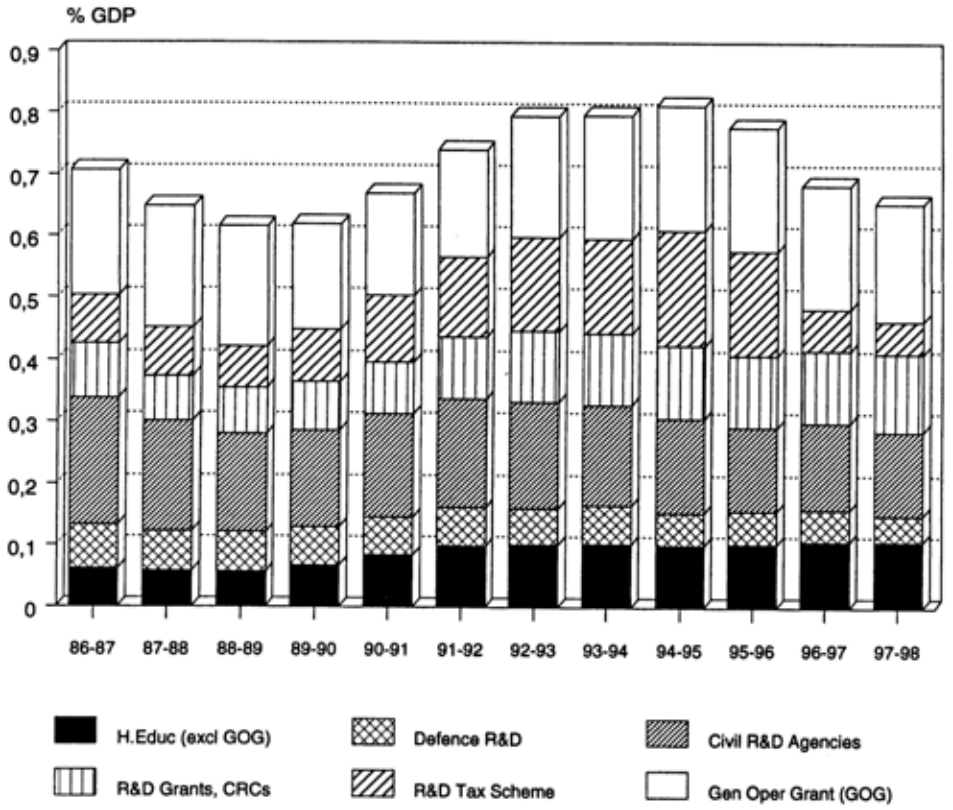
Over the past three decades there has been considerable international effort to reach agreed definitions of R&D. The resulting definitions have been applied with some rigour in periodic surveys conducted within most OECD countries. This so-called 'Frascati' methodology has been applied in Australia since 1969 when the national R&D surveys, now conducted regularly by the Australian Bureau of Statistics (ABS), were introduced.

The results from the R&D surveys have been essential in establishing benchmarks and time series in various expenditure and workforce indicators related to the Australian research effort.

At the same time, commentators have frequently sought to use data taken from the Budget papers to formulate views on the adequacy of Commonwealth support for research and the implications of this for science and technology policy. The data series presented in this Section has been developed to meet that need. For this reason, data presented here will not exactly match the R&D aggregates reported in ABS surveys. The practice followed here of listing whole agencies and programs as defined for administrative and financial purposes inevitably leads to the partial inclusion of non-R&D activities. In addition, there is a significant amount of R&D funded through agencies and programs not listed. Nevertheless, there are broad similarities between trends in what is described here as 'science and innovation' and R&D expenditures as reported by ABS.

Figure 5

MAJOR COMMONWEALTH SUPPORT FOR SCIENCE AND INNOVATION AS A PERCENTAGE OF GDP

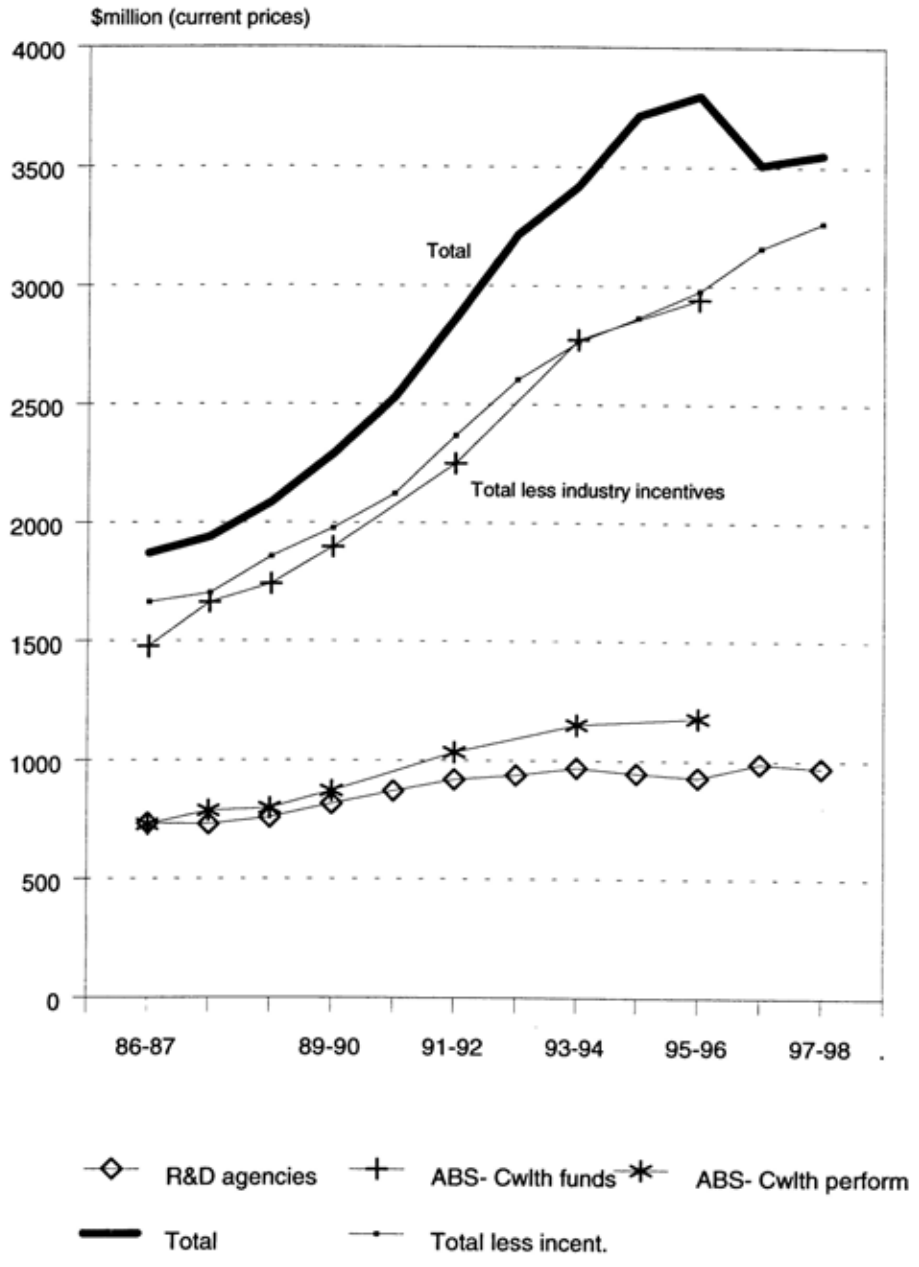


Source: *See Table 2 and ABS 5206.0*

Figure 6 shows the comparison between the 'science and innovation' series presented in this Section and ABS (Frascati) R&D. The total appropriation income of the research agencies shows a small but increasing deviation from ABS R&D performance data. The discrepancy which occurs can be explained largely in terms of CSIRO's external income. (ABS R&D performance data for the agencies includes expenditure from all sources of funds. The series based on Table 3 shows only directly appropriated Commonwealth funding.)

Figure 6

BUDGET-BASED DATA AND ABS R&D



Source: DIST and ABS

TABLE 3 Summary of Major Commonwealth Support for Science and Innovation, through the Budget and Other Measures ($m)

	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97 (est)	1997-98 (est)
MAJOR SCIENTIFIC RESEARCH AGENCIES												
• Defence	191.4	195.1	219.0	235.0	237.1	242.4	241.5	268.5	247.4	267.6	266.9	237.8
• Civil	541.7	534.1	539.5	580.7	632.7	676.2	695.9	699.7	697.9	659.8	721.1	732.2
SUB-TOTAL	733.1	729.3	758.4	815.7	869.8	918.6	937.4	968.2	945.3	927.4	988.0	970.0
SCIENCE AND INNOVATION GRANTS												
• Health and Medical	64.7	69.7	76.9	89.9	108.6	125.9	132.7	142.4	151.8	163.0	164.0	175.8
• Industry and space	88.9	78.4	85.9	92.8	98.2	129.6	153.9	123.8	130.7	125.5	144.6	200.9
• Cooperative Research Centres						18.2	45.3	90.6	103.7	132.7	141.9	146.2
• Rural	63.8	54.3	73.0	82.0	82.2	94.5	110.5	117.0	130.5	126.5	135.8	145.4
• Energy and environment	14.3	11.3	11.7	18.5	22.8	19.9	19.9	19.1	19.1	19.6	11.4	14.8
• Transport	2.0	2.0	2.0	2.0	2.2	2.2	2.2	2.2	2.2	2.2	2.0	2.0
SUB-TOTAL	233.8	215.7	249.4	285.2	313.9	390.3	464.6	495.0	538.0	569.7	599.8	685.1
COSTS OF IR&D & RELATED INCENTIVES	206	238	230	314	409	494	610	656	849	820	348	286
HIGHER EDUCATION RESEARCH												
• ARC and related grant schemes	65.0	72.0	84.5	124.4	182.5	244.3	263.1	295.4	309.8	349.3	398.9	430.4
• Specific R&D support	97.0	100.0	108.0	122.0	134.0	141.2	144.8	146.3	147.6	149.9	152.1	153.0
• Est. general research support	534.0	584.0	656.0	629.0	622.0	673.0	794.0	858.0	924.0	981.0	1021.0	1026.0
SUB-TOTAL	696.0	756.0	848.5	875.4	938.5	1058.5	1201.9	1299.7	1381.3	1480.2	1572.0	1609.4
TOTAL COMMONWEALTH SUPPORT	**1869**	**1939**	**2086**	**2290**	**2531**	**2861**	**3214**	**3419**	**3714**	**3797**	**3508**	**3551**
% GDP	0.706	0.648	0.615	0.619	0.668	0.739	0.794	0.795	0.811	0.777	0.682	0.652
TOTAL COMMONWEALTH SUPPORT AT ESTIMATED 1989-90 PRICES	**2302**	**2239**	**2220**	**2290**	**2429**	**2697**	**2992**	**3154**	**3376**	**3357**	**3034**	**2996**
EST. REAL % INCREASE/DECREASE		-2.7	-0.9	3.2	6.1	11.0	11.0	5.4	7.0	-0.6	-9.6	-1.3

SOURCE See Tables 4, 5 and 6

TABLE 4 Major Commonwealth Research Agencies - Budget Outlays ($m)

	Outlays										(est.)	(est.)
	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	199798
THE ENVIRONMENT, SPORT & TERRITORIES												
Antarctic Division	47.4	49.2	46.3	57.7	62.8	67.3	65.4	61.0	61.3	63.1	60.1	61.3
Bureau of Meteorology Research Centre (BMRC)	2.3	2.5	2.2	2.4	2.8	3.3	3.3	3.6	3.6	4.0	4.2	4.6
Supervising Scientist - including ERISS	6.1	6.0	6.6	7.6	6.7	7.5	7.6	6.6	6.5	6.0	5.4	5.3
DEFENCE												
Defence Science and Technology Organisation[1]	191.4	195.1	219.0	235.0	237.1	242.4	241.5	268.5	247.4	267.6	266.9	237.8
EMPLOYMENT, EDUCATION, TRAINING & YOUTH AFFAIRS												
Anglo-Aust Telescope	2.0	2.4	2.5	2.7	2.9	3.0	3.1	3.1	3.0	3.2	3.3	3.5
HEALTH & FAMILY SERVICES												
Australian List, of Health & Welfare (excl. grants)	5.2	3.4	4.2	4.4	4.2	5.0	6.8	7.2	8.1	7.1	7.6	7.7
CSL Ltd (Budget component)	15.8	17.3	16.6	9.4	3.0	4.2	8.2	17.0	4.3	2.8	2.9	3.0
Nuclear Safety Bureau	-	-	-	-	-	-	0.8	0.8	0.8	0.9	0.9	0.9
INDUSTRY, SCIENCE & TOURISM												
Aust Nuclear Science & Technology Organisation	45.2	50.8	54.3	57.5	62.6	64.3	68.2	64.2	66.2	65.6	63.7	70.4
Australian Institute of Marine Science	8.2	9.5	11.0	11.4	13.6	14.2	14.2	16.9	16.5	16.6	16.4	16.4
CSIRO	367.8	347.8	348.1	375.2	414.4	446.3	456.2	460.4	460.8	416.7	433.1	466.8
Kraft Pulp Mill study (CSIRO)	-	-	-	0.5	1.4	1.9	1.9	1.9	-	-	-	-
PRIMARY INDUSTRIES & ENERGY												
Contribution to CSIRO for Aust Animal Health Labs	4.4	4.7	4.7	4.9	5.3	5.5	6.0	5.9	6.2	5.8	6.0	6.1
AGSO (note capital works in 96-97 & 97-98)	37.4	40.6	42.9	47.0	52.9	52.9	54.2	50.9	60.5	68.0	117.4	86.2
TOTAL	**733.1**	**729.3**	**758.4**	**815.7**	**869.8**	**918.6**	**937.4**	**968.2**	**945.3**	**927.4**	**988.0**	**970.0**

(1) DSTO expenditure shown here includes overhead components attributable to other Defence appropriations, such as salaries for service personnel, FBT and some superannuation. These have been added to the DSTO figures published in the Budget Papers. Prior to 1994-95, the data also include computer services. For the 1996-97 financial year, DSTO funding includes an additional one-off appropriation provided for the costs of voluntary redundancy packages and relating to a redirection of administrative savings.

TABLE 5 Major R&D Granting Programs and other Support for Science and Innovation through the Budget ($m)

						Outlays					(est.)	(est.)
	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98
THE ENVIRONMENT, SPORT & TERRITORIES												
Aust Biological Resources Study	1.0	1.1	1.3	1.6	1.2	2.0	2.3	2.3	2.0	1.8	1.3	1.0
Greenhouse research (NGRP)	-	-	0.8	5.7	5.7	6.1	6.0	5.8	6.0	6.0	3.5	3.6
EMPLOYMENT, EDUCATION, TRAINING & YOUTH AFFAIRS												
Research evaluation and Academies	-	-	-	-	1.6	2.0	2.0	2.0	2.1	2.1	2.2	2.2
ARGS & ARC grants/fellowships (including marine R&D grants) [1]	39.8	42.7	50.7	35.6	1.2	-	-	-	-	-	-	-
Post-graduate Awards[1]	19.3	20.3	21.7	11.3	-	-	-	-	-	-	-	-
Targeted Institutional Links Program	-	-	-	0.2	1.0	2.0	1.1	1.4	1.4	0.8	0.5	1.2
HEALTH & FAMILY SERVICES												
AIDS Research	1.5	3.0	3.5	5.0	7.1	10.8	10.5	11.6	12.1	12.1	11.7	12.0
NH&MRC Research Grants[2]	61.7	66.7	73.4	84.9	96.5	105.1	112.2	120.8	126.7	141.3	150.3	156.4
Capital Works for Medical Institutes	1.6	-	-	-	5.0	10.0	10.0	10.0	13.0	9.6	2.0	7.4
INDUSTRY, SCIENCE & TOURISM												
R&D Start	-	-	-	-	-	-	-	-	-	-	68.5	164.3
Industry Innovation Program grants	-	-	-	-	-	-	43.5	40.3	46.9	52.4	-	-
Advanced Manufacturing Tech Program	-	-	-	-	-	0.1	-	-	-	-	-	-
Technology Development Program	1.2	1.4	1.1	1.9	3.0	3.2	-	-	-	-	-	-
National Procurement Development Program (NPDP)	-	0.7	3.9	5.6	4.2	4.4	-	-	-	-	-	-
IR&D Act 1986 (GIRD)	10.8	25.6	31.8	32.0	29.6	32.2	-	-	-	-	-	-
IR&D Incentives Act 1976												
. Commencement grants	16.9	3.1	0.1	-	-	-	-	-	-	-	-	-
. Project grants	17.9	6.4	2.8	0.3	-	-	-	-	-	-	-	-
. Public interest projects	3.5	1.0	0.3	-	-	-	-	-	-	-	-	-
Australian Technology Group Pty Ltd	-	-	-	-	-	-	30.0	-	-	-	-	-
Cooperative Research Centre Grants	-	-	-	-	-	18.2	45.3	90.6	103.7	132.7	141.9	146.2
National Research Facilities	-	-	-	-	-	-	-	-	-	6.4	17.0	16.3

TABLE 5 Major R&D Granting Programs and other Support for Science and Innovation through the Budget ($m) — *continued*

	Outlays										(est.)	(est.)
	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98
Malaria Vaccine Joint Venture	0.4	0.8	1.2	0.8	2.3	9.4	-	-	-	-	-	-
Research associations[3]	2.0	2.0	-	-	-	-	-	-	-	-	-	-
Motor Vehicle R&D	11.6	8.4	8.3	4.7	2.3	-	-	-	-	-	-	-
Assistance under the Bounty[4] (Computers) Act 1984	19.4	25.7	31.1	45.0	51.3	74.5	75.0	78.0	74.8	64.1	56.5	19.5
National Space Program	5.0	3.2	5.4	2.4	5.5	5.7	5.4	5.4	9.0	2.7	2.7	0.7
PRIMARY INDUSTRIES & ENERGY[5]												
Wool Research	14.4	12.1	21.7	20.8	11.7	13.8	13.2	12.0	15.1	11.7	12.6	13.5
Meat Research	8.4	8.6	11.9	13.8	13.6	20.8	22.9	22.1	25.1	22.6	22.3	23.8
Fishing Industry Research	6.2	6.2	5.4	8.1	8.4	6.6	7.5	8.5	9.2	10.4	11.7	7.8
Grains	17.9	11.2	11.1	13.3	14.4	14.8	15.7	21.2	23.3	21.3	29.1	33.0
Horticulture Research	-	-	0.6	1.2	3.1	4.4	8.3	9.6	10.7	11.4	14.8	14.9
Energy research	13.3	10.2	9.6	11.2	15.9	11.8	11.6	11.0	11.1	11.8	6.6	10.2
Land & Water research	4.9	7.8	10.4	9.9	13.3	13.3	13.7	11.8	11.3	10.6	9.8	10.9
Rural Industries R&D Corporation	1.5	3.0	4.0	5.0	6.0	8.4	10.5	10.5	10.5	10.5	5.6	10.8
Other rural research	10.6	5.5	8.0	10.1	11.7	12.4	18.8	21.3	25.5	28.0	29.9	30.6
TRANSPORT & REGIONAL DEVELOPMENT												
Payments to Australian Road Research Board	2.0	2.0	2.0	2.0	2.2	2.2	2.2	2.2	2.2	2.2	2.0	2.0
TOTAL	**292.8**	**278.8**	**321.9**	**332.2**	**317.7**	**394.4**	**467.7**	**498.4**	**541.5**	**572.6**	**602.5**	**688.5**

FOOTNOTES TO TABLE 5

(1) From 1989-90 most ARC funding has been appropriated through the *Higher Education Funding Act* rather than the Budget. See Table 6.

(2) Includes funding for health and community services research grants.

(3) Since 1988-89 the Associations have been fully funded by industry.

(4) Assistance is provided for local manufacturers of computer hardware, systems software and electronic microcircuits. It covers design and development costs.

FOOTNOTES TO TABLE 5 - *continued*

(5) For consistency, the expenditure figures for Wool, Meat, Other Rural Research, Fish, Horticulture and Grains exclude that component of Commonwealth outlays funded from industry levies. The component of outlays provided by way of industry levy or contribution is given in the following table .

INDUSTRY CONTRIBUTION
(estimated proportion of levies attributable to research purposes - $m)

	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97 est.	1997-98 est
Wool	15.25	18.31	14.21	19.63	17.11	14.05	12.32	12.45	19.50	10.94	12.62	13.50
Meat	7.68[a]	8.65[a]	11.58[a]	13.30[a]	15.17[a]	25.60[a]	25.55	24.65	23.52	22.40	23.16	23.17
Grains												
- Grain[b]	2.07	2.35	2.53	3.99	4.27[b]	5.31[b]	9.36	12.61	8.51	17.18	14.28	13.83
-Wheat	6.40	5.16	8.35	9.84	8.45	12.92	18.35	19.95	16.28	33.65	34.62	23.92
Coal[c]	4.82	7.07	15.02	17.05	14.95	13.88	16.10	1.48	-	-	-	-
Special Rural	-	-	-	0.20	0.30	0.15	0.99	1.03	1.32	1.57	1.99	1.99
Fish	-	-	-	-	0.50	1.12	1.01	2.01	2.41	2.46	2.85	3.00
Horticulture	-	-	0.20	1.62	3.26	4.94	7.24	3.12	3.61	4.28	9.37	11.26
Other Rural												
- Chicken Meat	0.38	0.40	0.38	0.46	0.55	0.78	0.65	0.67	0.71	0.71	0.74	0.74
- Cotton	1.04	0.86	1.55	1.87	2.66	3.87	3.89	2.57	2.13	2.90	4.26	4.30
- Dairying	1.26	1.64	1.57	2.94	4.82	5.21	5.65	6.20	6.13	5.75	8.74	9.15
- Dried Fruit	0.32	0.26	0.29	0.39	0.45	0.78	0.92	0.46	0.49	0.39	0.67	0.46
- Grape & Wine	0.67	0.82	0.94	1.28	1.25	0.96	1.60	1.70	2.08	1.91	2.60	2.50
- Honey	0.09	0.11	0.10	0.12	0.14	0.07	0.12	0.15	0.15	0.15	0.16	0.16
- Pig Industry	1.00	1.43	1.37	1.95	2.58	2.68	2.88	3.61	3.75	3.57	3.44	3.52
- Egg Industry	0.31	0.28	0.37	0.30	0.45	0.57	0.68	0.67	0.63	0.68	0.65	0.65
- Sugar	-	1.28	1.40	1.37	1.48	1.28	3.40	4.48	4.89	5.46	5.99	6.14
- Tobacco	0.69	0.64	0.94	0.77	0.59	0.59	0.92	0.64	0.33	0.49	0.58	0.72
- Forestry	-	-	-	-	-	-	-	-	0.38	1.00	1.20	0.85
Total	41.98	49.25	60.82	77.09	79.00	94.86	111.62	96.97	96.84	115.49	127.91	119.87

(a) Industry contributions for meat R&D to the Australian Meat Research Corporation.
(b) From 1990-91 barley, grain legumes, and oilseeds are covered by a single outlay to the Grains R&D Corporation.
(c) Coal research was funded entirely through industry levies. As there is no Commonwealth contribution it is omitted from Table 4.

TABLE 6 Estimated Costs of Programs and Incentives providing support for Research and Innovation outside the Budget ($m)

	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97 (est)	1997-98 (est)
EMPLOYMENT, EDUCATION, TRAINING & YOUTH AFFAIRS												
Higher Education Funding Act: special research assistance [1]	6.0	9.0	12.1	77.3	178.7	240.3	260.0	292.0	306.3	346.4	396.2	427.0
Funding for ANU Institute of Advanced Studies[2]	97.0	100.0	108.0	122.0	134.0	141.2	144.8	146.3	147.6	149.9	152.1	153.0
Estimated research & research training component sourced in the operating grant[3,4,5]	534	584	656	629	622	673	794	858	924	981	1021	1026
INDUSTRY, SCIENCE & TOURISM												
Tax Concession[6] for industrial R&D	186	218	223	295	375	494	610	656	849	820	348	286
Tax Deduction for equity subscriptions in Management Investment Companies (MICs)[7]	20	20	7	19	34	-	-	-	-	-	-	-
TOTAL	**843**	**931**	**1006**	**1142**	**1344**	**1549**	**1809**	**1952**	**2227**	**2297**	**1917**	**1892**

* These data are estimates of funding provided for higher education research through the *Higher Education Funding Act* and predecessor legislation. About 70% of these funds cover research in the natural sciences and engineering, with the balance going to support social sciences and humanities research.

(1) Includes ARC/DEETYA funding for research grants, fellowships, centres, postgraduate awards and infrastructure.

(2) This is an estimate of funds for research and research training provided to the Institute of Advanced Studies (IAS) of the Australian National University (ANU) through the operating grant. Funding for the John Curtin School of Medical Research (JCSMR) of the ANU was provided through the Health Portfolio from 1992-93 to 1996-97, but has been returned to the EETYA portfolio in 1997-98. All historical data are now included in Table 6 (JCSMR funding makes up $18.7 million out of the total IAS funding of $153 million in 1997-98).

(3) The sum of the estimates in the previous row and this row of figures is an estimate of the research and research training component of the university operating grant. It does not include funds spent on research by the former advanced education sector institutions prior to the 1989 amalgamations.

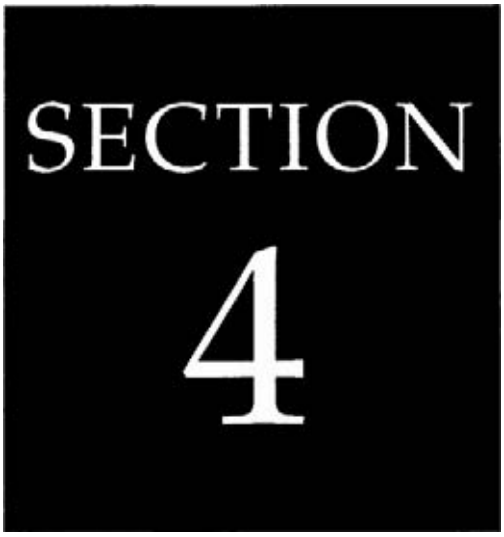
(4) A new methodology of estimating research and research training is used for 1993-94 onwards due to changes in ABS data collection introduced in 2994 *Research and Experimental Development - Higher Education Organisations* (8111.0). The methodology prior to 1993-94 uses estimates for 1984-85, 1986-88,1988-89, 1990-91 and 1992-93 based on ABS R&D surveys in the calendar year in which each of these financial years commences. From 1993-94 onwards, the estimate is based on the ABS survey of research expenditure of universities by source of funds. One of the sources identified by the ABS is General University Funds (GUF), a term that covers all university expenditure attributable to Commonwealth funding excluding funds provided through competitive granting schemes and other funding mechanisms identifiable in the ABS R&D Survey. The ABS estimates GUF for 1994 as $1166 million. The operating grant component is the major part of GUF, and can be estimated by using the operating revenue figures from *DEETYA Selected Higher Education Finance Statistics.* A research and research training component of the operating grant can then be calculated by multiplying the proportion of GUF attributable to the operating grant, by the R&D funds sourced from GUF (this latter is obtainable from ABS Higher

Education R&D surveys for 1994, 1995 and any subsequent years). The estimate for 1993-94 is based is based on 1994 data; with adjustment for 1993. The estimate for 1994-95 is the most accurate, as it is based on existing 1994 and 1995 data. Estimates for 1995-96 and beyond are based on the 1995 data, using forward projections of the non-capital unified system operating grant for subsequent years.

(5) Data prior to 1993-94, as presented in previous *Science and Technology Budget Statements*, have been adjusted downwards (pro rata) to minimise any break in the data series due to the introduction of the new methodology.

(6) A 150% company tax deduction for eligible industrial R&D expenditure applied from 1 July 1985 to 20 August 1996, when the rate was reduced to 125%. The data series comprise estimates by the Department of Industry Science and Tourism based both on information provided in registrations for the concession and from the Australian Taxation Office (ATO). They do not account for any recoupments arising from the dividend imputation system. The focus of the Table is on the effect of Government actions in the wider community. The figures in the Table are the estimated cost to revenue that would have occurred if companies had claimed the tax concession in the same financial year in which the R&D expenditure was incurred. In fact, some claims are not made until subsequent years (not necessarily in the next financial year). The estimated revenue forgone for the years when claims for the concession are lodged with the Australian Taxation Office is, from 1986-87 to (estimated) 1997-98, as follows: $105m, $150m, $190m, $220m, $290m, $360m, $465m, $560m, $630m $815m, $785m and $420m. Figures published here are revised over those published previously. While these data represent best estimates at the time of publication, they may require further revision as more information becomes available.

(7) Licensed Management and Investment Companies invested in approved high technology /growth activities. The equity subscription in these companies attracted a 100% income tax deduction in the year that subscriptions were made. The scheme concluded in June 1991.



Australia in an International Context

AUSTRALIAN SCIENCE & TECHNOLOGY
- KEY FACTS -

- In 1994-95, Australia's total R&D expenditure stood at Aus$7.3 billion. This corresponds to 1.61% of GDP.
- In 1994-95, the annual investment of Australian business in R&D was 0.74% of GDP. This is a relatively low level compared with other developed countries. However, it has increased very substantially since the early 1980s. Over 1988 to 1994, Australia's growth rate in business R&D expenditure was the second highest in the OECD.
- Comparing Australian business R&D expenditure and external patenting applications, each as a share of total activity within the OECD, shows a good correlation between R&D and Australian patent applications to other countries. This indicates an international orientation in Australia's industrial R&D and confirms the reliability of data on R&D expenditure in the business sector.
- In 1994-95, R&D expenditure in Australian public sectors (government agencies and universities) was 0.84% of GDP, the fifth highest in the OECD.
- Australia has about 86,200 people in its R&D workforce. These include 40,100 in universities (including 22,000 postgraduate research students), 25,200 in the business sector and 19,100 working in Federal and State Government laboratories.
- In 1995, Australian universities graduated some 14,600 students with bachelor degrees in science, and 5,900 with bachelor degrees in engineering. Some 37 universities awarded these degrees. In the same year, 840 science and 310 engineering PhDs graduated.
- Australia's net gain in scientists, engineers and academics through migration has been considerable - over a nine year period totalling about 30,700, of whom 22,000 were engineers. On average, the annual gain in scientists and engineers is equivalent to the graduate output from 6 universities. The high volume of this "brain gain" should dispel concerns of any overall loss of high level skills.
- A highlight of 1996 was Professor Peter Doherty's share in the Nobel Prize for medicine. This brings to seven the number of Australian scientists who have received this prestigious international prize in science or medicine.
- Australia ranks eleventh in international scientific effort normalised by population - by publishing some 830 scientific papers per million population per year.
- As measured by use of the Internet, Australia has a high capability and readiness to take up new technology. In January 1997, Australia had the sixth highest number of host computer connections to the Internet and, normalised by population, ranked fourth.

This information is extracted from *Australian Science and Technology at a Glance 1997*, being released in May 1997. See also Table 1 (p. 3.3), Figure 3 (p. 3.5) and the associated text.

Broad international comparison of R&D levels

R&D levels in different economies are most commonly compared by considering the ratio of gross domestic expenditure on R&D (GERD) to gross domestic product (GDP). This ratio of GERD/GDP is the most often quoted R&D indicator and provides a standardised method of international comparison. The major advantage of this ratio is that it removes any need for consideration of exchange rates or inflation.

Table 7 shows the latest available GERD/GDP data for nineteen OECD and five Asian economies. Since it is also useful to know the relative scales of R&D effort, the list is ranked by the total R&D expenditure level (in US

TABLE 7 Gross expenditure on R&D (GERD), GERD as a proportion of GDP, and change and growth rates - international comparisons

			Period 1981 to 1988			Period 1988 to 1994		
	GERD (est. 1995 US$m)	GERD/GDP	Change	Average annual real increase in GERD	Average annual real increase in GDP	Change	Average annual real increase in GERD	Average annual real increase in GDP
United States (1994)	172801	2.53	0.36	5.5	3.4	-0.26	0.6	2.0
Japan (1994)	77345	2.64	0.54	7.4	3.9	-0.02	2.1	2.6
Germany (1994)	38926	2.33	0.43	4.6	2.0	-0.53	1.2	5.1
China (1994)	29939	0.49	na	na	5.4	-0.14	6.1	10.0
France (1994)	27594	2.38	0.30	4.1	2.0	0.10	2.2	1.4
United Kingdom (1994)	21433	2.19	-0.19	2.8	3.6	0.02	0.6	0.6
Italy (1994)	10665	1.16	0.34	7.9	2.4	-0.06	0.7	1.1
South Korea (1993)	10120	2.41	1.22	28.6	10.2	0.58	12.9	6.8
Canada (1994)	9720	1.62	0.14	5.3	3.8	0.22	3.9	0.9
India (1992)	7467	0.74	0.26	11.1	5.4	-0.11	-0.1	3.9
Netherlands (1994)	6829	2.05	0.37	5.1	2.2	-0.17	0.9	2.5
AUSTRALIA (1994)	**4866**	**1.61**	**0.26**	**7.4**	**3.9**	**0.34**	**6.0**	**2.3**
Sweden (1993)	4384	3.28	0.69	7.2	2.5	0.30	1.9	-0.2
Switzerland (1992)	4294	2.68	0.57	6.8	2.1	-0.20	-1.4	0.7
Chinese Taipei (1994)	4267	1.80	0.32	13.7	8.9	0.55	13.2	6.7
Spain (1994)	3686	0.82	0.29	10.4	3.0	0.10	5.0	1.8
Belgium (1991)	3177	1.65	0.02	2.5	1.7	0.03	3.2	1.7
Austria (1994)	2499	1.53	0.18	3.8	1.9	0.18	4.9	2.6
Finland (1994)	1798	2.35	0.61	9.7	3.3	0.54	3.2	-1.5
Denmark (1993)	1755	1.79	0.40	7.5	3.0	0.30	4.9	1.4
Norway (1993)	1375	1.74	0.53	8.4	1.5	0.08	2.6	2.2
Ireland (1994)	746	1.41	0.14	6.4	2.5	0.58	14.9	4.6
Singapore (1993)	606	1.20	0.60	25.7	5.3	0.33	15.5	7.2
New Zealand (1993)	439	1.03	-0.14	-2.0	2.1	0.16	6.3	2.0
Average (24 economies)		**1.81**	**0.36**	**8.6**	**3.5**	**0.12**	**4.6**	**2.8**
Average (OECD only)		**1.94**	**0.31**	**5.8**	**2.4**	**0.09**	**3.4**	**1.8**

Source: DIST based on ABS, OECD and national sources.

dollars at 1995 prices). The Table also shows the change in the GERD/GDP ratio between 1981 and 1988, and between 1988 and 1994 (or nearest years), and the average annual real growth rates over each period both for GERD and GDP.

The Table shows that the scale of Australia's total R&D expenditure is about one thirtyfifth that of the largest national effort (USA) and about eleven times that of the smallest. In terms of the relative share of national wealth devoted to R&D (GERD/GDP), Australia lies in the middle range. Australia's relative R&D effort is about half that of Sweden (the highest in relative terms) and is about three times that of the lowest. In almost all economies, real growth rates in GERD over the second period were substantially lower than in the first - with Ireland being the striking exception. In the period 1988 to 1994, many economies showed slower growth in GERD than in GDP, particularly compared to the period 1981 to 1988. Australia was one of the exceptions in this case. The three "dynamic Asian economies" shown (Singapore, South Korea and Chinese Taipei) have dramatically increased their total level of R&D effort and show exceptionally high growth rates in GERD and GDP.

GERD is, however, made up of R&D expenditure undertaken in quite different sectors (principally, the business sector, government agencies and universities). There are wide international differences in the relative contribution of these sectors to GERD and policy issues may differ substantially between research sectors. Figure 7 indicates the relative sizes of the research sectors for the economies listed in Table 7, but re-orders the list according to level of GERD/GDP.

There is much advantage in comparing the sectors separately. A complication, however, is that there is great variation internationally in the scope of R&D activities and institutional structures in the government and academic sectors. The type of research or function typically undertaken in government agencies in one economy may be undertaken in universities in another. The reverse also applies. Thus, international comparisons are best based, not on GERD alone, but on its components relating to:

(i) R&D in government agencies and universities combined; and

(ii) R&D in the business sector.

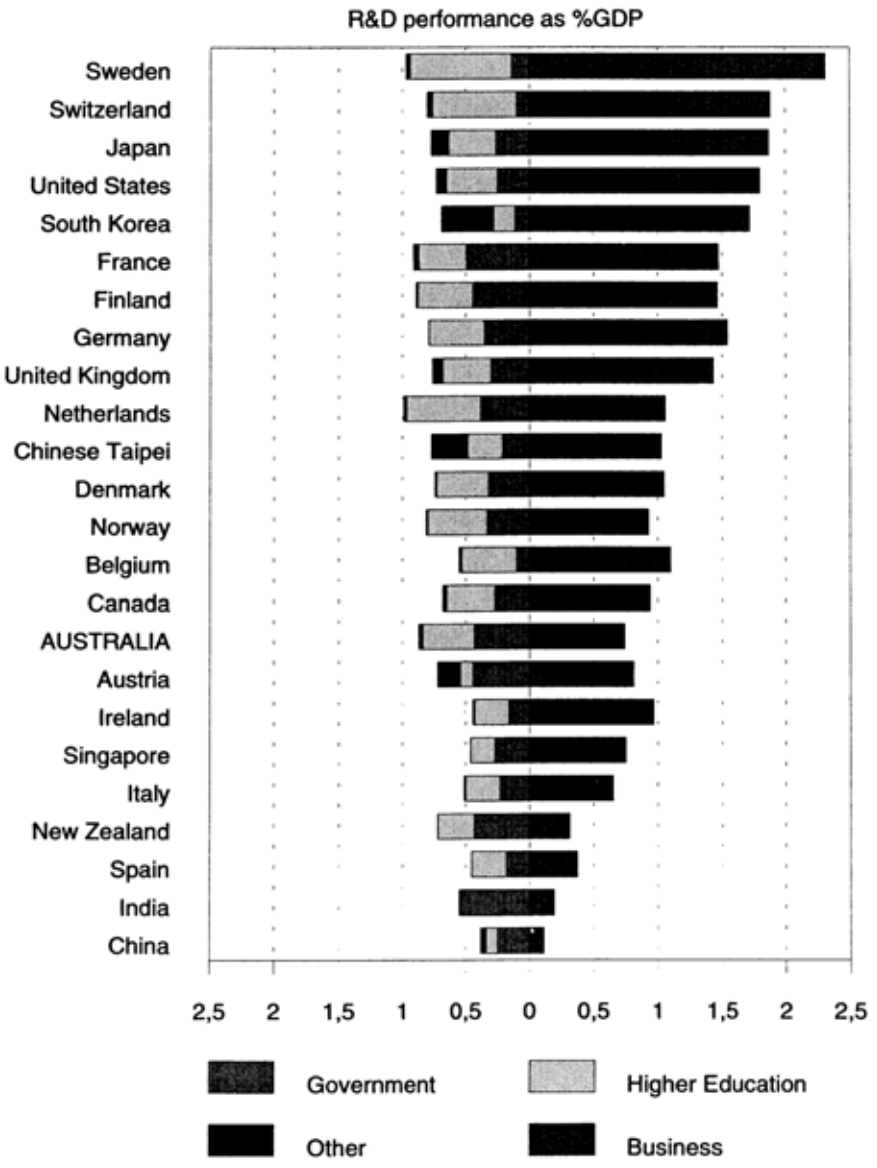
R&D expenditure in government agencies and universities

Table 8 shows comparative international data for combined R&D expenditure within government agencies and universities. In this list, the arrangement is in order of R&D expenditure as a percentage of GDP. The Table also shows shows changes in this ratio for the periods 1981 to 1988 and 1988 to 1994, as well as the average annual real growth rates.

In terms of the share of national wealth expended on R&D within government agencies and universities (R&D expenditure as a per cent of GDP), Australia has a high ranking of 0.84% compared with an average of

Figure 7

R&D EXPENDITURE AS A PERCENTAGE OF GDP - INTERNATIONAL COMPARISONS



Source: DIST based on ABS, OECD and national sources.

0.65% for all twentyfour economies listed. The change in this ratio for Australia was negative between 1981 and 1988, but over the period since 1988 was twice the OECD average increase. Among all countries, there was some convergence towards the mean over the whole period since 1981.

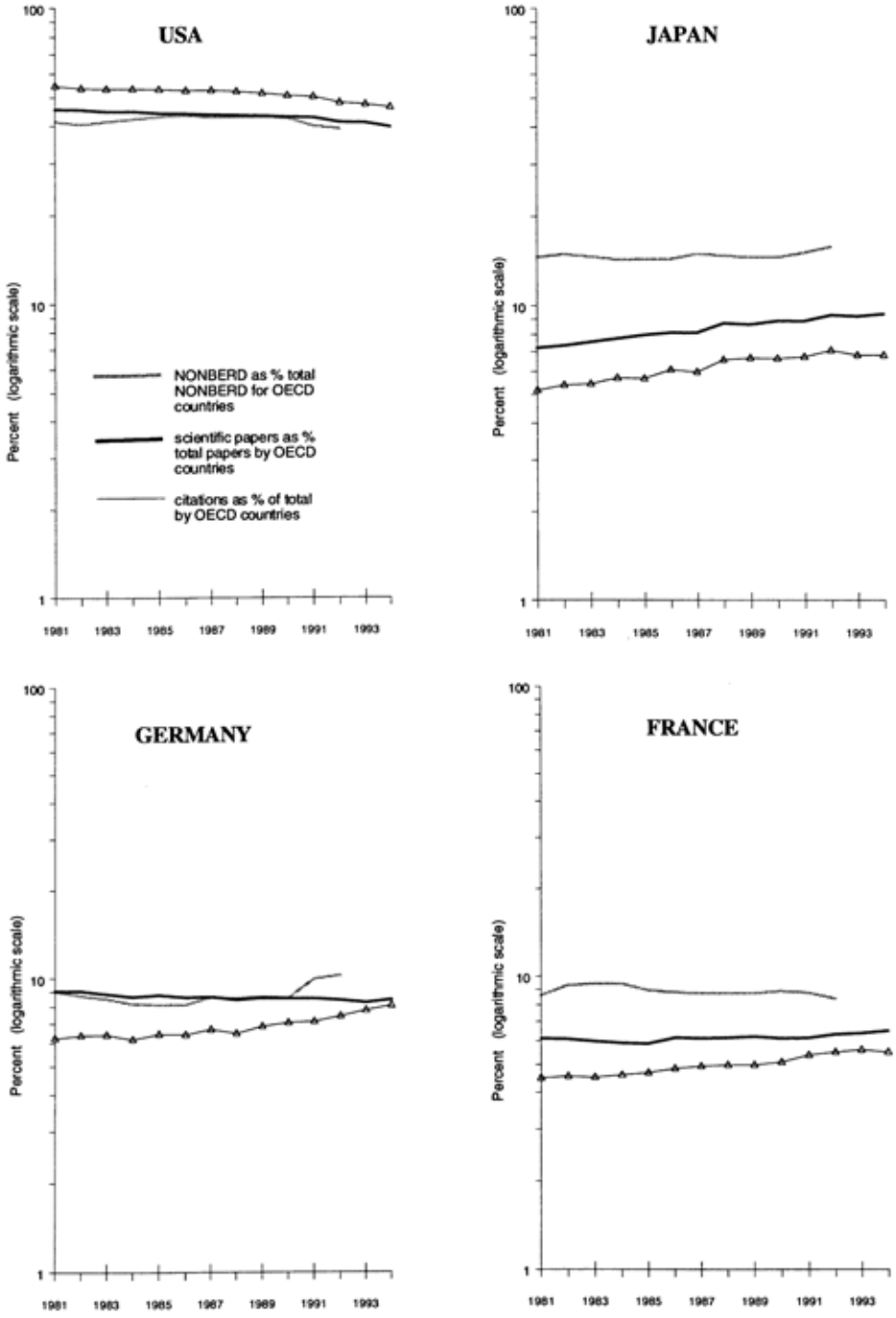
Australia's level of effort in basic research has been a matter of some interest. In fact, comparative data are available for only eleven countries. These are shown in Table 8. (The data also include small amounts of basic research conducted in the business and private non-profit sectors.) Australia has increased its level of effort in basic research from 0.33% of GDP in 1978-79, to

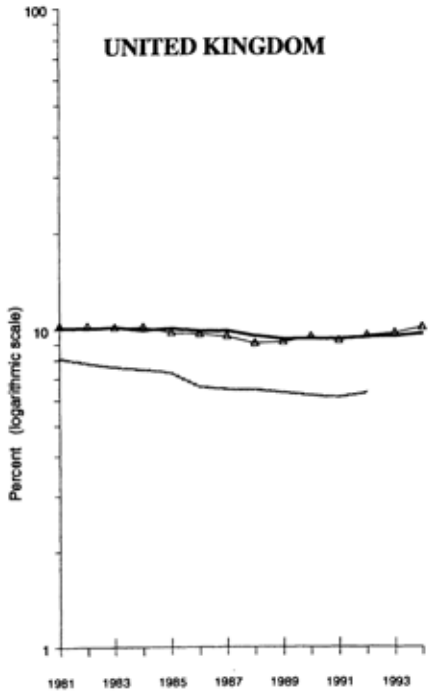
TABLE 8 Expenditure on R&D in government agencies and universities as a proportion of GDP, change and growth rates, and basic R&D as a proportion of GDP- international comparisons

		Period 1981 to 1988		Period 1988 to 1994		
	R&D expend. in govt and universities as % GDP	Change	Average annual % real increase in R&D	Change	Average annual % real increase in R&D	Basic R&D as %GDP (most recent year)
Netherlands (1994)	0.97	0.03	2.3	0.13	5.3	na
Sweden (1993)	0.94	0.16	5.3	-0.05	-2.7	0.53
Finland (1994)	0.89	0.18	7.9	0.17	3.7	na
France (1994)	0.87	0.11	3.7	-0.03	0.8	0.50
AUSTRALIA (1994)	**0.84**	**-0.02**	**3.3**	**0.11**	**4.1**	**0.44**
Norway (1993)	0.81	0.07	3.7	0.19	4.4	0.28
Germany (1994)	0.79	0.07	3.5	0.02	5.6	0.49
Switzerland (1992)	0.77	0.10	0.7	0.08	4.3	na
Denmark (1993)	0.73	0.11	5.6	0.08	3.0	na
New Zealand (1993)	0.72	-0.18	-2.5	0.13	7.5	na
United Kingdom (1994)	0.69	-0.18	-0.4	0.06	2.3	na
Canada (1994)	0.65	-0.03	2.3	0.04	2.4	na
United States (1994)	0.64	0.07	5.1	-0.07	0.0	0.42
Japan (1994)	0.63	-0.02	3.6	0.03	3.9	na
Austria (1989)	0.55	0.06	4.9	na	na	na
India (1992)	0.54	0.23	12.4	-0.11	-1.2	na
Belgium (1991)	0.53	-0.03	0.6	0.16	14.2	na
Italy (1994)	0.51	0.13	7.3	-0.01	1.4	0.24
Chinese Taipei (1994)	0.48	0.16	10.6	0.06	10.8	0.29
Singapore (1993)	0.46	0.23	22.8	0.10	13.2	na
Spain (1994)	0.44	0.07	6.4	0.14	9.8	0.15
Ireland (1994)	0.44	-0.03	2.2	0.08	8.7	0.07
China (1994)	0.33	na	na	-0.07	8.6	0.03
South Korea (1993)	0.28	0.11	17.3	0.03	8.6	na
Average (24 economies)	**0.65**	**0.06**	**5.8**	**0.05**	**5.2**	
Average (OECD only)	**0.70**	**0.04**	**3.5**	**0.07**	**4.1**	**0.35**

Source: DIST based on ABS, OECD and national sources.

Figure 8: TRENDS IN NONBERD AND SCIENTIFIC PAPERS

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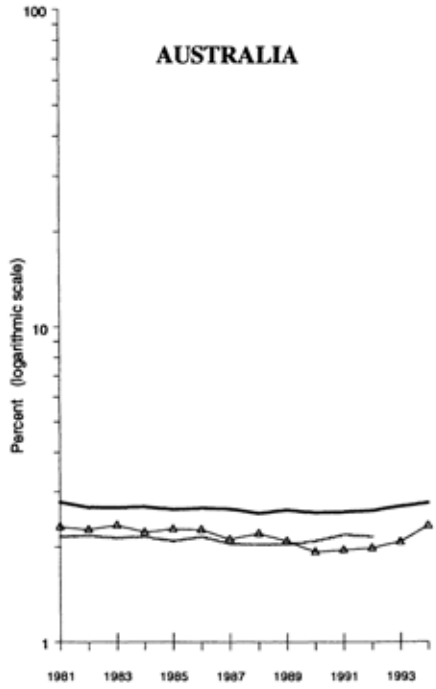
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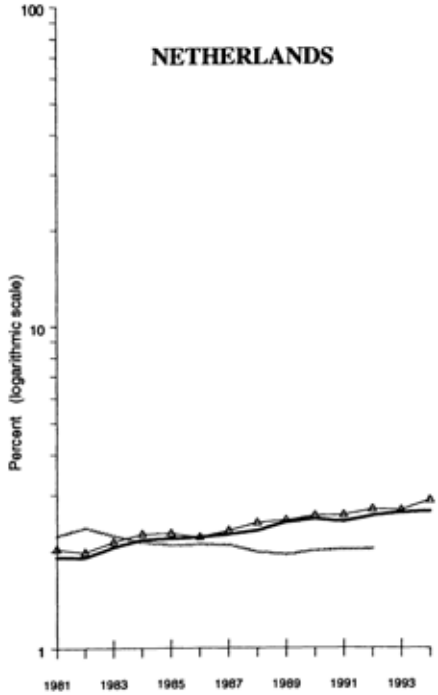
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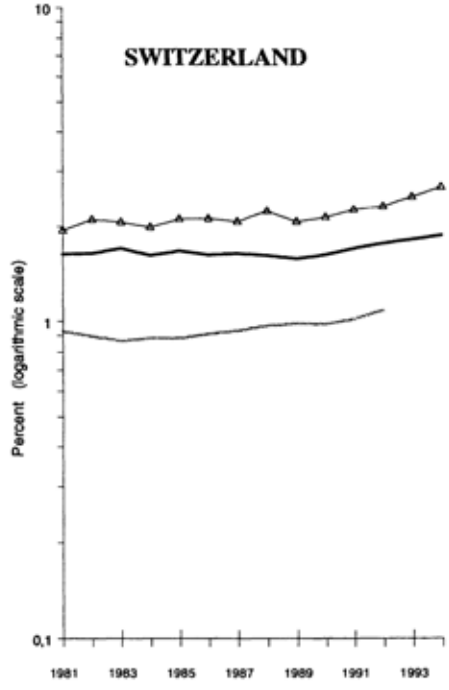
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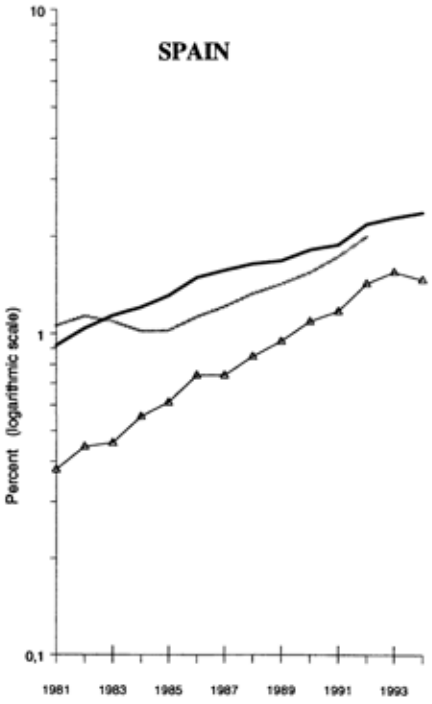
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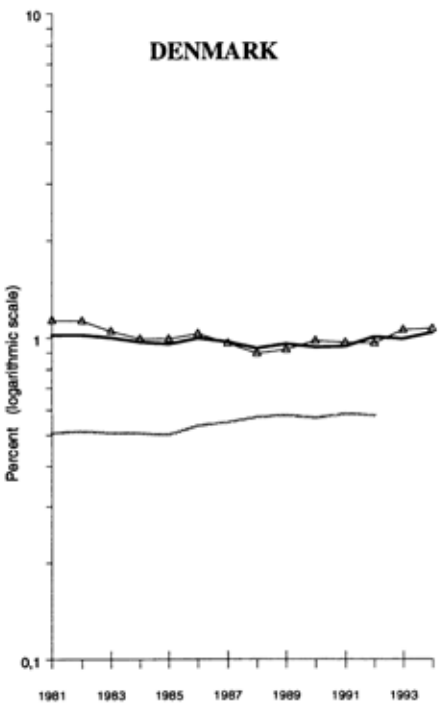
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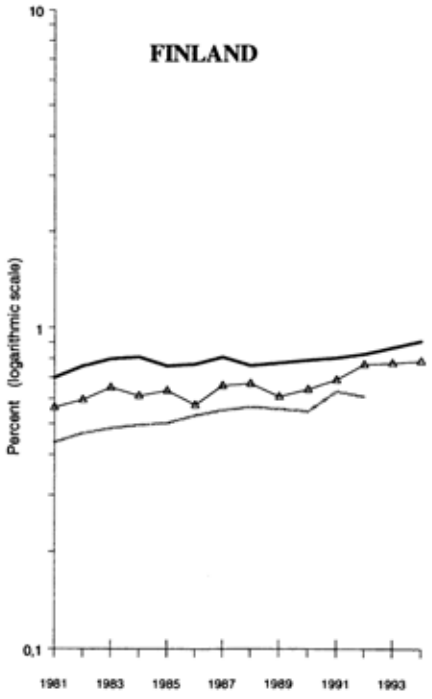
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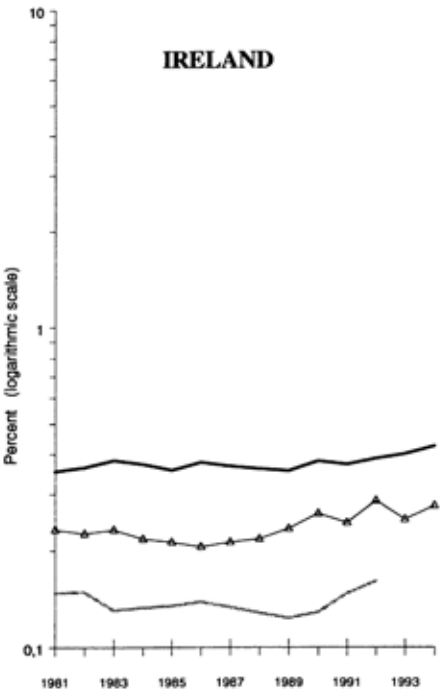
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0.35% in 1984-85 to the most recent level (1994-95) of 0.44%. This compares well on the limited comparisons that are available.

One alternative to making international comparisons as a fraction of GDP is to compare national levels as a proportion of aggregate OECD levels. International trends on this basis are shown in Figure 8 for 'nonBERD' (all R&D expenditure other than in the business sector). An advantage of comparing national performance in this way is that comparisons can also be made on the same basis with national outputs of scientific research papers (the principal measurable output of the non-business sector), and with the impacts of those papers. Figure 8 shows levels and trend on this basis for twelve OECD countries. For a number of reasons (caveats on publication data, particularly, have been well discussed in many recent reports) these comparisons should be treated with some caution. Nevertheless, there are a number of interesting features. For Australia, a recovery in share of expenditure on nonBERD from about 1990 appears to have improved shares in the output of scientific papers and, more markedly, the relative impact of those papers. Among other countries, the substantial improvement in Spanish shares in all three quantities are very striking.

Business expenditure on R&D

Table 9 shows comparative international data for business expenditure on R&D (BERD). The list in this case is arranged in order of BERD as a percentage of GDP. The Table also shows changes in this ratio in parallel with those of Table 8.

There were substantial increases in levels of BERD in most countries over the 1980s and much higher growth rates than for the composite category of R&D expenditure in government agencies and universities. However, changes in BERD and in growth rates were much lower for the period 1988 to 1994 than for 1981 to 1988. As in most other economies beginning with relatively low levels of BERD, Australia achieved increases in BERD/GDP and growth rates well above OECD averages - the highest OECD rate of growth for the period up to 1988, and the second highest for the period since then. Nevertheless, growth rates in OECD nations were all much lower than for the three dynamic Asian economies in the Table - Singapore, with a real annual growth rate of about 18 per cent, Chinese Taipei on 16 per cent, and South Korea on 13 per cent - but Ireland, with the leading OECD growth rate (19 per cent), is now ahead of all these.

Figure 9 provides OECD comparisons for the business sectors in 12 OECD economies on a parallel basis to Figure 8. However, output here should be assessed on the basis of the share in external patent applications (domestic patent applications in most cases have less relevance). For smaller countries in particular, changing patterns in the share of R&D expenditures are reflected (with a small lag) in similar patterns in the share of external patenting. The similarities are particularly striking for Australia - and verify the reality of increased R&D expenditures reported since the early 1980s.

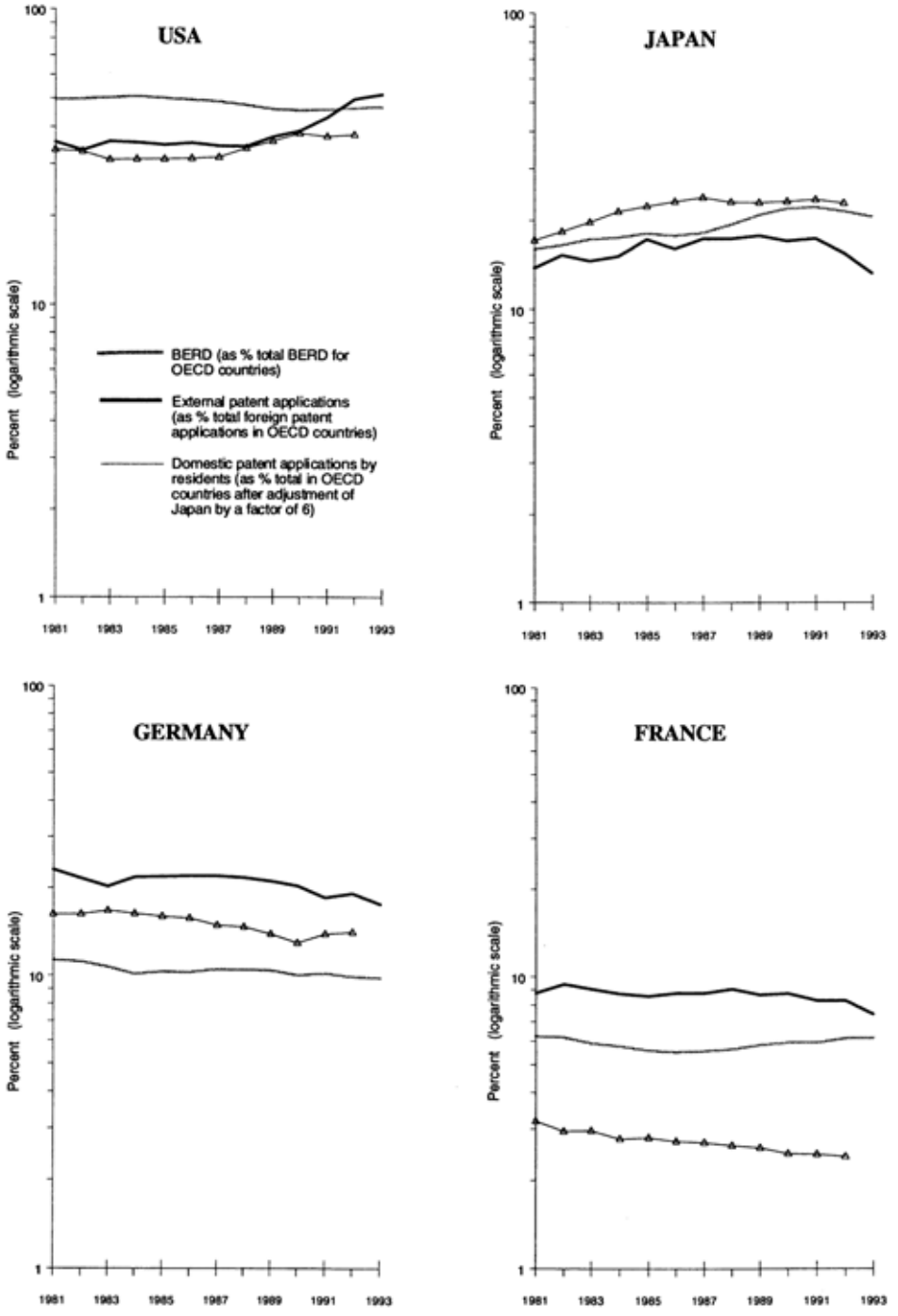
However, improvements for Spain, Finland, Denmark and Ireland should be noted. These might be regarded as indicating the dynamic European economies - to a degree, counterparts to those in Asia.

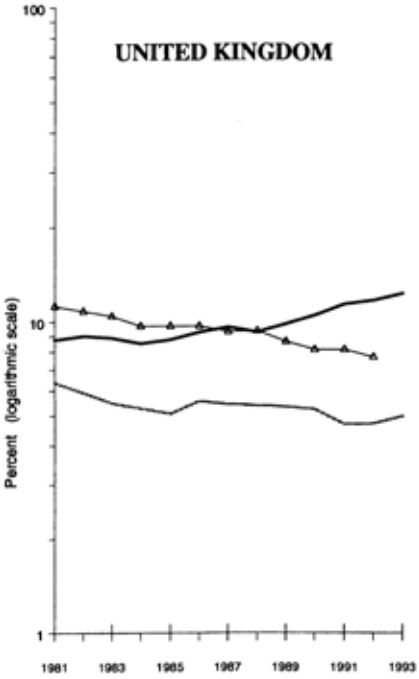
TABLE 9 Business expenditure on R&D (BERD) as a proportion of GDP, change and growth rates in BERD - international comparisons

		Period 1981 to 1988		Period 1988 to 1994	
	%BERD/GDP (latest)	Change	Average annual real increase in BERD	Change	Average annual real increase in BERD
Sweden (1993)	2.31	0.54	8.3	0.32	3.8
Switzerland (1992)	1.88	0.44	7.9	-0.26	-3.6
Japan (1994)	1.87	0.54	8.8	-0.06	1.4
United States (1994)	1.80	0.29	5.7	-0.20	0.5
South Korea (1993)	1.72	1.02	37.9	0.44	12.9
Germany (1994)	1.54	0.36	5.0	-0.53	-0.5
France (1994)	1.47	0.19	4.4	0.11	2.9
Finland (1994)	1.46	0.43	11.2	0.38	2.9
United Kingdom (1994)	1.43	-0.02	4.1	-0.04	-0.2
Belgium (1991)	1.10	0.16	3.9	-0.10	0.2
Netherlands (1994)	1.06	0.35	7.5	-0.28	-2.3
Denmark (1993)	1.05	0.28	9.1	0.22	6.3
Chinese Taipei (1994)	1.03	0.08	14.1	0.44	15.6
Ireland (1994)	0.97	0.16	10.6	0.50	19.1
Canada (1994)	0.94	0.17	8.0	0.18	5.0
Norway (1993)	0.93	0.45	11.7	-0.10	1.2
Austria (1993)	0.81	0.15	3.5	0.01	0.0
Singapore (1993)	0.75	0.36	28.1	0.24	17.6
AUSTRALIA (1994)	**0.74**	**0.28**	**17.7**	**0.21**	**8.0**
Italy (1994)	0.65	0.21	8.2	-0.05	0.3
Spain (1994)	0.37	0.21	13.9	-0.04	0.7
New Zealand (1993)	0.31	0.06	-0.6	0.03	3.6
India (1992)	0.19	0.03	7.0	0.01	3.7
China (1994)	0.11	na	na	-0.08	-1.6
Average (24 economies)	**1.10**	**0.29**	**10.3**	**0.06**	**4.1**
Average (OECD only)	**1.19**	**0.29**	**8.4**	**0.02**	**2.6**

Source: DIST based on ABS, OECD and national sources.

Figure 9: TRENDS IN BERD AND PATENT PERFORMANCE

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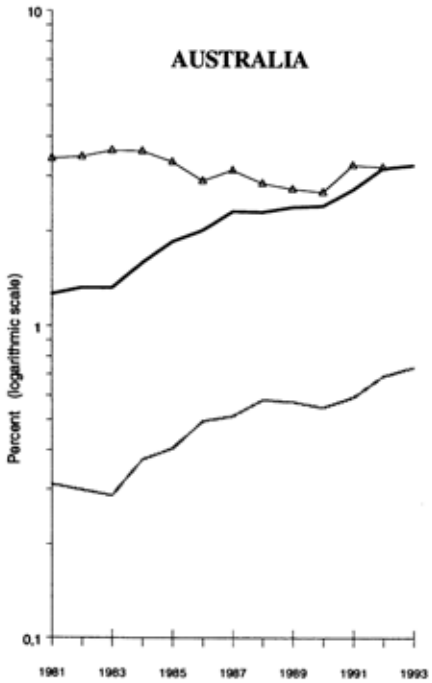
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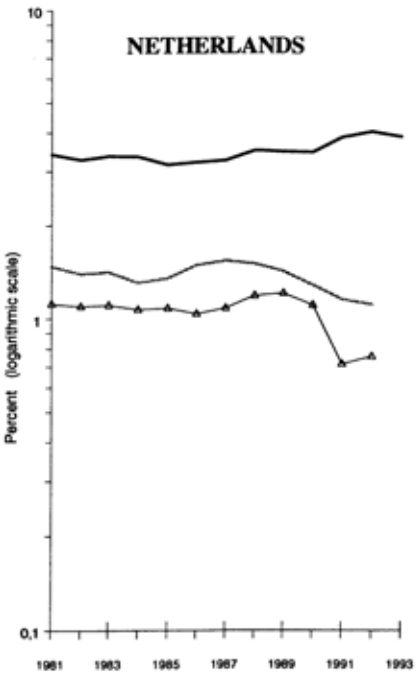
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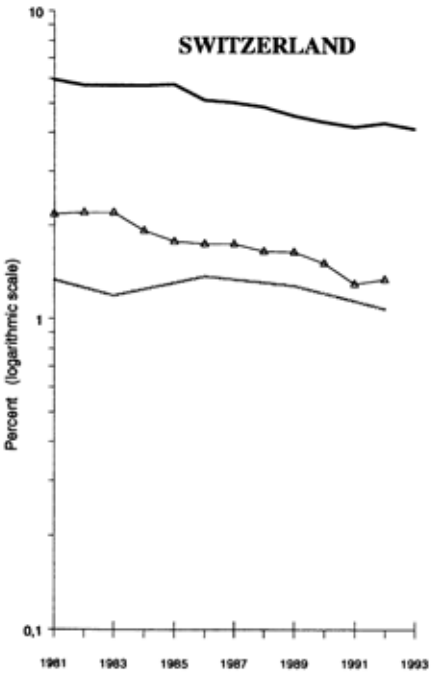
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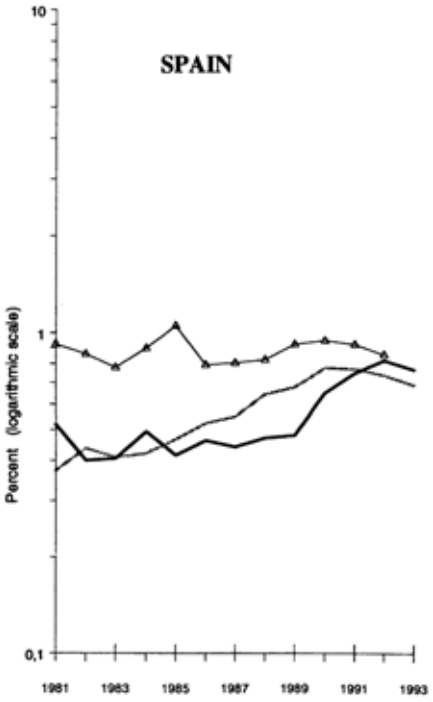
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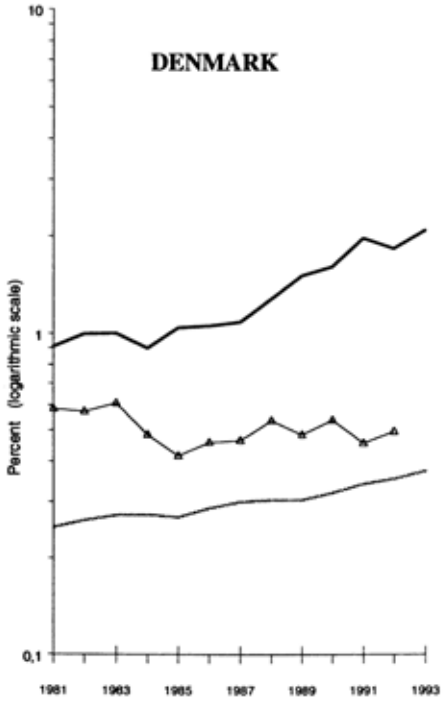
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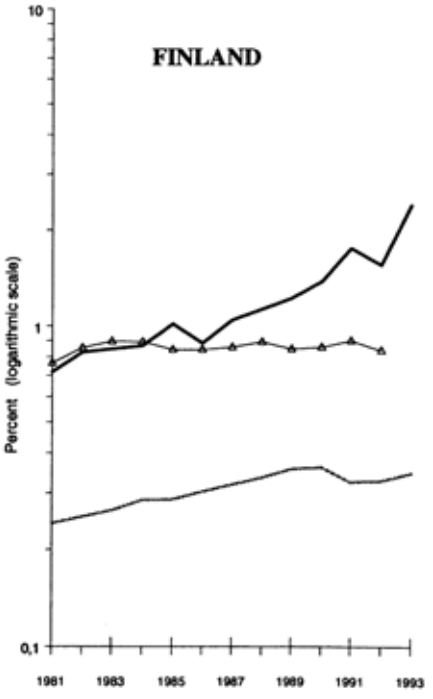
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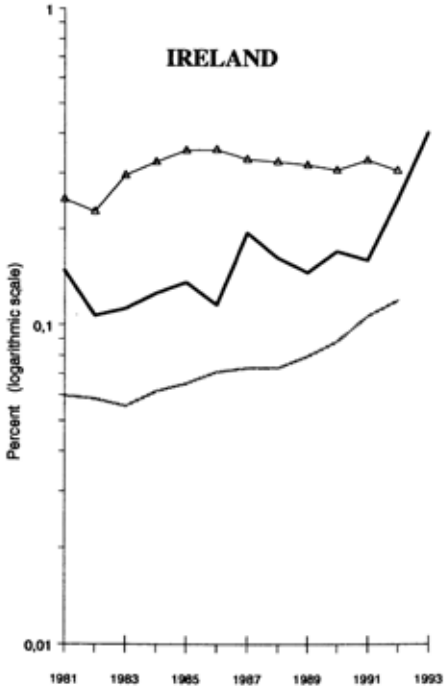
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A regional perspective

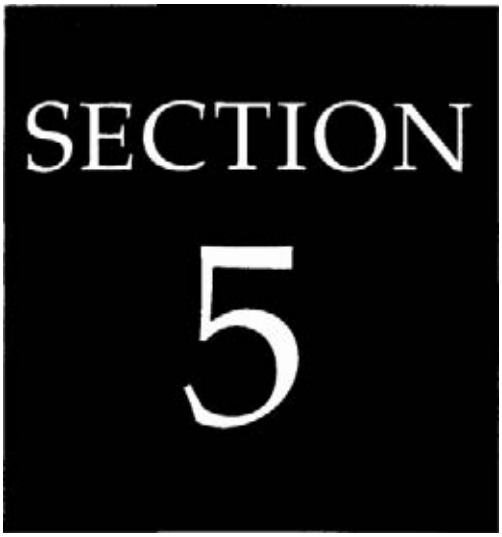
Internationally, while there has been increasing attention paid to *national* 'systems of innovation', this work has also pointed to the importance of *regional* systems. This is particularly pertinent to the situation of Australia's States and Territories, where the geographical dispersion of centres of economic activity point to the value of considering indicators relating to individual regions as well as those of the nation as a whole. Taken as a whole, Australia shares some features in common with the five Nordic countries - another set of geographically dispersed centres of activity with a degree of economic integration and having, in total, similar levels of GDP and population. This approach can be carried one step further by considering combined indicators for both signatories to the Closer Economic Relationship (CER) Agreement. Table 10 then presents a range of indicators along these lines - with a range of developed countries included that are comparable to Australia's States and Territories in terms of GDP and population. The various economies listed are ranked by scale of total R&D activity.

TABLE 10 R&D in Australia's regions - an international perspective

	GERD (US$m 1995)	% GERD/GDP	change since 1981	BBRD (US$m 1995)	% BERD/GDP	change since 1981	GDP (US$m 1995)	Population (thousands)
Nordic Countries	9345	2.33	0.78	5978	1.49	0.59	400798	23574
CER (Aust. & NZ)	5305	1.52	0.52	2360	0.67	0.42	350068	21529
AUSTRALIA (1994)	**4866**	**1.61**	**0.61**	2227	0.74	0.49	304812	18049
Sweden (1993)	4384	3.28	0.99	3090	2.31	0.86	136999	8718
Switzerland (1992)	4294	2.68	0.40	3009	1.88	0.18	160040	6875
Austria (1993)	2395	1.52	0.35	1283	0.81	0.16	162909	7993
Finland (1994)	1798	2.35	1.15	1119	1.46	0.81	76653	5088
Denmark (1993)	1755	1.79	0.70	1023	1.05	0.50	102106	5189
New South Wales (1994)	**1536**	**1.46**	**0.63**	**821**	**0.78**	**0.56**	**105367**	**6112**
Victoria (1994)	**1436**	**1.80**	**0.72**	**828**	**1.04**	**0.63**	**79825**	**4501**
Norway (1993)	1375	1.74	0.56	736	0.93	0.31	82680	4312
Ireland (1994)	746	1.41	0.71	511	0.97	0.66	52799	3571
Singapore (1993)	606	1.20	0.93	376	0.75	0.60	50296	3200
Queensland (1994)	**556**	**1.12**	**0.40**	**170**	**0.34**	**0.19**	**49595**	**3277**
New Zealand (1993)	439	1.03	0.02	133	0.31	0.09	45256	3480
Western Australia (1994)	**430**	**1.36**	**0.68**	**215**	**0.68**	**0.56**	**31595**	**1731**
South Australia (1994)	**391**	**1.76**	**0.52**	**135**	**0.61**	**0.40**	**22222**	**1474**
Australian Capital Territory (1994)	**337**	**5.23**	**-1.15**	**17**	**0.26**	**0.24**	**6456**	**304**
Tasmania (1994)	**109**	**1.68**	**0.73**	**24**	**0.36**	**0.10**	**6500**	**473**
Northern Territory (1994)	**48**	**1.47**	**1.07**	**3**	**0.08**	**0.08**	**3251**	**174**
Iceland (1994)	33	1.39	0.76	10	0.43	0.37	2360	267

Since the end of the 1970s, measures to stimulate R&D activity in the business sector have been taken in a wide range of countries, and have proved successful. The results can be seen in the table, with most economies exhibiting substantial increases. In Australia's case, measures taken at a Federal level have had substantial effects in increasing business R&D expenditures in the States and Territories.

Table 10 provides a different comparative view than that usually seen at a purely national level. For example, Victoria's levels of business R&D activity are seen to be equivalent to those of Denmark, and clearly exceeding those of Ireland, Norway, Austria and Singapore. While the R&D levels for the ACT seem remarkably high, these are essentially for the city of Canberra. Even higher levels would be seen if it were possible to obtain comparable indicators for cities such as Cambridge, Berkeley, etc. where there are also high concentrations of academic and other research within relatively small cities.



Portfolio
Budgets and Priorities

Introduction

This Section presents summaries of both 1997-98 budgetary allocations, and priority goals, in science and innovation. The information is arranged by Ministerial portfolio. There is a particular focus on agencies engaged in R&D and on programs funding R&D.

For comparison, budgetary allocations for 1997-98 are listed next to the corresponding expenditure outcomes for 1996-97. On financial aspects, the bias is towards brevity of discussion. For additional information it may be useful to refer to Statement Number 3 of Budget Paper Number 1, which provides a discussion of financial trends for those scientific programs allocated to the Budget function 'general research'.

Priority goals are drawn from the performance forecasts for 1997-98 that are published in the *Portfolio Budget Statements* (Budget Initiatives and Explanations of Appropriations 1997-98). These statements provide detailed information on the purpose and nature of portfolio budget measures. *Portfolio Budget Statements* are available from individual departments after the Budget each year.

COMMUNICATION AND THE ARTS

Science and Innovation in the Portfolio Budget

The Government has recognised that science and technology is part of the cultural mainstream of Australian society. Through the creation of the Department of Communications and the Arts and through its cultural policy, the Government has sought to develop fully the synergies between development in communications and information technology and the creative industries sector.

The Communications and the Arts portfolio has a diverse range of science and technology responsibilities and activities which includes agencies such as the National Science and Technology Centre, the National Film and Sound Archive and the Australian Film Commission.

The National Science and Technology Centre has been allocated $6.2 million for 1997-98 to stimulate public awareness and understanding of, and interest in, science and technology throughout Australia. The Centre achieves this by providing interactive exhibitions and education programs to audiences of about a million people each year throughout Australia and the Asia Pacific region.

The Department of Communications and the Arts:

- is a major stakeholder in the Heritage Collections Committee of the Cultural Ministers Council, which is a collaborative partnership of Commonwealth, State and Territory Governments and the museums sector;
- provides support for the Information Policy Advisory Council, which advises on strategic issues relating to information and communication services for action by governments, industry and other stakeholders in the online economy;
- provides support for the Online Government Council, a Ministerial Council, established to coordinate Commonwealth, State and local government activities relating to online services; and
- provides support for the Coordination Committee on Information Services, a committee of officials coordinating and sharing information between Commonwealth departments and agencies on policies and programs related to information services.

1997-98 Science and Innovation Priorities

National Science and Technology Centre

In 1997-98, the Centre will continue to provide a national focus for popularising science and technology through the touring of interactive exhibitions and the conduct of a range of educational programs aimed at increasing the awareness and understanding of Australians in science and technology.

The Centre will further explore and use innovative technologies to enhance access to the Centre's programs and services. During the period, the Centre is also expected to open a new major exhibition and be the leading contributor to the establishment of a formal network of science and technology centres in the Asia Pacific Region

National Film and Sound Archive

In 1997-98, the Archive will:

- acquire audiovisual items of cultural significance (e.g. sound recordings and films) and negotiate agreements with commercial producers to allow the Archive to acquire such material;
- remove from the collection duplicate items and items not considered to be of cultural significance.
- improve standards of collection description and the availability of access guidelines and catalogues;
- update the collections' database and reduce the accessioning backlog.
- improve preservation and safe storage of collection material;
- review preservation and storage practices.
- Contribute to developing audiovisual archiving nationally and internationally; and
- arrange visits from international representatives to learn from the Archives' preservation techniques.

DEFENCE

Science and Innovation in the Portfolio Budget

The Budget allocation for the Defence science and technology function will be $230.3 million in 1997-98 ($253.7 million expected outcome in 1996-97).

1997-98 Science and Innovation Priorities

Defence Science and Technology Organisation (DSTO)

DSTO's activities planned for 1997-98, and the expected outcomes, are grouped below in broad areas corresponding to DSTO's client groups.

Policy and Command Priorities for 1997-98 include:

- developing a testbed for generation of the Recognised Air Picture for operation in exercise Pitch Black 97. This testbed will integrate data from a wide range of surveillance and intelligence sensors;
- demonstrating in the field a compact deployable information network, based on commercial GSM digital phone technology, developing plans for its integration with the PARAKEET trunk communications system, and seeking solutions to military encryption requirements;
- undertaking systematic evaluation of the key factors which impact on ground truth accuracy of over the horizon radar. This work will also be used to evaluate the performance of the Jindalee Operational Radar Network coordinate registration process as a risk mitigation strategy;
- providing advice on the vulnerability of personnel to munitions, in particular land mines, and the medical logistics implications of munitions injuries; and
- providing technical support for the Government's opposition to the proliferation of weapons of mass destruction through the chemical and biological weapons' conventions and missile technology control regime initiative or the UN.

Maritime Force Capabilities Priorities for 1997-98 include:

- providing advice and technical assistance on the monitoring of strain at critical regions of *HMAS Collins* and *HMAS Farncomb* during shock tests and on eddy current testing methods of advanced materials that are used in the submarines;
- assisting the RAN with the acquisition, assessment and acceptance of optronic systems for the COLLINS class submarines;

- supporting the proposed upgrading of the Seahawk helicopter capability by evaluating the operational effectiveness of the helicopter in its various roles, and by coordinating the assessment of the adequacy of support to the helicopter;
- developing techniques and algorithms for the implementation of onboard electronic countermeasures on guided missile frigates against surveillance and targeting radars; and
- identifying sensor technologies which have the potential to increase a ship's detection, tracking and/or classification range against other surface vessels and low-flying aircraft/missiles, leading to improved beyond-horizon surveillance and situation awareness and improved ship self-defence.

Land Force Capabilities Priorities for 1997-98 include:

- developing procedures to conduct analysis and optimisation of Army organisational structures, operations and logistic support and mobility including interactions with HQAST, to inform the process of Restructuring the Army;
- developing a dynamic deployed force mobility model to improve the capability, effectiveness and efficiency of logistic support to the deployed land force;
- demonstrating automated target detection cues for assisting analysts rapidly and reliably to identify the targets of military interest in radar imagery of broad tracts of land and contiguous littoral areas; and
- supporting Project Bushranger by carrying out ballistic and shock trials on candidate vehicles and by modelling of the land mine threat.

Air Force Capabilities Priorities for 1997-98 include:

- assisting in the AP-3C upgrade by:
  - evaluating classification aids for the new radar;
  - developing improved techniques for the prediction of detection performance against small targets in sea clutter;
  - optimising the operational effectiveness of the updated weapons systems; and
  - ensuring that noise at tactical crew and sensor task stations is within acceptable levels.
- supporting the acquisition of an airborne early warning and control (AEW&C) system by:
  - modelling of tactical and battle level AEW&C operations;
  - assessing AEW&C radar performance; and
  - research into fusion of multi-sensor and multi-source data, decision support, automation and human-machine interfaces.
- supporting the F / A-l 8 radar upgrade by:
  - verifying the capability of the radar upgrade hardware;
  - ensuring that the radar upgrade is capable in regional terms; and

  - evaluating the electronic protection performance of radar upgrade against modern jamming techniques to improve aircraft capability in hostile jamming environments.
- providing advice on the acquisition of simulators for: AP-3C; AEW&C; Black Hawk; and ANZAC Ship Helicopter; and
- providing the capability for detection and classification of low probability of intercept radar signals.

Defence S&T Research Priorities include:

- investigating the use of micro-eloctromechanical systems in 'smart' materials and structures to monitor the health of bonded components to reduce through-life costs;
- continuing to collaborate with The Australian National University and the US Air Force in the development of a novel weapon-guidance concept based on fly vision and navigation; and
- applying innovative uses of genetic algorithms and genetic programming to flight dynamics to identify unresolved aircraft equations and aerodynamic stability and control parameters from flight trials.

EMPLOYMENT, EDUCATION, TRAINING & YOUTH AFFAIRS

Science and Innovation in the Portfolio Budget

Through the Employment, Education, Training and Youth Affairs portfolio, the Government will provide about $1,611 million in 1997-98, through university operating grants and targeted research funding schemes, to support research and research training in Australian universities.

Support through university operating grants

The major part of the Government's support for university research and research training, approximately $1,179 million, is provided through the operating grant. This amount includes the following nominal components: (a) the Research Quantum (RQ), $219 million; (b) the Research Training Component (RTC), $482 million; and (c) approximately $153 million of The Australian National University's operating grant, including overhead costs, which is provided as block funding for the research schools and centres of the Institute of Advanced Studies.

Targeted research programs

Approximately $432.1 million will be provided in 1997-98 directly to universities, researchers and other bodies through a range of targeted research programs: Research Grants ($128.33 million); Postgraduate Awards ($84.84 million); Research Fellowships ($27.69 million); Research Centres ($18.45 million); Research Infrastructure ($109.98 million); Collaborative Research Grants ($29.24 million); Overseas Postgraduate Research Scholarships ($15.43 million); Higher Performance Computing and Communications Centres of Expertise Program ($7.3 million); Learned Academies ($1.53 million); Anglo-Australian Telescope Board ($3.5 million); Research Evaluation Program ($0.66 million); Advanced Engineering Centres ($1.6 million); and other research funds approximately $3.4 million.

Where appropriate, these funds are allocated on a competitive basis to ensure that their allocation to the universities and researchers able to make the best use of them. Research grants, centres and fellowships are awarded on the advice of the Australian Research Council.

Support for research through both university operating grants and targeted research programs is intended to promote the following Government objectives: excellence in basic and applied research; support for research training; selectivity and concentration of research resources; improved collaboration between universities and industry; commercialisation of research outcomes; international cooperation in research; and the development of infrastructure to support high quality research.

Research Funding Activities

University Operating Grants

In addition to supporting high quality undergraduate teaching, university operating grants support the research and research training capacity of universities with the aim of achieving internationally competitive basic and applied research and high quality research training and promoting research collaboration between universities and industry, the commercialisation of research outcomes, international links and the development and maintenance of Australia's capacity in key technological areas.

In previous *Statements,* DEETYAhas given two estimates of the research and research training component of the operating grant, based on the two distinct approaches available to estimate this figure. For this and subsequent *Statements,* use of some aspects of the method based on the 1990 Relative Funding Model (RFM) analysis of the operating grant has been discontinued. A single estimate based on Australian Bureau of Statistics (ABS) data will now be given. Relevant ABS data is now available for 1994 and 1995.

This estimate is based on the ABS survey of research expenditure of universities by source of funds (the ABS methodology is outlined in *1994 Research and Experimental Development - Higher Education Organisations* (8111.0)). One of the sources identified by the ABS is General University Funds (GUF). The operating grant component is the major part of GUF, and can be estimated by using the operating revenue figures from *DEETYA Selected Higher Education Finance Statistics.* Using this method, the estimated research and research training component of university operating grants for 1997-98 is $1,179 million. See Table 6 in Section 3 of this *Statement* (page 3.18), and the associated footnotes.

Within this amount several components can be identified:

- The *Research Quantum (RQ):* The RQ is an amount within the operating grant which is reallocated to institutions on the basis of research performance, as measured by the Composite Index. In 1997-98, the RQ will be $219 million.
- The *Research Training Component (RTC):* The RTC is estimated on the basis of higher degree research student load, weighted in accordance with the relative teaching costs matrix developed in 1990 in the context of the RFM. In 1990, the RTC was estimated to be 7.6 percent of the operating grant. Due to strong growth in postgraduate research student load-since 1990, the RTC has increased and is currently estimated to be 10.7 percent of the operating grant, or $482 million in 1997-98.
- *Funding for the schools and centres of Institute of Advanced Studies of The Australian National University:* From 1997-98, funding for the John Curtin School of Medical Research will be provided through the EETYA portfolio. For 1997-98, the IAS block grant is estimated to be $153 million.

Targeted Research Funding

Australian Research Council (ARC)
Role: The Council's mission is to provide advice on research funding and research policy, and to promote the conduct of research and research training of the highest quality for the benefit of the Australian community. The Council has special responsibility for research in the higher education sector, basic research and research training.

The majority of targeted research funding, including research grants, fellowships and centres, is allocated on the advice of the Australian Research Council, which conducts competitive peer review through its panels and committees as necessary. The primary criterion for the awards is the performance record of researchers and the quality their proposals, though some weight may be given to other criteria such as national priority areas and links to industry where appropriate. In 1997-98, the budget for targeted research programs referred to the ARC is $321.6 million.

Research Grants

The 1997-98 allocation for Research Grants is $128.3 million. The Research Grants program has two components:

- *Large Grants Scheme:* supports basic and applied research projects in all disciplines except clinical medicine and dentistry with grants ranging from a minimum size of $20,000 for the social sciences, humanities, mathematics and theoretical physics, up to more than $250,000 for Special Investigator Awards. The Australian Research Council (ARC) provides advice on the allocation of grants with proposals being selected on a competitive basis by peer review provided by the ARC's Research Grants Committee and its expert discipline panels.
- *Small Grants Scheme:* provides block grants to universities to enable them to offer research grants at less than the minimum value of Large Grants. Eligible universities receive a base grant of $50,000 with the remaining funds distributed according to a formula that takes into account institutional success in obtaining Large Grants and the distribution of Small Grants in the previous year.

Amongst the sub-elements of the Large Grants Scheme are the Special Research Initiatives Program (SRIP) and the Aboriginal and Torres Strait Islander Researchers Development Program. The SRIP provides seed funding to enhance the quality and effectiveness of ARC-supported research by encouraging collaboration among researchers, through research networks and similar activities. $500,000 is available for this sub-element in 1997-98.

The Aboriginal and Torres Strait Islander Researchers Development Program aims to encourage Aboriginal and Torres Strait Islander researchers to improve their research skills to a level where they will be competitive for mainstream research funding. Emphases of the Program include the

provision of support for research projects, training in research methodology and the preparation of larger research proposals. $210,000 is available for this sub-element in 1997-98.

Collaborative Research Grants

The Collaborative Research Grants Scheme supports research collaboration between universities and industry by funding high quality research which has the potential to economically and socially benefit Australia. It covers projects in basic, strategic, applied and developmental research in all fields. It is a requirement of grants that dollar for dollar matching funds from industry are available to the grantee. In 1997-98, $29.24 million will be available to the Scheme.

From 1998, the Collaborative Grants Scheme and Australian Postgraduate Awards (Industry) will be combined into a new scheme, the Strategic Partnerships with Industry - Research and Training (SPIRT) Scheme. The purpose of combining the two schemes is to provide greater flexibility for institutions in their negotiations with industry on collaborative research and training activities. Proposals under the combined scheme can include collaborative research projects, collaborative research training or a combination of research projects and training. There will also be scope to seek funding for an Australian Postdoctoral Fellowship (Industry) (APD(I)).

Research Fellowships

Fellowships provide support for individuals to undertake research at postdoctoral level and above. In 1997-98, $27.69 million will be available for Research Fellowships.

There are five types of Fellowship:

- *Australian Postdoctoral Research Fellowships (APRF):* These are normally for researchers with less than three years' postdoctoral experience. Sixty-seven new APRFs have been taken up in 1997.
- *Australian Research Fellowships (ARF):* These are normally for researchers with more than three years' postdoctoral experience. Fifteen new ARFs have been taken up in 1997.
- *Queen Elizabeth II Fellowships (QEIIF):* These are for outstanding researchers who would usually have no more than six years' postdoctoral experience. Fifteen new QEIIFs have been taken up in 1997.
- *Senior Research Fellowships (SRF):* These are for researchers with established reputations who would normally have no more than fifteen years' postdoctoral experience. Fifteen new SRFs have been taken up in 1997.
- *International Research Fellowships (IRF):* These fellowships arise from the implementation of reciprocal research ward agreements with the French Ministry of Higher Education and Research, the Alexander von Humbolt Foundation of Germany and the Korea Science and Engineering Foundation. Thirteen Fellowships were awarded in 1997.

Research Centres

The Research Centres Program supports centres of research concentration on the basis of excellence and their potential to contribute to the economic, social and cultural development of Australia. A total of $18.45 million is being provided to Research Centres in 1997-98. Two types of centres are supported:

- *Special Research Centres:* Receive between $0.5 million and $1 million a year to concentrate research effort in areas of national importance. In 1997 funding is being provided to 19 Special Research Centres. Eight new Special Researcn Centres selected in 1996 will begin operating in 1997.
- *Key Centres of Teaching and Research:* Key Centres give equal weight to teaching and research. They are based in existing university departments and aim to boost expertise in areas relevant to national development and to promote cooperation between the higher education sector ana industry. Key Centres receive an average grant of $360,000 a year from the program, with most Centres obtaining additional funding from other sources. In 1997 funding is being provided to 15 Key Centres of Teaching and Research. A selection round for up to eight new Key Centres will take during 1998 with funding to commence in 1999.

Postgraduate Awards

Two types of award with stipend are available under this program, Australian Postgraduate Awards with stipend and Australian Postgraduate Awards (Industry). In addition, 19,900 Equivalent Full-time Student Units (EFTSU) are provided exemption from HECS. $79.3 million is available under the Scheme in 1996-97. The stipend elements of the Scheme are:

- *Australian Postgraduate Awards (APA):* Around 4,500 APAs provide a stipend of up to $20,180, mainly for students undertaking postgraduate research degrees. They are tenable for up to two years in the case of a Masters student, or three and a half years in the case of a student undertaking a PhD. 1605 new awards are available in 1997. APAs with stipend are allocated to institutions on a formula reflecting research student load, research degree completions and comparative research strength measured by the Composite Index.
- *Australian Postgraduate Awards (Industry) (APA(I)):* 580 APA(I)s are being provided in 1997 (205 new awards), giving a stipend of $20,180. They support higher degree research training for postgraduate students on research projects developed to meet the needs of industry. Each project is sponsored by an industry partner who is required to contribute $5,000 in cash plus an additional $5,000 in cash or kind for each year of the higher degree training course. APA(I)s are awarded on the recommendation of the ARC.

Overseas Postgraduate Research Scholarships

The Overseas Postgraduate Research Scholarships Scheme supports high quality overseas postgraduate students in areas of research strength in higher education institutions. The scholarships offer students the opportunity to obtain a postgraduate qualification and to gain experience

with leading Australian researchers. In 1997-98, $15.43 million will be available to the scheme. In 1997 three hundred new scholarships are available.

Research Infrastructure (Equipment and Facilities) Scheme

The Research Infrastructure (Equipment and Facilities) (RIEF) Scheme is the element of the Research Infrastructure Program (see below) referred to the ARC for advice on the allocation of funds. The Scheme funds relatively large scale initiatives which develop major research infrastructure on a cooperative basis across groups of institutions and with organisations outside the higher education sector. Grants can also be made to individual institutions in cases where cooperative arrangements are impractical or inappropriate. In 1997-98, this element of the Research Infrastructure Program will provide $20.9 million. In 1998 and 1999, $2.0 million will be provided from RIEF to The Australian National University to be allocated within the Institute of Advanced Studies. As noted in Section 2 of this *Statement*, from 1998 the Institute of Advanced Studies will be eligible to compete for funds from the RIEF Scheme.

Research Infrastructure Program

The Research Infrastructure Program provides the Commonwealth Government's contribution, $110 million in 1997-98, to research infrastructure in higher education institutions to support high quality research, by ensuring that areas of recognised research potential have access to the support necessary for their development, enhancing support for areas of research strength and remedying deficiencies in research infrastructure. The Research Infrastructure (Equipment and Facilities) Scheme element of the Program is referred to the ARC and is described above.

The non-referred element is the Research Infrastructure Blocks Grants (RIBG) Program. RIBGs are provided to universities to assist in the development and maintenance of research infrastructure. Consistent with the program priority of providing infrastructure support for Commonwealth competitive grant schemes, the RIBG is allocated to institutions on the basis of the National Competitive Grants Index (NCGI). This element of the Program will provide $89.1 million in 1997-98.

High Performance Computing and Communications (HPCC) Centres of Expertise Program

The HPCC Centres of Expertise Program will provide seed funding to establish two or three centres beginning in the latter half of 1997. It is part of the Government's national strategy for HPCC and will complement the HPCC Technology Diffusion Centres Program administered by the Department of Industry, Science and Tourism. The Program will focus on the education, training, research and development aspects of the national strategy, and will aim to establish a high quality resource of technical and research expertise in this key enabling technology. $12.03 million is available in calendar 1997 and a further $2.55 million in 1998. Current estimate of funding for 1997-98 is approximately $7.3 million. Some of these funds will be available for the provision of additional HPCC infrastructure.

Advanced Engineering Centres

DEETYA provides the Government's contribution to the operation of three Advanced Engineering Centres (AECs):

- *Advanced Engineering Centre for Information Technology and Telecommunications*, involving Adelaide and Flinders Universities and the University of South Australia in conjunction with the SA Department of Technical and further Education;
- *Advanced Engineering Centre for Manufacturing*, involving Melbourne University and the Royal Melbourne Institute of Technology; and
- *Australian Graduate School of Engineering Innovation*, involving Sydney University and the University of Technology, Sydney.

The Centres were established as a part of a wider agenda to enhance the contribution of engineering skill, research and development in the evolution of internationally competitive industries for Australia. They are designed to promote collaboration between higher education and industry to:

- improve advanced engineering education;
- increase industry's capacity to apply and commercialise technology; and
- focus on teaching and short term research and consultancy projects.

Each Advanced Engineering Centre received establishment funding of $1.4 million in 1992 and receives recurrent funding of $0.5 million annually. University and industry partners also contribute to operating costs. $1.63 million will be provided to AECs in 1997-98.

Targeted Institutional Links Program

The Targeted Institutional Links Program provides seed funding to Australian higher education institutions to support links between Australian and overseas education, training, research and industry organisations, especially in the Asian region. The Program aims to foster Australia's research and development capacity and Australia's integration with the Asian region. In 1996-97, $480,000 will be spent under this program and an estimated $1.2 million in 1997-88.

1997-98 Science and Innovation Priorities

The Government will continue to strengthen Australia's research and research training capability through the additional funding for research infrastructure, collaborative research and postgraduate awards as announced in the 1996-97 Budget. Additional funding for infrastructure will improve the ratio of infrastructure to direct costs funding through Commonwealth Competitive Grants from the current 24 cents in the dollar to 31-33 cents in the dollar in 1998.

The Department will continue to monitor performance of the targeted research sub-program and the higher education research system. In 1997-98, evaluations of the Large Grants Scheme, Small Grants Scheme, industry-linked research schemes, biological sciences research and a review of grants administration processes will be completed. Through its annual research grants programs, the Australian Research Council will continue to advise the Minister on the performance of researchers and institutions seeking funding for research grants, fellowships, postgraduate awards, research centres and infrastructure in 1997-98.

The performance of the higher education research system will be monitored through performance indicators and a component of university's general funding allocated on this basis.

ENVIRONMENT, SPORT AND TERRITORIES

Science and Innovation in the Portfolio Budget

Major organisations in the portfolio include the Australian Antarctic Division, the Bureau of Meteorology, and the Environment Protection Group which includes the Environmental Research Institute of the Supervising Scientist.

The Australian Antarctic Division has a total budget allocation of $60.8 million in 1997-98 ($60.4 million in 1996-97). The Division directly undertakes as well as supports scientific research in the Australian Antarctic Territory, the Southern Ocean and Australia's subantarctic islands, with priority to understanding global climate change and protecting the Antarctic environment and the marine ecosystem.

The Bureau of Meteorology, as the national meteorological service for Australia, has primary responsibility for research in support of its own operations and services, including research directed to the broad delineation of the characteristics of Australian weather and climate and for liaison with the World Meteorological Organization, in relation to relevant research in Australia.

The Environmental Research Institute of the Supervising Scientist, part of the Environment Protection Group, carries out independent research on behalf of the Australian community to establish the best methods available for the protection of people and ecosystems in the Alligator Rivers Region, both during and following mining in the region. The Institute also conducts general environmental research at the request of Government and makes a special contribution to the well-being of people and the environment of the region, through research on the protection and management of wetlands.

Since 1994, Australia has been working to implement the Australian and New Zealand Environment and Conservation Council (ANZECC) *National Strategy on the Management of Scheduled Wastes.* This work is characterised by the close cooperation between governments at all levels through the Scheduled Wastes Management Group which consists of representatives from Commonwealth, State and Territory environment agencies. Interest groups are represented through the National Advisory Body which advises on aspects of the implementation of the *National Strategy* and undertakes consultation with the wider community.

Through the *National Strategy,* ANZECC has endorsed management plans for polychlorinated biphenyls (PCBs) and for ICI Australia's stockpile of about 9,000 tonnes of hexachlorobenzene (HCB) waste, and has begun developing a management plan for organochlorine pesticides (OCPs) such as DDT. The PCB and HCB waste management plans are now being implemented by Australian Governments. One of the important tests of the effectiveness of

the *National Strategy* is whether the stockpile of waste is being destroyed. Since the conflict over whether we should export our waste to other countries and/or incinerate it, four scheduled waste treatment facilities have been established in Australia utilising three different techniques (plasma-arc, hydrogenation and base-catalysed dechlorination).

The Commonwealth Government committed significant funds to developing a National Pollutant Inventory (NPI) program. In the past a lack of easily accessible information has made it difficult for people to find out how much and what kind of pollution enters their environment. The National Pollutant Inventory will collect information on emissions of hazardous substances from industry, motor vehicles and other day-to-day human activity and provide this information in an easily accessible interactive database. The NPI is being established through the National Environment Protection Council.

The National Greenhouse Research Program for the next four years has been designed to provide national level focus and direction for greenhouse research; meet policy needs for information on the science and impact of climate change; meet commitments under the Framework Convention on Climate Change and the National Greenhouse Response Strategy to advance scientific knowledge of climate change, and maintain a level of core climate change science research that provides the foundation for present and future information needs. The Budget provides $3.9 million for 1997-98, and a total of $13.7 million over 1996-2000.

As part of the Commonwealth Coastal Action Program, the Department is establishing a Coastal Monitoring Initiative. This includes a national coastal monitoring directory and a coastal monitoring network. The Coastal Monitoring Initiative focuses on ensuring availability and quality of information for coastal management and Australia's contribution to global monitoring systems.

The Department continued to provide funding to support development of the *National Strategy for Rangeland Management and Action Plan*, by a joint Working Group of the Australian and New Zealand Environment and Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ). The draft strategy was available for public comment until 13 December 1996. The *Strategy* will provide a framework for a national approach to the ecologically sustainable management of Australia's rangelands, an area approximately three-quarters of the size of the continent.

The *National Strategy for the Conservation of Australia's Biological Diversity* has been endorsed by the Commonwealth and all State and Territory governments and work is now underway to implement the *National Strategy*. The establishment of the Biological Diversity Advisory Council (BDAC) and the Biodiversity Strategy Executive Group (BSEG) will ensure that the objectives of the *Strategy* are met.

Work will continue on the implementation of the *Convention of Biological Diversity* as well as the *National Strategy*. For example, work on bioregional planning and incentives for conservation and sustainable use will be advanced. Work on biosafety, access to genetic resources and intellectual property rights is also underway. A clearing house of biodiversity information - Biolinks - has been set up on the World Wide Web.

1997-98 Science and Innovation Priorities

Antarctic

In 1997-98, the Antarctic Program will continue to implement the 1995-2000 science strategic plans and associated logistic and operational activities, and maintain the existing four stations in support of the Government's goals for Antarctica.

Maintaining the Antarctic Treaty System and Australia's Influence in the System

- Further development, at the 16th meeting of Commission for Conservation of Antarctic Marine Living Resources (CCAMLR), of sustainable management practices, including reviews of catch limits for fisheries and improved controls on illegal fishing.

Understanding Global Climate Change

- Sea-ice, which plays an important role in the global climate system and is a sensitive indicator of climate change, will be monitored using ship-based observations, satellite imagery, moored oceanographic instruments, and drifting data buoys.
- Marine science voyages will seek to understand the role of the Sub-Antarctic in controlling poleward heat transport and atmospheric carbon dioxide levels including moderating anthropogenic climate change, and in determining Southern Ocean ecosystem productivity and structure.
- The Division's new LIDAR (Light Ranging And Detection) instrument nearing completion will conduct observations of temperature and winds in the upper atmosphere at Kingston, Tasmania prior to deployment at Davis during 1998-99.

Undertaking Scientific Work of Practical Importance

- The Division will continue to maintain its support of the Bureau of Meteorology, Ionospheric Prediction Service and Australian Geological Survey Organisation in obtaining meteorological, ionospheric, magnetic, and seismological observations which are of practical importance to their functions in Australia.

Protecting the Antarctic Environment

- Threats to the antarctic environment are being studied, including the introduction of disease, disturbance of wildlife by helicopters, introduced species and contamination arising from stations, floating marine debris and the effects of fisheries on wildlife.
- Procedures to limit impacts on the environment are being developed including an assessment of the potential for alternative technologies to replace fossil fuels at Antarctic stations.
- Surveys of pack-ice seals will be undertaken as part of an international program to understand the significant predator-prey interactions or this species in the Southern Ocean.
- An interim *Environmental Atlas of the Eastern Antarctic Region* will be produced to assist with area protection, tourism management, environmental impact assessment, and the planning or science and logistic activities.
- Conservation work on Mawson's huts at Commonwealth Bay by the AAP Mawson's Huts Foundation will be supported.
- Tourism activity in the Australian sector will be appropriately managed, including the assessment of environmental impacts of proposed activities.

Revised Environmental Management Plans for Mawson and Davis will be produced.

- Environmental audit of the procurement, transport, storage, and use of station fuel will be undertaken.
- Expeditions Support Activities: Support of science field programs in the Southern Prince Charles Mountains.

Bureau of Meteorology

In support of the Monitoring and Prediction program during 1997-98, the Bureau of Meteorology will:

- restore the performance of the Bureau's basic observational networks in line with the funds provided in response to the recommendations of the 1996 Review of the Operation of the Bureau of Meteorology; and
- enhance the efficiency and effectiveness of forecasting operations through the operational implementation of the Australian Integrated Forecast System (AIFS).

In support of the Scientific Development program during 1997-98, the Bureau of Meteorology will:

- improve further the scope, accuracy and reliability of the Bureau's numerical forecasting systems;
- continue work towards improved climate prediction including the development of a seasonal prediction system;
- maintain a program of climate research directed towards improved understanding of the natural variability of Australia's climate and reducing uncertainties in simulating changes to climate resulting from increased concentration of greenhouse gases;
- consolidate further understanding of the processes controlling weather and climate in tropical Australia and apply this knowledge to improved forecasting services; and
- continue active participation in meteorology and hydrology-related Cooperative Research Centres to strengthen the overall foundations of Australian meteorology.

In support of the Weather Services program during 1997-98, the Bureau of Meteorology will:

- continue monitoring and evaluating the Bureau's weather service operations to enable the Weather Services Program to operate efficiently and to a high and gradually improving standard.

In support of the Climate Services program during 1997-98, the Bureau of Meteorology will:

- finalise the redevelopment phase of the national computer archive for meteorological data (ADAM - Australian Data Archive for Meteorology);
- review and update the range of standard data summaries and the format and media through which climate information is provided for public use;
- continue development towards the preparation of new reference maps of climate parameters as the basis of a major climate review; and
- monitor the status of the national Reference Climate Station Network and participate in international programs to analyse global trends in climate.

In support of the Hydrological Services program during 1997-98, the Bureau of Meteorology will:

- complete the investigation of temporal patterns of rainfall antecedent to storms in the Generalised Southeast Australia Method set;
- implement relevant components of the Australian Integrated Forecast System (AIFS) in Regional Hydrology Sections, in accordance with the timetable of that project, to improve the robustness of the operational flood forecasting system; and
- progress, in conjunction with the State water agencies, the National Water Resources Assessment component of the National Land and Water Audit.

Environment Protection Group

The work of the Environment Protection Group (EPG) involves building long term relationships with others to achieve improvements in Australia's environmental performance. Some of the quantifiable areas of EPG activities during 1997-98 are:

- play a major part in international negotiations under the Climate Change Convention in the lead up to the Kyoto Conference in December 1997 and work with other Portfolios and States to complete and implement a revised *National Greenhouse Strategy*;
- implement the recommendations of the Independent Inquiry into Urban Air Pollution through a coordinated national strategy incorporating cooperative agreements with government agencies and industry groups as well as a community education program;
- prepare a comprehensive National Profile to assess the national infrastructure for the management of chemicals in Australia;
- submit a national collection, storage and destruction scheme to Australian and New Zealand Environment and Conservation Council (ANZECC) and Agricultural and Resource Management Council of Australia and New Zealand (ARMCANZ) by February 1998;
- endorse a proposed organochlorine pesticide management plan by the November 1997 meeting of ANZECC;
- use of innovative Australian technologies to solve wastewater treatment problems encouraged through the Clean Seas Program under the Natural Heritage Trust; and
- phase out of the import and manufacture of all ozone depleting substances will meet or exceed Australias international obligations - a *National Methyl/Bromide Response Strategy* will be finalised for the phase out of this ozone depleting agricultural fumigant.

The National Environment Protection Council will have issued its first draft *National Environment Protection Measures* for public review in several critical areas of environmental protection, including ambient air quality, hazardous waste transport, and the National Pollutant Inventory. The forward agenda for the Council is expected to include national Measures for ambient water quality and diesel emissions.

ANZECC will release, for industry and community consultation, a *Draft National Strategy for Cleaner Production* aimed at encouraging widespread sustainable industrial production in Australia.

The Environmental Research Institute of the Supervising Scientist forms a part of the Environment Protection Group and will use 1997-98 funding to support a variety of research including radiological assessment of the rehabilitated Nabarlek mine and validation of the SIBERIA landscape evolution model to help assess alternatives for long-term disposal of tailings at the Ranger mine. Revision of the ANZECC water quality guidelines should be completed. The Institute's wetland research program will focus on establishing a monitoring network for coastal change in the region,

characterisation of wetlands and provision of research advice on protection and management of wetlands to traditional owners of Aboriginal lands in the wet-dry tropics.

Wilderness

The four-year Wild Rivers project, conducted jointly with States and Territories will be finalised by mid-1997. Major products of the project are the national identification of wild rivers, a continental database of disturbance to river systems and their catchments and a code of voluntary conservation management guidelines to assist managers to conserve wild rivers.

The National Wilderness Inventory database will continue to be maintained and updated, providing the technical basis for Government decisions on wilderness, including those made under the Regional Forest Agreements. The database will also continue to support the identification of wilderness values for national estate assessment outside forests.

Wild rivers are those whose biological, hydrological and geomorphological processes have been little disturbed by modern development. Indigenous custodianship and customary practices have been, and in many places continue to be, significant factors in creating what non-Indigenous people refer to as wilderness and wild rivers. The Government will also pursue with indigenous groups the application of wilderness concepts and management in Australia and will undertake research into the role of wilderness areas and wild river systems in nature conservation.

World Heritage

The Commonwealth will seek to fulfil its obligation under the World Heritage Convention to identify, protect, conserve and present World Heritage areas in Australia, in cooperation with the States and Territories and through public consultation. In 1997-98, this will be done through improved management of all World Heritage properties using strategic plans, management structures and/or standards.

The Government will give special support to improved monitoring of the condition of World Heritage values as an essential means of ensuring that the values are protected and to allow the Commonwealth to meet its international obligation. It will assist management agencies by providing the overall framework and guidelines for monitoring and reporting and by funding development of monitoring methodology and indicators.

Australian Heritage Commission

The Government will continue to consult widely on strategies and options to provide for a more effective, consistent and enhanced heritage conservation system for Australia. The aim is to remove gaps in the protection regime, reduce duplication and provide for increased access and involvement by the public, business and government. Proposed outcomes include:

- a national heritage listing system giving enhanced protection; and
- a National Heritage Places Policy designed to provide appropriate recognition and management of all types of places of heritage significance around Australia.

Guidelines to support the *Australian Natural Heritage Charter* released in December 1996 will be published to pursue the Charter's dual purpose of assisting in soundly-based decisions on conservation of natural heritage. It is intended to achieve a uniform approach to conservation of places of natural significance in Australia which can be applied to public and privately-owned places, to terrestrial, marine or freshwater areas, and to protected and unprotected areas.

Australia's National Estate is all those natural, historic and indigenous places which should be kept for the future and which have aesthetic, historic, scientific or social significance or other special value for this and future generations. The Government compiles and maintains a Register of the National Estate. The Register now has over 11,000 places listed on it and helps meet the aim to educate Australians and alert them, particularly when making decisions, to places of heritage significance. Access to the Register of the National Estate will continue to be improved through updating of the comprehensive Internet site. Further development will centre around the issue of whether the Register becomes a comprehensive nation-wide database with input from all levels of government and the community. The National Estate Grants Program will continue its significant role in facilitating protection of the National Estate. It has been refocussed on projects of national importance with the two key funding priorities of identification, conservation and promotion of nationally important heritage places, and facilitation of community involvement in heritage activities. Priority in the short term will be given to cultural heritage.

Great Barrier Reef Marine Park Authority

The Great Barrier Reef Marine Park Authority is directly responsible for management of the Great Barrier Reef Marine Park. The Authority works jointly with a range of Commonwealth and Queensland government agencies, such as the Queensland Department of the Environment and the Queensland Fish Management Authority, to more effectively achieve Marine Park management objectives. The Authority will continue to focus on a series of issues which are critical for appropriate protection and use of the Great Barrier Reef Marine Park and World Heritage Area.

These Critical Issues as identified in the Authority's Corporate Plan are:

- World Heritage values;
- conservation: threatened species; representative areas; crown-of-thorns starfish and other large-scale ecological perturbations;
- tourism and recreation;

- Shipping and marine pollution;
- coastal development;
- effects of fishing;
- water quality; and
- Aboriginal and Torres Strait Islander issues.

During 1997-98, the Great Barrier Reef Marine Park Authority will give highest priority to addressing conservation issues, including the protection of threatened species; the provision of a comprehensive system of strictly protected representative areas; and tourism use management.

FINANCE

Science and Innovation in the Portfolio Budget

Major agencies in this portfolio include the Australian Government Analytical Laboratories and the Australian Surveying and Land Information Group.

The Australian Government Analytical Laboratories (AGAL) operate through the DAS Business Services Trust Account on a fee-for-service basis. AGAL play an important strategic role in the protection of Australian public health and safety and agricultural trade through its quality services in analytical chemistry and microbiology. AGAL's operations now include the Scientific Services Laboratory (SSL), which offers specialist advice, industry support and export facilitation activities, particularly in the areas of building, fire safety, paint technology, and low frequency electromagnetic radiation.

The Australian Surveying and Land Information Group (AUSLIG) operates through the DAS Business Services Trust Account. AUSLIG is part of the information services industry, specialising in surveying, mapping related products and professional services. AUSLIG's geodesy, national mapping, remote sensing, offshore boundary information and coordination of Commonwealth geographic information activities are supported through Budget appropriation of approximately $23 million and public interest sales of $5 million. These represent AUSLIG's core activities, which are delivered alongside a smaller commercial program.

The DAS Centre for Environmental Management (DASCEM) is a business unit which operates along commercial lines in the DAS Business Services Trust Account. In 1992, the Government allocated $4.2 million over four years to DASCEM to subsidise the deposits of halon from small business and the community with the Halon Bank. In the 1996 Budget, the Government allocated a further $5.3 million over four years to complete this program.

IPS Radio and Space Services is budget-funded at $3.6 million for 1997-98. IPS has extensive experience and expertise in analysing radio propagation and the frequency management aspects of radiocommunication systems, as well as the space environment that supports them. IPS provided the national radio propagation and space environment services.

1997-98 Science and Innovation Priorities

Australian Government Analytical Laboratories (AGAL)

Following the major business restructuring and reengineering program undertaken in 1996-97, AGAL is positioned to achieve a substantial improvement in financial performance commercial operations in 1997-98. AGAL will operate on a separate Trust Account from 1 July 1997 to ensure transparency of the application of competitive neutrality principles.

Two CSO funded public interest program initiatives will be implemented in 1997-98:

- development of the National Analytical Reference Laboratory to strengthen the accuracy of chemical measurement in the food, drug and environmental areas; and
- commencement of a Sydney 2000 Olympics Drug Research Program, to develop the new drug detection capabilities expected to be required for the Sydney 2000 Olympic Games.

Australian Surveying and Land Information Group (AUSLIG)

In accordance with 1996-97 Budget decisions, AUSLIG is responsible for coordination of Commonwealth land information programs, advice to Government on land information issues, and management of national mapping, geodesy, remote sensing and maritime boundaries programs. AUSLIG also has lead agency responsibility at Commonwealth level for development and implementation of the Australian Spatial Data Infrastructure (ASDI), an umbrella of policies, standards and procedures which will ultimately provide consistent national coverage of key geographic information.

AUSLIG is focusing on the management of programs and market testing their delivery for outsourcing. Market testing for topographic map and data production will be finalised by September 1997 and for satellite laser ranging operations and map data distribution by November 1997.

To provide fundamental land information for a range of government and non-government activities including public administration, defence and emergency services, transport, communications and resource and environmental studies, AUSLIG will:

- develop a Commonwealth policy for the implementation of ASDI;
- continue a cyclical program of revision and maintenance of national topographical maps and map data;
- assist with delineation of maritime zones in accordance with the United Nations Convention on the Law of the Sea;

- acquire and process Global Positioning System and satellite laser ranging data, and ensure availability of data via the Internet;
- maintain a program of acquisition and processing of data obtained from earth observation satellites; and
- facilitate private sector value adding to the products derived from these programs.

IPS Radio and Space Services (IPS)

Strategies of staff development, marketing to customers, harnessing new technologies, development of new services, and alliance with other groups for whole-of-government benefits will be pursued to maintain core business and increase the sales of IPS software.

IPS is pursuing a policy of having realtime data and services embedded in the longer term forecasting of space weather conditions. This requires reliable communication between the monitoring network and service delivery centres. The network is to be refurbished to increase data availability. The IPS monitoring network will be automated so as to provide the basic ingredients of customer services. This will link with the Internet to provide direct services, many in realtime.

New services in specialised technical training will be trialed with the Australian Defence Force.

Staff development, particularly through group participation and Individual Learning Agreements, is to be continued at the 2 percent salary level to lift technical and financial skills.

IPS engineering support will be reviewed against possible outsourcing.

HEALTH AND FAMILY SERVICES

Science and Innovation in the Portfolio Budget

Research activities are undertaken within the Health and Family Services Portfolio and are funded by it through major research funding programs. Research is undertaken by the Australian Radiation Laboratory, the Nuclear Safety Bureau, the National Acoustic Laboratories and the Australian Institute of Health and Welfare. Research funding is provided through the National Health and Medical Research Council (NHMRC), the Commonwealth AIDS Research Grants Scheme and a number of smaller grant schemes which fund applied medical and health research relevant to the activities of the Department of Health and Family Services.

Funding for health and medical research through the NHMRC in 1997-98 will be $156.4 million which includes funding for health services research ($150.0 million in 1996-97). Research into HIV/AIDS will be the subject of a $12.0 million program ($11.7 million in 1996-97).

The Australian Institute of Health and Welfare will receive $7.7 million ($7.6 million in 1996-97).

The budget for the National Acoustics Laboratories is allocated from the appropriation to the Australian Hearing Services. In 1997-98, this is expected to be maintained at the level provided in 1996-97, $3.8 million.

The appropriation for the Australian Radiation Laboratory in 1997-98 is $7 million. Of this about 25 percent will be spent on research and development ($1.8 million on R&D in 1996-97).

The Nuclear Safety Bureau will receive $0.9 million in 1997-98 ($0.9 million in 1996).

1997-98 Science and Innovation Priorities

Health Research and Information

Priorities for 1997-98 are:

- the advisory, information and research management capacity to support Commonwealth leadership in the introduction of evidence-based medicine;
- a high level of national health and medical research and training in research directed towards improving the health and well-being of the population;
- a high standard of ethics in national health and medical research; and
- an improved capacity to base health policy, health practice and government funding decisions on sound scientific evidence.

Australian Institute of Health and Welfare

Priorities for 1997-98 are:

- to be the leading agency in Australia in coordinating, developing, collecting where appropriate, and analysing data, and disseminating accurate, consistent and timely information and statistics, on the health of Australians and their health and welfare services; and
- to ensure the availability of competent, timely and reliable information on the full range of Australia's health and welfare services.

INDUSTRY, SCIENCE AND TOURISM

Science and Innovation in the Portfolio Budget

Portfolio activities in science and innovation are aimed at developing Australia's science and technology capabilities and infrastructure, ensuring effective benefits from public sector scientific research, and building competitive firms and a competitive national environment through the enhancement of innovation in the Australian business sector.

There are three scientific research organisations in the portfolio: the Australian Institute of Marine Science (AIMS), the Australian Nuclear Science and Technology Organisation (ANSTO) and the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

There are also agencies and programs supporting technological development in industry through the provision of grants, concessions and services. For example, the Industry Research and Development (IR&D) Board, which includes both industry and government representatives, is concerned with promoting the development and improving the efficiency and international competitiveness of Australian industry by encouraging research and development activities.

Science and technology policy advisory arrangements

- *Advice and awareness* of key issues and developing trends in science and technology is maintained at Cabinet level through the Prime Minister's Science and Engineering Council (PMSEC), consisting of the Prime Minister and other senior Ministers, business leaders, the Chief Scientist, eminent scientists and engineers, and representatives of leading professional organisations and science and engineering interest groups. Through the Minister for Science and Technology, PMSEC is supported by the Coordination Committee on Science and Technology (CCST), consisting of chief executives of major science agencies and Deputy Secretaries of Departments with science and technology interests and the Chief Scientist. CCST provides a means for improving coordination and cooperation on science and technology issues between departments and agencies. Secretariat support for PMSEC and CCST is provided by the Science and Technology Advisory Branch of the Department's Science and Technology Division.
- *Independent policy advice* to Government is provided by the Australian Science and Technology Council (ASTEC, to be re-named as the Australian Science, Technology and Engineering Council), which is chaired by the Chief Scientist, with secretariat support from the Science and Technology Advisory Branch. ASTEC is chaired by the Chief Scientist.

- *The Chief Scientist* provides advice on such matters affecting science, technology, and engineering as the Prime Minister or the Minister request, and on issues to which science and technology are relevant.
- *Policy advice and analysis* across a broad front relating to science, innovation, research and technology is provided by the Science and Technology Policy Branch of the Department's Science and Technology Division.

Business growth through AusIndustry

AusIndustry offers a suite of programs to help eligible businesses to grow, including support for R&D activities. AusIndustry programs include:

- The *Research and Development Tax Concession* allows companies registered with the Industry Research and Development Board to deduct eligible R&D expenditure at a rate of 125 percent when lodging their tax returns.
- The *Strategic Assistance for Research and Development (R&D Start) Program* is a competitive scheme that provides a mix of support measures, including grants and loans, for R&D projects in small to medium-sized enterprises.
- The *Technology Support Centres Program* is designed to facilitate the establishment of a national network of Technology Support Centres to improve industry's access to technology and technical advice. The program offers competitive grants in three categories: Network Grants; Technology Demonstration and Awareness Grants; and Feasibility Studies.
- The *AusIndustry Enterprise Improvement Program* is a joint Commonwealth/State program which provides extension services to firms in the traded goods and services sectors to increase internal efficiency and international competitiveness.
- The *AusIndustry Enterprise Networking Program* is designed to encourage small to medium-sized enterprises to cooperate with other firms in strategic areas of business to exploit opportunities beyond the reach of the individual firms. Support is available to establish networks, including customer-supplier, innovation and lead firm networks.

Industry development through innovation

- The *Australian Technology Group Limited* (ATG), a technology commercialisation company specialising in investment and management of early stage commercialisation of research outcomes from the public and private sectors.
- The *Pharmaceutical Industry Development Program*, of which the Factor (f) Scheme is a major element, contributes to the development of an internationally competitive pharmaceutical industry in Australia. Under Factor (f), companies can gain increased prices for some of their products listed on the Pharmaceutical Benefits Scheme in return for increased activity in Australia, including new investment,

production, research and development. The Factor (f) Scheme will be succeeded by the Pharmaceuticals Industry Investment Program (see page 2.8).

- The *Australian Industrial Property Organisation* provides industrial property rights services for inventions, trade marks and designs. Legal protection given with the rights encourages industry to develop and exploit new technology as well as facilitating the transfer of overseas technology to Australia. The organisation operates on full cost recovery.
- The *Computer Bounty* provides assistance for the production of computer hardware, certain assemblies, electronic microcircuits, printer circuit boards, modems and multiplexors, and certain operating software (due to end on 30 June 1997).
- The *Telecommunications Industry Development Plans* encourage the licensed telecommunications carriers and key suppliers to undertake strategic investment, R&D and export activities in Australia which are internationally competitive.
- The *Partnerships for Development and Fixed Term Arrangement Programs* encourage international companies in the information technology and telecommunications industries to undertake strategic investment, R&D and export activities in Australia which are integrated into the global marketplace.
- The *Renewable Energy Industry Program* aims to facilitate the development of a viable internationally competitive Australian renewable energy industry. The program aims to improve the competitiveness of the industry by the development of critical mass and increased access to export markets. Financial assistance is available on a competitive basis for projects which are already technologically proven, yet require assistance with commercialisation and/or market development.

Science, technology and industry linkages

- The *Cooperative Research Centres (CRC) Program* provides support for long-term collaborative ventures linking researchers and research users from universities, Commonwealth- and State-funded research organisations and business enterprises. It promotes high quality cooperative research and education programs through centres of research concentration, strengthening the links between research and its commercial and other applications.
- The *Major National Research Facilities (MNRF) Program* is directed at keeping Australia at the leading edge of scientific and technological developments. Under the Program, funding is provided for facilities in a range of key scientific fields where the establishment costs are beyond the capacity of any individual Australian institution. These facilities will create centres of capability for pursuing research with state-of-the-art equipment.
- The *Space Industry Development Centres (SIDC) Program* is directed at the development of an Australian commercial space industry. The objective of the program is to encourage industry to put R&D funds

into space-related activities through collaborative ventures with University-based space research centres. Two SIDCs are operating at Griffith University and Queensland University of Technology.

- The *International Science and Technology Program* aims to stimulate Australian involvement in international research collaboration and generate awareness of Australian S&T capabilities. A longer term aim is to build commercial opportunities through collaborative research.
- *The Science and Technology Awareness Program* aims to increase awareness and understanding of the central role which science and technology play in Australia's economic and social well-being.

Program or agency	Estimated expenditure 1996-97 $m	Budget estimate 1997-98 $m
AIMS	16.4	16.4
ANSTO	63.7	70.4
CSIRO	433.1*	466.8
Industry Innovation Program grants	68.5	164.3
CRC Program	141.9	146.2
Computer Bounty	56.5	19.5
Enterprise Development Program	23.9	32.6
Enterprise Networking Program	6.9	8.2
National Space Program	2.7	0.7
Science and Technology Awareness	2.0	2.3
International S&T Program	5.7	5.6
National Research Facilities	17.0	16.3
TOTAL	838.2	949.
PORTFOLIO TOTAL (Outlays)	3160.0	3198.6

* Takes into account the North Ryde loan repayment.

Budget support for these programs is shown in the table. The Australian Industrial Property Organisation is not included in the above figures as it operates on full cost recovery.

1997-98 Science and Innovation Priorities

AusIndustry

The key priorities for the AusIndustry sub-program in 1997-98 are to effectively deliver to client firms a broad range of Government business assistance programs, including:

- the *Strategic Assistance for Research and Development (R&D Start) Program*: The program aims to increase the number of R&D projects having high commercial potential (including collaboration with research institutions), and fosters greater commercialisation of outcomes of R&D projects. This will be achieved by:
  - targeted grants and loans assistance to SME companies;
  - promoting good planning and management of R&D and commercialisation of R&D through selection processes which give priority to these aspects; and
  - maximising economic growth by funding projects which have significant national benefit and spill over opportunities for Australian companies and industry.
- the *125% R&D Tax Concession Program*: The program aims to increase the level of business expenditure on R&D undertaken in Australia. A major emphasis in 1997-98 will be to:
  - promote the Tax Concession program to business generally to educate and advise claimants and potential claimants of the changes made to the Concession during 1996-97; and
  - expand monitoring activities under a risk management approach to encourage compliance by claimants under a self assessment regime.
- continue to develop measures which encourage greater levels of private sector research and development and commercialisation of technological innovation;
- implement the Government's new $130 million *Small Business Innovation Fund* relating to venture capital; and
- support the operation of the IR&D Board and its Committees in the operation of R&D Start and the R&D Tax Concession programs.

Industry Policy

Key priorities and activities for the Industry Policy Sub-program in 1997-98 include:

- giving priority to considering outcomes of, and the development of appropriate responses to, the Mortimer Review, the review of Pooled Development Funds Program, the alternative equity market study;

- contribute to the formulation of the *National Greenhouse Strategy*; and
- develop policies to support the advancement of cleaner production in industry.

Science and Technology

Key priorities for the Science and Technology sub-program in 1997-98 include:

- completion of the independent risk assessment of the research reactor (HIFAR);
- a marine science and technology plan as an integral part of the Government's oceans policy;
- increase collaboration between researchers and their active interaction with research users, through the Cooperative Research Centres (CRC) Program;
- contribute to the maintenance and enhancement of public research infrastructure by implementing the Major National Research Facilities (MNRF) Program; and
- raise awareness in Australia, and encourage a well informed policy debate, on the strong interrelationship between science, technology and economic and social wellbeing.

Australian Institute of Marine Science (AIMS)

The Australian Institute of Marine Science is seeking to generate the knowledge to support the sustainable use and protection of the marine environment through innovative, world-class scientific and technological research. In pursuit of this objective AIMS is working closely with some industries - e.g. offshore oil and gas, tourism, pharmaceuticals - and indirectly with others, such as fisheries, and has reorganised its research program to focus on problems of national significance.

The research program for the next triennium will be conducted within eight major projects:

- human impacts on coastal food webs and nutrient cycles;
- marine biogeochemistry, contaminants and global change;
- monitoring change in tropical marine biota;
- predicting the coastal marine environment;
- sustaining coral reefs;
- science supporting tropical fisheries;
- marine biotechnology - mariculture, biodiversity and genetics; and
- marine bioproducts.

Australian Nuclear Science and Technology Organisation (ANSTO)

Consistent with ANSTO's Strategic Plan (1997-2000), ANSTO's science will focus on five core scientific areas where nuclear science and technology and related capabilities offer strategic and technical benefit to Australia. These are:

- international strategic relevance of nuclear science;
- core nuclear facilities operation and development;
- applications of nuclear science and technology to the understanding of natural processes;
- treatment and management of man-made and naturally occurring radioactive substances; and
- competitiveness and ecological sustainability of industry.

To underpin its core science activities, ANSTO is concentrating on a limited number of areas of knowledge generation (Topics) that have the potential to contribute to the socio-economical development of Australia. In 1997-98 strategic research will continue on seven such Topics:

- ecological sustainability and competitiveness of the mining and mineral (particularly uranium) industries;
- international cooperative research to enhance safety of nuclear facilities and safeguards for nuclear materials;
- environmental dynamics - application of nuclear techniques;
- global climate change - application of nuclear techniques;
- radioactive waste management;
- designer materials; and
- radionuclides and radiopharmaceuticals for the 21st century.

Commonwealth Scientific and Industrial Research Organisation (CSIRO)

1997-98 is the first year of a new funding triennium for CSIRO. CSIRO's budget for the new triennium was agreed with the Government at the time of the 1996-97 Budget.

In order to secure maximum benefits from R&D for Australia, CSIRO seeks to focus on those areas where there are firm signals of market or community support for CSIRO's research. CSIRO seeks to assemble strong interdisciplinary teams that are internationally competitive, of critical size, and which address areas where R&D can best contribute to national well-being.

CSIRO's Planned Investment Profile 1997-98

CSIRO Alliance and Sector	Appropriation Funds	Total Funds[1]
Agribusiness		
Field Crops	6.2%	6.5%
Food Processing	3.9%	4.1%
Forestry, Wood & Paper Industries	3.7%	3.8%
Horticulture	2.3%	2.3%
Meat, Dairy & Aquaculture	9.2%	9.2%
Wool & Textiles	6.4%	7.0%
Environment & Natural Resources		
Biodiversity	4.6%	4.7%
Climate & Atmosphere	4.6%	4.3%
Land & Water	5.0%	5.0%
Marine	5.1%	4.4%
Information Technology, Infrastructure & Services		
IT&T	4.8%	4.4%
Infrastructure (Built Environment)	5.4%	5.1%
Measurement Standards	2.0%	1.7%
Radioastronomy	2.9%	2.6%
Services	1.9%	1.8%
Manufacturing		
Chemicals & Plastics	3.7%	4.1%
Integrated Manufactured Products	7.7%	7.0%
Pharmaceuticals & Human Health	4.8%	4.2%
Minerals & Energy		
Coal & Energy	4.3%	4.7%
Mineral Exploration & Mining	4.1%	5.0%
Mineral Processing & Metal Production	5.7%	6.1%
Petroleum	1.8%	2.0%

1 Including projected external earnings, total available funds in 1997-98 are estimated to be $693 million

For the triennium commencing on 1 July 1997, CSIRO will increase its allocation of appropriation funds to the Marine and Petroleum Sectors. There will be some reduction of funds for the Building Materials Component of the Infrastructure (Built Environment) Sector. CSIRO's planned investment of appropriation funds, and of total funds including external earnings, is illustrated in the accompanying table.

Within each Sector, those points at which CSIRO's involvement can make the greatest contribution are identified with the assistance of a Sector Advisory Committee. These priority areas, and specific planned outcomes for each of the 22 Sectors, are identified in the soon to be published CSIRO Strategic Research Plan. Further detailed information on anticipated performance will be available in the CSIRO Operational Plan 1997-98, to be published in July 1997.

PRIMARY INDUSTRIES AND ENERGY

Science and Innovation in the Portfolio Budget

The objective of the research and assessment programs operating within the Primary Industries and Energy Portfolio is to contribute accurate information and high quality scientific and economic research, analysis and advice to assist informed and objective decision-making processes for resources management, ecologically sustainable development and industry competitiveness.

Strong linkages with industry and relevant parts of Government, at both corporate and program levels, are essential to ensure the structural and administrative arrangements for research and development facilitate these outcomes. Portfolio R&D structure and arrangements are designed to take into account Government and industry needs and objectives in the development of research programs, and to facilitate the rapid integration of outcomes from new technologies into industry so it benefits directly from the R&D.

Two key institutional arrangements exist within the Portfolio which influence the strategic and operational aspects of Portfolio research objectives and priorities:

- three independent research bureaux; and
- fifteen Research and Development Corporations and one Research and Development Council.

These institutional arrangements allow the key stakeholders in the Portfolio's research effort, including producers, scientists, and Commonwealth and State Government policy and program managers, to have an input into research priority setting.

Research Bureaux

The structure of the Department of Primary Industries and Energy includes three independent research bureaux:

- the Australian Bureau of Agricultural and Resource Economics (ABARE);
- the Australian Geological Survey Organisation (AGSO); and
- the Bureau of Resource Sciences (BRS).

The research bureaux play a vital role in the conduct of public sector research and provide scientific and economic analysis to assist the process of government. The intention is to ensure that research, scientific, technical

support and resource related policy advice to Government is provided in the most efficient way and takes into account the interests of Australia's primary and energy industries and the broader community.

Research undertaken by these bureaux is funded predominantly from consolidated revenue and will total around $73 million in 1997-98. It is generally directed to areas where the external benefits are high, to the more basic lines of research, to research that may have a wide social impact, and where user-pays funding is not generally cost-effective. In addition, the bureaux undertake research on a contract basis for other agencies and industry.

R&D Corporations and Councils

The R&D Corporation model is an alliance between industry and the Government that seeks to increase the economic, environmental and social benefits to industry and the general community with innovation through R&D.

R&D Corporations and Councils were established to:

- attract a higher level of industry expenditure on R&D by providing funding incentives for statutory levies;
- maximise the benefits to both industry and the general community by integrating public and private good R&D;
- achieve effective transfer of technology and a high rate of adoption and commercialisation of research by placing emphasis on the total innovation process;
- cause the research undertaken to be demand driven by involving industry in the setting of R&D priorities; and
- allow R&D Corporations to operate in a commercial environment relatively free from Government control of their R&D investment while making research managers fully accountable to both industry and Government.

There are currently twelve rural industry R&D Corporations, and one rural industry R&D Council:

- Australian Wool Research and Promotion Organisation;
- Cotton R&D Corporation;
- Dairy R&D Corporation;
- Fisheries R&D Corporation;
- Forest and Wood Products R&D Corporation;
- Grains R&D Corporation;
- Grape and Wine R&D Corporation;
- Horticultural R&D Corporation;
- Meat Research Corporation;
- Pig R&D Corporation;

- Sugar R&D Corporation;
- Tobacco R&D Corporation;
- Dried Fruits R&D Council.

The R&D Corporations and the R&D Council are jointly funded by industry and the Commonwealth, with Commonwealth contributions generally matching on a dollar-for-dollar basis levies (or export charges) up to a maximum of 0.5 percent of the industry's gross value of production (GVP). Beyond the GVP limit, no Government funds are provided to match levies (or export charges). Exceptions to these arrangements are the Fisheries R&D Corporation which, in addition to appropriation funding of 0.5 percent GVP, has dollar-for-dollar matching up to 0.25 percent of GVP, and the Forest and Wood Products R&D Corporation which receives one Commonwealth dollar for every two industry dollars matching up to 0.25 percent of GVP.

Three other R&D Corporations in the Portfolio receive the majority of their funding through appropriation:

- Energy R&D Corporation;
- Land and Water Resources R&D Corporation;
- Rural Industries R&D Corporation.

Direct funding of R&D by Government was judged as being appropriate for these Corporations, particularly as the private sector is likely to underinvest in R&D in these fields and substantial benefits could accrue to the community as a whole. These Corporations are, however, able to generate income from royalties and licences for successful R&D they have sponsored, to solicit funds to finance worthwhile research proposals, and to accept voluntary contributions from industry.

In addition to its appropriation, the Rural Industries R&D Corporation also receives funding from industry levies from smaller industries which are matched by the Commonwealth in a similar manner to the industry specific R&D Corporations.

The Corporations and the Council report and are accountable to both their respective industry and either the Minister for Primary Industries and Energy or the Minister for Resources and Energy. As a result they are aware of, and responsive to, the needs of both industry and Government.

1997-98 Science and Innovation Priorities

Australian Bureau of Agricultural and Resource Economics

Outlook for 1997-98

Throughout 1997-98, the Australian Bureau of Agricultural and Resource Economics (ABARE) will be embarking on a program of work in the international trade sphere for agricultural products. This work is designed to assist Australian negotiations in major international forums to attain greater access to markets for Australian farm products and to reduce competition from subsidised products produced elsewhere. The focus of the work is in two main areas - preparation for the next round of World Trade Organisation multilateral agricultural negotiations which is scheduled to commence in 1999, and work for Australian negotiators and the APEC Food Task Force for the APEC negotiations.

ABARE will further develop GIGABARE the next generation of its global trade general equilibrium model. In addition to the features of the existing model (MEGABARE), GIGABARE will incorporate linkage between policy changes and labour markets; substantially greater detail in the representation of key sectors and economies and an enhanced representation of the dynamics of technological change. These new features will give ABARE the capability to provide projections and scenario analysis for fields such as energy supply, demand & security; food security; forest sinks; and urban development implications of economic growth and environmental analysis, including integrated assessments of climate change linking costs and benefits.

ABARE will continue in the four-year development of the Comprehensive Regional Assessment (CRA) process - a key initiative of the National Forest Policy Statement. To analyse the economic and social impacts of changes in forest use, ABARE researchers will continue to develop and enhance a spatial economic model, called FORUM.

Commodity outlook analysis will remain a cornerstone of ABARE activities. Emphasis will be given to the development and public release of both short and medium term outlooks for the agricultural and resource sectors. In 1997-98, there will be increased attention given to further improving forecasting techniques for the agricultural sector.

ABARE will continue to collaborate with industry to collect a comprehensive set of physical, financial and socio-economic data from Australia's primary and energy sectors through its industry surveys. This year ABARE will be seeking additional information from the rural sector on the use of irrigation in horticultural regions as well as on broadacre and dairy farms. Analyses of these data will form part of a wider assessment of the impacts on farmers and rural communities of irrigation policies in the Murray-Darling Basin and of the need for major expenditures on refurbishment of irrigation and other infrastructure.

To assist decision makers, ABARE will continue to disseminate its research output widely through its annual OUTLOOK conference, to be held on 3-5 February 1998, regional conferences throughout Australia, presentation of papers at other conferences and government and industry meetings, distribution of its own series of publications, and media coverage of these events.

Bureau of Resource Sciences

Outlook for 1997-98

The Bureau of Resource Sciences (BRS) National Resource & Information Centre will extend the use of its Sustainable Land Use Information System to help achieve sustainable development in Australia's highly variable climate.

BRS's National Residue Survey will underpin the Supermarket to Asia export initiatives by continuing to support increased involvement of horticulture industries in random monitoring programs.

BRS will provide scientific and technical analyses and advice on priority energy and greenhouse gas emission issues for the portfolio. This includes establishing a method for calculating rates of emission resulting from biomass removal and soil carbon disturbance for the national greenhouse gas inventory.

BRS will continue to publish best-practice management guidelines for the major feral animal species

BRS will complete Comprehensive Regional Assessments of Forests for Eden and the Central Highlands districts and update its National Plantation Inventory.

BRS will develop and implement techniques for assessing the impact of fishing on unwanted species and the marine environment.

BRS will publish 1997 *Fisheries Status Reports* and extend their scope to included non-target species.

BRS will continue to provide high quality independent scientific advice on quarantine issues, and develop methods for quarantine risk assessment of proposed imports.

BRS will continue to promote petroleum exploration in Australia by producing reference maps, digital data and status reports; managing physical and seismic data lodged under the *Petroleum Search Subsidy Act 1957* and the *Petroleum (Submerged Lands) Act 1967;* and publishing studies of the petroleum prospectivity of Australia's offshore sedimentary basins.

BRS will integrate social and natural resource assessments into decision support systems for multiple and sequential land use.

Australian Geological Survey Organisation

AGSO will maintain a program of geoscientific mapping and research activities in cooperation with State/Northern Territory geological surveys under the National Geoscience Mapping Accord and continue to provide new geoscience information for specific regions of Australia to encourage minerals exploration and assist responsible resource management.

The Australian Ocean Territory (AOT) Mapping Program will continue with completion in 1997-98 of technical data acquisition and data analysis for the documentation of Australia's legal continental shelf claim under the United Nations Convention on the Law of the Sea, which must be submitted to the UN by 2004. This will involve data acquisition for remaining three of the nine areas subject to Australia's claim under the Convention. Seabed mapping under the AOT program for resource and environmental management purposes will focus in 1997-98 on offshore areas of Western Australia. Marine data acquisition and analysis activities will also be maintained to support the Petroleum Acreage Release program with the objective of improving understanding of petroleum prospectivity in Australia, the main focus of this activity being in offshore Western Australia.

AGSO will continue to undertake geoscientific research into land and water resources, with specific focus on land degradation and groundwater management strategies in the Murray-Darling Basin and Great Artesian Basin, as well as groundwater quality assessment in Aboriginal lands to enable Aboriginal communities to manage their water supplies.

AGSO will continue to undertake a geohazards program that will assess earthquake and magnetic risk using its nation-wide observatory network and contribute to risk assessment and mitigation of earthquake, landslide, tsunami and vulcanological risk with an emphasis on city environments.

TRANSPORT AND REGIONAL DEVELOPMENT

Science and Innovation in the Portfolio Budget

Areas in the portfolio dealing with science and technology relate to road safety and motor vehicle emissions research conducted by the Federal Office of Road Safety, and transport sector research conducted by the Bureau of Transport and Communications Economics, and by ARRB Transport Research Ltd. Expected expenditure outcomes are $2 million for 1996-97 and $4.4 million for 1997-98.

1997-98 Science and Innovation Priorities

Federal Office of Road Safety

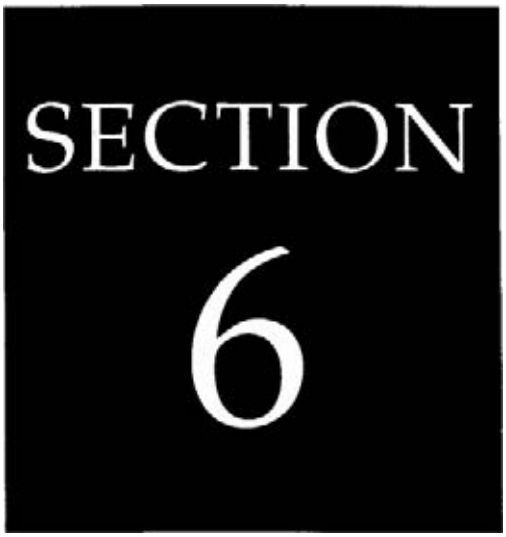
Priorities in 1997-98 include:

- implementation of new Australian Design Rules including offset frontal and side impact protection standards for passenger cars, heavy vehicle braking standards, and emissions standards for petrol and diesel vehicles. Research emissions for LPG, petrol and diesel vehicles and improve vehicle design for pedestrian safety;
- undertaking research analysis and public education integrated with national strategies: including research on vehicle safety standards; speed management; and heavy vehicle driver fatigue;
- development of common vehicle design rules between Australia and New Zealand, emphasising the role or vehicle standards harmonisation for improved export prospects. Promotion of Australian road safety expertise in APEC and the ASEAN region;
- progressing road transport reform, including the national road transport reform program strategy, the second Heavy Vehicle Reform Package, alternative compliance schemes for industry, and publishing the 6th edition of the *Australian Code for the Transport of Dangerous Goods by Road and Rail.* Implementing the outcomes of the *Review of National Road Transport Legislation,* as agreed by COAG;
- review of the *Motor Vehicle Standards Act* and implementation of a new vehicle certification system with electronic lodgement and processing. Improved client services with the development of a Client Service Charter; and
- implementing year two of the Federal Road Safety Black Spot Program.

Bureau of Transport and Communications Economics

Priorities in 1997-98 include:

- Eastern Indonesia and Northern Australia transport synergies study;
- methodological issues in assessing transport infrastructure;
- projected demand for infrastructure;
- non-urban rail infrastructure;
- urban infrastructure;
- air services model;
- *Transport and Communications Indicators;*
- *Waterline,* including waterfront reliability indicators and monitoring crew-to-berth ratios;
- development of a communcations and the arts database;
- compendium of transport statistics;
- greenhouse benefits of improved roads;
- film and TV program production;
- access to information and communications services; and
- digital radio broadcasting.



Research Achievements

Introduction

This Section complements the discussion in other sections with an account of recent achievements for the major research agencies and programs. While necessarily selective, these are intended to be illustrative of the discoveries, advances in understanding, improvements in techniques, or steps in commercialisation which are the outcomes of the financial support received.

Where contact details have been provided by contributors, these are included after each achievement.

COMMUNICATION AND THE ARTS

National Film and Sound Archive

Role *To increase knowledge, appreciation, use and enjoyment of Australia's screen and recorded sound heritage by acquiring, preserving and providing access to a national collection of film, television, video, radio and recorded sound materials.*

The Engineering and Research Group provides engineering support and strategic technical research for the Archive. The group focuses on future directions in technologies, such as digital video and audio, as well as conservation of audiovisual materials and assessment of current handling and storage practices.

Recent Achievements

Film unblocking
The Archive has researched the process where film layers adhere into a solid mass, either from decomposition or high humidity. A chemical model of the blocking mechanism has been developed, and identifies a range of solvents that address the problem. Film once thought destroyed has been restored successfully.

Tape quality
Following the adoption of Digital Audio Tape for high quality sound recording, the Archive has set up a system for measuring errors in these tapes. Accurate detection of errors in new tapes will help determine the most appropriate stock for use in the Archive; and error detection in existing Archive tapes will be used to monitor the current health of the collection and its rate of deterioration. This in turn will more accurately determine the storage and handling standards to be specified for the Archive collection.
{Contact: Mark Nizette, Preservation Branch, National Film and Sound Archive, tel: (06) 209 3055, fax: (06) 209 3165, e-mail: Mark_Nizette@nfsa.gov.au, http://www.aa.gov.au/nfsa/nfsa.htm}

DEFENCE

Defence Science and Technology Organisation (DSTO)

Role *To give advice that is professional, impartial and informed on the application of science and technology that is best suited to Australia's defence and security needs.*

Recent Achievements

Radar surveillance
The first stage of an experimental national air surveillance system was installed and evaluated during exercise Pitch Black 96. The system combined over-the-horizon and microwave radar data for use at the Sector Air Defence Operations Centre in Darwin. It will be used to support the development of operational requirements for future ADF command and control systems.

Communication networks
An advanced computer simulation model has been developed and used extensively to test highly complex communication networks for traffic handling performance and survivability. The model will be used to define minimum standards for Defence contracts. It will provide a tool for industry to refine final system designs and it will enable Defence to rapidly test and evaluate delivered systems over a wide range of ionospheric conditions.

Satellite surveillance
Several collaborative surveillance trials with the US used satellite observations of targets in Australian air-space. The trials have helped refine and validate models used in the evaluation of satellite capabilities for wide area surveillance.

Brighter outlook for maritime surveying
A new optical filter has been developed for the Laser Airborne Depth Sounder (LADS) system. The filter screens out sunlight reflected from water and allows transmission of laser reflections, thus allowing survey operations to be conducted during brighter conditions than hitherto.

Improved air defence systems
A collaborative study with industry has demonstrated enhanced performance of air defence systems. This involved modifying combat system software to assess the threat regimes of surface to air missiles during engagements. The results of this work will be incorporated into the ANZAC frigate combat system.

Eyes in the sky
The Ingara imaging radar has been further developed into an airborne system tailored to surveillance over land and contiguous littoral areas. It is now able to detect smaller objects, such as stationary and moving vehicles or watercraft while undertaking surveillance at high coverage rates.

Maritime radar
A software tool has been developed which uses computer simulations of radar backscatter from the surface of the ocean to assist in the design of maritime surveillance radars.

Artificial intelligence for the Air Force
The SWARMM Air Mission model, developed by DSTO and the Australian Artificial Intelligence Institute, is now employed by DSTO to support RAAF operational tasking. SWARMM employs an advanced artificial intelligence reasoning system to model military team and individual operational procedures.

F-111 engines
DSTO has developed an automated test system for acquiring and processing engine performance and vibration data from F-111 engines. The system will greatly improve engine diagnostic capability and reduce operator exposure to high intensity noise.

Industry and external relations
DSTO signed four new industry alliance agreements and granted ten licences for the following technologies: radar absorbing material, track pads for armoured vehicles, chemical equilibrium calculations for detonation products, technology demonstrator for recognised air picture, ionospheric simulation software, fast Fourier digital processing cards, real time frequency management algorithms, software analysis tools, and the Starlight information security device.

DSTO now shares information and intellectual property under eighteen alliances, participates in eight Cooperative Research Centres and has 59 licence agreements. An Affiliation Agreement in the area of Human Factors was signed with an Australian university, a Memorandum of Understanding with a French company for collaborative research on Helmet Mounted Displays was signed, and a three-way collaborative program involving an Australian university and the US Air Force, to develop new weapons guidance concepts, was established.

EMPLOYMENT, EDUCATION, TRAINING & YOUTH AFFAIRS

Recent Achievements

Research activity in universities is supported by all of the programs listed in Section 5 as well as funds from other sources including Commonwealth Government agencies, State Governments, business, private non-profit organisations and international sources. Any given group of researchers is likely to receive support from several sources, including more than one ARC/DEETYA program. The recent research achievements listed below have all benefited from ARC/DEETYA research support programs and are arranged by broad field of research from the Australian Standard Research Classification. Given the increasingly multidisciplinary nature of research and technology, some activities would involve major inputs from more than one major field of research. In most cases researchers themselves have indicated the appropriate field of research classification for each research achievement.

Biological Sciences

Turning off pollen
Botanists at La Trobe University have developed a mechanism for turning off pollen production in plants during breeding programs. This could be used to increase crop productivity by up to twenty percent, and is subject to a provisional patent. The team has discovered eight genes in the *Arabidopsis* plant believed to be crucial in the development of plant tissues and organs. Known as myb genes, they act as master switches - triggering the major developmental stages in a plant's life cycle. Canola will be the first target crop of a joint research initiative applying the mechanism.

A long way to swim for sex (on the reef)
Recent research at James Cook University has used a remote ultrasonic tracking technique to demonstrate that the coral trout, an important coral reef fisheries species, rarely strays more than a few hundred metres from its favourite patch of coral. An important exception to this stay-at-home habit occurs during the annual spring reproductive season, when some coral trout travel as far as five kilometres to reach spawning aggregation sites where they are more vulnerable to fishing. Given the fish's importance in commercial and recreational fishing, this understanding will help improve management strategies for long-term sustainable use of this resource.
{Contact: Mr Dirk Zeller, Department of Marine Biology, James Cook University of North Queensland, tel: (077) 81 5732}

Australia's oldest amphibians

University of Queensland researchers have discovered some of the world's oldest fossil amphibians in Central Queensland, including amphibians not previously found outside the northern hemisphere. The fossils are the first Australian evidence of how and why fish first crawled onto land 350 million years ago, leading to the emergence of amphibians and modern reptiles, birds and mammals. Palaeontologists had assumed that the breakthrough from water to land-based animals occurred in Euramerica, because the earliest fossil amphibians had been found there, particularly in Scotland and North America. The discovery means that the great breakthrough onto land is just as likely to have occurred in Australia, as in Europe or North America. The researchers published their findings in June 1996 in the prestigious scientific journal, *Nature*.

{Contact: Dr Tony Thulborn, Zoology Department, University of Queensland or Mr Hamley, Zoology Department, University of Queensland}

Tropical grasslands in the 21st century

Understanding how rising atmospheric carbon dioxide (CO_2) and climate change will affect tropical grasslands is essential for the sustainable management of one of the world's most productive ecosystems. These grasslands are important because they store twenty-six percent of the world's terrestrial carbon and provide millions of people with a livelihood. Physiologists in the School of Horticulture at the University of Western Sydney, Hawkesbury, have discovered that the growth of tropical grasses is very sensitive to drought and low humidity, but that increasing the atmospheric CO_2 to concentrations expected in the next 200 years overcomes the inhibitory effects of these stresses. The results are being incorporated into a model, developed by the Queensland Department of Natural Resources, to evaluate risks of pasture degradation.

Algae fight bacteria

Researchers at the University of New South Wales have discovered that secondary metabolites produced by a marine alga inhibit bacterial colonisation on its surfaces. The discovery has implications for the development of control measures for bacteria, including many that cause disease in humans, animals and plants.

{Contact: Professor S Kjelleberg, tel: (02)9385 2102}

Heat stable enzymes for brewing

Considerable international effort has been directed to the identification of heat stable enzymes for use in the malting and brewing processes. In particular, enzymes known as beta-glucanases help remove barley polysaccharides that cause haze in beer. However, these enzymes are usually unstable at the higher temperatures used in brewing processes and the troublesome polysaccharides are incompletely removed. In collaboration with x-ray crystallographers at the Biomolecular Research Institute, staff at the University of Adelaide have engineered greatly enhanced heat stability into a native barley beta-glucanase.

Malaria unmasked!
A University of Melbourne plant scientist has discovered that the organism responsible for the disease malaria has plant genes and it is better thought of as a plant and not an animal. This discovery has added a major new dimension to efforts to fight the disease. The discovery was made with collaborators in Canada and the USA.
{Contact: Dr Geoff McFadden, Department of Botany, tel: (03) 9344 5054}

Bacteria as natural food preservative
Scientists at the University of Melbourne have found that natural agents made by lactic acid bacteria could replace chemical preservatives in many processed foods. They found that bacteriocins are active against key pathogenic organisms found in processed meats, dairy products and similar food. The use of these bacteriocins as preservatives may have enormous impact on world food processing and distribution.
{Contact: Dr Barrie Davidson, Department of Biochemistry and Molecular Biology, tel: (03) 9344 5912}

Linking grass pollen, hayfever and asthma
A multidisciplinary team at the University of Melbourne has identified the genetic segments of grass pollen allergens. This information has led to a better understanding of how these allergens trigger hayfever and allergic asthma. Genetic information also provides material for use in the diagnosis and treatment of pollen-induced allergies, and in the design of new therapeutic vaccines. The investigations have resulted in patents and commercial interest.
{Contact: Professor Bruce Knox, School of Botany, tel: (03) 9344 5055}

Reproduction in native mammals
Little is known of the reproductive endocrinology of most native mammals and many animals have proved difficult or impossible to breed in captivity. Melbourne University scientists have developed a new assay technique for measuring reproductive hormones in faecal samples of captive and wild monotremes and marsupials, which will allow, for the first time, study of these animals without the disturbances associated with handling. Zoos and sanctuaries have shown considerable interest in the project for its potential value in the management of captive breeding programs, particularly for endangered species.
{Contact: Dr Barbara Evans, Department of Zoology, tel: (03) 9344 4951}

Yabbies distribute trace metals
Research at Southern Cross University has identified the geochemical effects of populations of yabbies. These burrowing shrimp affect the sediment in terms of the geochemical profile, the distribution of several trace metals and the exchange of the metals between sediment and water. Several trace metals are concentrated in the walls of the yabby burrows and even more concentrated in faecal pellets. The findings of the study have interesting implications both for environmental management and for understanding the formation of some types of sedimentary ore deposits.

Groundwater resources and native vegetation

Public supply and private use of groundwater has led to a significant decline of native vegetation. Researchers at Edith Cowan University in collaboration with government and industry have established a generic biomonitoring program to assess the efficacy of environmental water provisions. The results of the study involve an adaptive strategy for the management of groundwater resources and conservation of native phreatophytic *Banksia* woodlands, groundwater dependent wetlands and riverine vegetation of the Swan Coastal Plain.

{Contact: Dr Ray Froend, tel: (09) 400 5563, e-mail: R.Froend@cowan.edu.au)

Temperature regulation of salmonid spawning

A collaborative project involving industry, the Cooperative Research Centre for Aquaculture and the University of Tasmania, has shown that the hormonal response to elevated temperature in rainbow trout provides a possible key to commercially valuable phase-shifting of spawning in Atlantic Salmon. High temperatures during egg development retard ovulation and spawning by interfering with hormonal control of the final stages of oocyte maturation. The process appears to be reversible and is being investigated as a possible tool to retard or advance salmon spawning so as to extend the commercial harvest season.

{Contact: Professor N Pankhurst, Department of Aquaculture, University of Tasmania, tel: (03) 6324 3813, fax: (03)6324 3804}

World's oldest living plant

Lomatia tasmanica (Proteaceae) is a rare and endangered plant species from south-west Tasmania. Scientists from the University of Technology, Sydney and the Parks and Wildlife Service, Tasmania, have completed a genetic analysis of the species to assist conservation plans. It was found that the species possesses no genetic diversity and an abnormal number of chromosomes. This strongly suggests that the entire species is a single clone that propagates vegetatively. The *L. tasmanica* clone (spanning 1.2km) is the second longest in the world and is therefore very old. Fossil leaf fragments, identical to living *L. tasmanica*, were found in a fossil deposit 8.5km from the extant population. These fossils have been carbon dated to 43,600 years which suggests *L. tasmanica* may be a plant that has regenerated and survived longer than any other living plant in the world today.

{Contact: Dr R Vaillancourt, Department of Plant Science, University of Tasmania, tel: (03) 6226 2603, fax: (03) 6226 2698}

Tagged birds reveal feeding secrets

Penguins and muttonbirds, carrying special radio transmitters and miniature computers, have revealed one of their most closely guarded secrets - where they collect their food. Researchers at Charles Sturt University have completed a study of Little Penguins and Wedge-tailed and Short-tailed Shearwaters, commonly known as muttonbirds, which nest on Montague Island. Preliminary results have revealed very different feeding patterns. Little Penguins fed in the nearby mainland bays and Wedge-tailed Shearwaters fed close to the coast and around the island, while the

Short-tailed Shearwaters flew at least 500 kilometres for up to ten days to feed. The research will provide an 'early-warning' system of environmental threats and so help in the protection of these and other species.
{Contact: Dr Nick Klomp, School of Environmental and Information Sciences, tel: (060) 41 9905, fax: (060) 41 9897}

Test for fish food poisoning
Using mass spectrometry, University of Queensland and Department of Primary Industries researchers have developed a method to detect a toxin responsible for around 25,000 food poisoning cases in the world each year. Ciguatera occurs after consumption of warm water fish contaminated with highly potent ciguatoxins; it frequently occurs in the atoll islands of the Pacific and also affects many Australians each year. Symptoms of ciguatera can be severe and may persist for many months; despite its potency in humans, the toxin can remain in fish for many years without any apparent effect. The test uses a simple lipid extract from a few grams of fish, rather than the more complex animal models (bioassay tests). It is thought to be the world's first such test for ciguatoxins.
{Contact: Dr Richard Lewis, Centre for Drug Design and Development, University of Queensland}

Leaf scald resistant sugarcane
Researchers from the University of Queensland and extension officers from the Bureau of Sugar Experiment Stations have discovered a gene resistant to the devastating sugarcane disease, leaf scald. The discovery has the potential to save the Australian and world sugarcane industry millions of dollars. Leaf scald occurs in more than 50 countries worldwide, is easily spread and can rapidly destroy an entire sugar crop. The gene, which inactivates the toxins produced by leaf scald bacteria, was cloned and implanted in two sugarcane varieties; so far none of the plants implanted with the resistance gene have developed leaf scald.
{Contact: Dr Robert Birch, Department of Botany, University of Queensland)

Cane toad advance
Researchers have devised a method for documenting the impact of cane toads on frog populations. Scientists from the Universities of Queensland, New South Wales and Melbourne established a network of solar-powered computer systems south of the Kakadu wetlands to record frog calling activity before and after the arrival of cane toads. Ten recording stations in pairs over a 120 mile stretch of wetlands were set up. Over the next five years it is expected to yield the first firm scientific data on the impact of cane toads on native fauna.
{Contact: Professor Gordon Grigg, Head, Department of Zoology, University of Queensland}

Earth Sciences

New base for surveying

Researchers from Curtin University in WA, the University of South Australia and the University of New South Wales have investigated the basis for the determination of the Australian geoid. The geoid is an imaginary surface at mean sea level, extending under the Australian continent. The methods and software will be supplied to the Australian Surveying and Land Information Group, who will release this as AUSGEOD97. The new geoid will allow Global Positioning System users to determine heights and will have wide application in Australia's surveying community.

{Contact: Dr Will Featherstone, tel: (09) 351 2734}

Oasis in a marine desert

The Coral Sea supports a reasonable yellow fin tuna fishery, despite being a virtual marine desert. Researchers from the University of New South Wales and CSIRO have discovered that Cato Reef, some 400 km east of Gladstone, acts as a great stirring rod, drawing up nutrients into the surface waters and stimulating the production of algae and zooplankton. Small fish that tuna feed on were found to be growing faster in the area of flow disturbance. Cato Reef provides a useful natural model for determining the effects of nutrient enrichment.

Fossils discovered in Antarctica

Research by palaeontologists at the University of Melbourne has led to a discovery of a unique deposit of marine fossils in Antarctica. The deposit of shell, whale and dolphin fossils are the only preserved evidence of marine fossils from the last 30 million years on the Antarctic continent.

{Contact: Dr Stephen Gallagher, School of Earth Sciences, tel: (03) 9344 6513}

Ultrastructure of clay coatings

Coatings of clay around soil structural pores affect water, nutrient and pollutant movement in the environment as well as being diagnostic features of soil formation. Research at Southern Cross University using electron microscopic methods has demonstrated that ultra-thin clay coatings are a widespread and common feature, the effects of which must be taken into account when assessing soil behaviour.

Clues to new mineral deposits

Researchers at the University of Tasmania have been working with mining companies on finding large zinc-lead-silver mineral deposits in the sedimentary basins of Northern Australia. Chemical and sedimentological indicators have been determined which allow geologists to locate a deposit not visible on the surface from up to 25 kilometres away.

{Contact: Professor R Large, Centre for Ore Deposit Research, University of Tasmania, tel: (03) 6226 2472, fax: (03) 6223 7662}

Evolution of the Riverina Plain

Research at Charles Sturt University has led to the development of a chronologically calibrated stratigraphic model showing the evolution of the Riverina Plain over the last 100,000 years. The study combined thermoluminescence dating, remote sensing and access to extensive sub-surface data. It shows that the rivers of the last glacial cycle had larger flood flows and carried a greater volume of coarse-grained bedload sediment than those of the present.

{Contact: Dr Ken Page, Head, School of Science and Technology, tel: (069) 33 2540, fax: (069) 33 2737}

Banded iron formations

Researchers at the University of Western Australia have been studying the origins of the banded iron formations in the Hamersley Ranges, which contain Australia's major iron resources. The research shows iron formations were deposited 2.45 billion years ago on an ancient continental shelf accompanied by emplacement of a large igneous province comprising 30,000 cubic kilometres of volcanic and intrusive rocks. This provides evidence of intense activity during what was believed to be a quiet period of Earth history. As banded iron formations provide evidence of rising oxygen levels in the ocean and atmosphere, demonstration of a direct link between deposition of the world's largest banded iron formations and a period of intense volcanism has important implications for models of the early evolution of the biosphere.

{Contact: Dr Mark Barley, Centre for Strategic Mineral Deposits, tel: (09) 380 2603}

Computer takes geologists on a journey back in time

The evolution of the planet over the past 500 million years is being modelled into a few minutes of computer based graphics by La Trobe University geologists. Fission track dating data was used to reconstruct ancient landscapes and locate potential sites of mineral deposits. These studies in Australia have become the major reference point for similar work around the world. Ancient river systems have already been reconstructed in south-west Africa to help De Beers find where diamond-bearing deposits have been eroded and deposited on the African coast.

Social Sciences and Humanities

Visual stability

Research at the University of Western Australia has shown that activity shuts down just before eye-movements in one of two pathways from eye to brain, but not in the other. The pathway that shuts down deals with motion so the positive result is we are not disturbed by motion when we move our eyes. The negative result is that things seen just before the eyes move can appear in the wrong place. These results solve a long-standing theoretical problem of visual stability. They also explain why drivers may often fail to see other cars at intersections or misjudge their speed and position. This research has

resulted in two papers in the journal, *Nature*, one in 1994, the other in 1997.
{Contact: Emeritus Professor John Ross, Department of Psychology, tel: (09) 380 3250}

Computer gives divorce advice
The divorce of the Prince and Princess of Wales has been assessed by a Melbourne computer program which 'thinks' like a family court judge. The program, known as Split Up, was not actually consulted by the royal couple but by a London newspaper following worldwide media interest in the product. Split Up is an innovative program that uses neural networks for the first time to weigh up case law and predict court judgments. The program, developed at La Trobe University, is aimed at the world's legal firms and predicts the way property would be divided for a particular divorce if it proceeded to court.

Taxes on share trading
For many years the Australian Stock Exchange (ASX) on behalf of investors sought to have transaction taxes (Stamp Duty) reduced on share trading. Without evidence to demonstrate their point, the ASX had been unable to convince State Governments that reducing the tax would have net social benefits to the community. Using ASX data, researchers from Sydney University demonstrated that a loss of revenue by State Governments of $126 million a year from halving the tax rate would be offset by a benefit to the overall community amounting to $4.6 billion. The study was influential in convincing State Governments to reduce taxes and the results bear out the predictions of the researchers (see following entry).

Stock Exchange investors value their stamp collections
Following the halving of stamp duty on stock exchange transactions by all States from 1 July 1995, Australian Stock Exchange investors have received benefits totalling more than $5 billion, the net benefit after hypothetically compensating governments for the tax loss. Researchers at the University of Sydney have shown that the Commonwealth benefited from additional capital gains tax revenue from higher share prices after the announcement. The gains to investors came from sizable falls in transaction costs, which were accompanied by volume increases amounting to billions of dollars. The study showed that the smaller, less liquid stocks gained the most in terms of volume increases, which should permit smaller firms to raise more capital.
Contact: Professor Peter Swan, Faculty of Economics, tel: (02)9351 6466}

Boys in literacy
In studies conducted in Queensland and South Australia by researchers at James Cook University, boys were shown to be significantly outperformed by girls in English subjects. In response to this problem a teaching package called *Meeting the Challenge* was developed, valuing literacy as a cultural practice, in the same way that science is valued.
{Contact: Professor Bronwyn Davies, School of Education, James Cook University of North Queensland, tel: (077) 81 4623}

Virtual reality in schools

Virtual reality (VR) is a form of computer display which gives users the impression that they can move around in, and interact with, a virtual scene. In 1995, a class of eleven and twelve year old students in Townsville became part of the first reported Australian study on VR in education. They used the Vream program to create solids such as cubes and pyramids as part of the mathematics curriculum. Students' ability to recognise these shapes in the environment, such as in buildings and other common objects, improved significantly, and they outperformed a control group who built the same shapes from card.

(Contact: Dr David Ainge, School of Education, fames Cook University of North Queensland, tel: (077) 81 5141}

Aru Islands dig

Archaeological research into the prehistory of the Aru Islands is being conducted by a team from James Cook University and The Australian National University. This large island group is located between northern Australia and Irian Jaya and, while now falling within the boundaries of eastern Indonesia, was once part of the extended land mass of Greater Australia. Two seasons of work in conjunction with Indonesian archaeologists have revealed a sequence of sites. These appear to start with the earliest colonisers into northern Australia, some 60,000 years ago. Subsequent arrivals appear to be agriculturalists and then the massive trading empires of Islamic sultanates, Arab and Chinese traders. Finally, the Dutch presence is heralded by the establishment of the forts of the Dutch East India Company.

{Contact: Dr Peter Veth, School of Anthropology and Archaeology, James Cook University of North Queensland, tel: (077) 81 5858}

Women in academic research

This project investigated the factors influencing women involved in research work at three post-1987 universities. Over a two year period, researchers at the University of Western Sydney interviewed 120 women academics at the universities. The study encompassed both institutional and personal imperatives. It was found that women perceived themselves as needing to work twice as hard as some male counterparts but were rarely rewarded with a suitable promotion. The research also found that many women felt that a commitment to quality teaching was often in direct conflict with institutional expectations of research activity.

Women's work and accident compensation law

Research conducted at the University of New South Wales has found that when women are injured in accidents for which they can claim compensation, they are often disadvantaged in the assessment of their damages. Women's claims for damages for loss of earning capacity - their loss of capacity to do paid work - tend to be artificially depressed by a variety of gendered assumptions about women's lack of attachment to the paid labour market. The researchers also found that a woman's loss of capacity to work in the home, doing non-market work, tends to be treated as a non-economic loss (and therefore of lesser value). By studying the reasoning

in a number of court decisions in accident compensation cases, this research helps to reveal the ways that unarticulated assumptions about gender and the differing roles of women and men can affect legal decision making.
Contact: Associate Professor R Graycar, Faculty of Law, tel: (02) 9385 2244}

Invisibility of older women workers
Research undertaken at the University of Technology, Sydney has examined issues associated with the aging of the population and older women workers employed in the retail industry. The research found that older women are not seen as a valuable community resource and that they are not generally accepted as part of a labour force. The researcher focused on employer and community attitudes to older women workers and concluded that the well-being and sense of worth of these women was undermined by the way that they were utilised by their employers.
{Contact: Dr Rosslyn Reed, Faculty of Humanities and Social Sciences, Social, Political and Historical Studies, University of Technology, Sydney, tel: (02) 9514 1963}

Barriers to global careers for women
A study undertaken at Edith Cowan University reports on a recent Australian survey of the selection, placement and management development of women for international placements. Findings suggest that women represent only a small percentage of expatriate appointments and are better qualified than their male counterparts. Women expatriates work in similar functional areas to men but their postings are geographically different. Women tend to be posted to less risky locations, and less commonly posted to Asia.
(Contact: Dr Catherine Smith, tel: (09) 273 8330, e-mail: Catherine.Smith@cowan.edu.au}

Media representation of children in crime
Researchers at Australian Catholic University and Monash University have investigated print and television representations of young people and their families in reporting on law and order. The study examined television news and found that youth are ignored as victims of crime despite being the age group most likely to be victims, while those much less likely to be victims, viz. children and the elderly, dominated as victims in reports of crime. Reporting crime was found to be a regular feature of television news but representations of age groups and types of crimes were often distorted from reality.
{Contact: Dr Peter Rendell, School of Social Science, Department of Psychology, Australian Catholic University, tel: (03) 9563 3703}

Media reporting of child abuse
A University of Sydney study of more than 1000 stories on child abuse published in 1995 in a quality newspaper and a tabloid in New South Wales has revealed a disproportionate coverage of abuse involving homicides and sexual assaults. The study also showed the media emphasis on attacks by strangers rather than those by family members, and cases involving well-known or 'respectable' perpetrators. The study highlighted the

superficial nature of the coverage of child abuse issues; for example, children were portrayed as being at high risk from strangers even though they are more at risk from family members.
{Contact: Dr Ania Wilczynski, Faculty of Law, tel: (02) 9351 0233}

Management of pain in children

Young children are often said to have a very limited understanding of the pain they experience. Research conducted at the University of New South Wales has shown that by 5 years of age children do possess a basic understanding of the causes of pain. This finding opens the door to improvements in paediatric pain measurement, and for the use with children of cognitively-based strategies for pain management, which are not solely dependent on the provision of analgesic drugs.

Poverty and the self-employed

Australian families with self-employed members receive over one billion dollars per annum in income-tested Social Security payments. Research undertaken at the University of New South Wales has examined the income and expenditure patterns of self-employed households using household survey data collected by the Australian Bureau of Statistics. Self-employed families receiving the additional family payments provided to low income working families had consumption levels about ten percent higher than equivalent employee families, as well as higher wealth levels. At the same time, however, there is evidence of severe hardship among some self-employed families. To better target Social Security assistance to the most needy, the researchers suggested methods of measuring income fluctuations and income accruing to companies and trusts.
{Contact: Mr B Bradbury, Social Policy Research Centre, tel: (02) 9385 3853}

Forgotten learning makes savings

The effects of previous learning tend to persist even when the original learning episode has been forgotten or deliberately eliminated. These effects are known as savings. They have a powerful influence in clinical psychology, particularly in the context of the frequent relapse of patients despite an initially successful therapeutic intervention. Research at the the University of New South Wales has elucidated the basic mechanisms of savings and has developed an innovative neural network theory that will help understand the source of relapse in clinical disorders, as well as provide guidance in order to prevent it.

The art of the Brontes

A researcher at the University of New South Wales, in collaboration with a British researcher, has produced the first full-scale study of the drawings and paintings of the Bronte sisters and their brother Branwell. It includes the first catalogue of all known Bronte illustrations, published and unpublished: almost 400 illustrated entries recording such details as medium, dating, provenance, sources, style and associated material. The study also explores the relationship of the four Bronte siblings to the visual arts, suggesting ways

in which their experience of drawing influenced their writing in such works as *Jane Eyre* and *Wuthering Heights*.
{Contact: Associate Professor C Alexander, School of English, tel: (02) 9385 2310}

Mapping linguistic phenomena

Researchers at the University of Adelaide, in collaboration with researchers at The Australian National University, have developed new sophisticated maps to represent the constantly changing contact languages and the consequences of linguistic contact in the Pacific, Asia and the Americas. Of particular importance is the development of language mapping as a heuristic tool which, in the case of the recently published *Atlas of Languages of Intercultural Communication in the Pacific, Asia and the Americas,* has led to the discovery of a large number of new contact languages and sophisticated information crucial to a more accurate reconstruction of the area's linguistic past.
{Contact: Professor P Mulhauser, University of Adelaide)

Aboriginal grammar

Research at the University of Melbourne Linguistics Department has resulted in an 800-page study of the grammar of Kayardild, spoken on Bentinck Island. This study has been acclaimed by the Australian Academy of the Humanities as a distinguished contribution to research.
{Contact: Associate Professor Nicholas Evans, Department of Linguistics, tel: (03) 9344 8988}

Height as a measure of living standards

Height is an accurate reflection of net nutrition, the disease environment and work intensity, and provides an alternative to per capita income as a measure of living standards. Using data on the height of males and females recruited in the Australian Army between 1914-18 and 1939-45, two researchers at the University of Melbourne showed that living standards fell from 1880 until 1895, before rising strongly. Contrary to the conventional economic wisdom, these new findings indicate that living standards fell during the economic boom of the 1880s.
{Contact: Professor Stephen Nicholas, Department of Business Development and Corporate History, tel: (03) 9344 5340}

Children of parents experiencing mental illness

Dependent children of a parent with psychiatric illness rarely understand the illness and sometimes fear suffering mental illness themselves, according to a study at the University of Melbourne. The three-year study explored the experiences of more than 300 parents with mental illness. It is the first research project in Australia to examine the service and support needs of parents with mental illness and their dependent children.
{Contact: Ms Vicky Cowling, School of Social Work, tel: (03) 9344 9428}

Creative accounting loses its stigma

Research by the University of Tasmania questions the accepted view that managers use creative accounting techniques to increase their own remuneration at the expense of other stakeholders. The study finds that the

majority of creative accounting accurately portrays the economic investment opportunities facing the firm. The study has implications for the nature and direction of future accounting regulation.

{Contact: Professor J Godfrey, Department of Accounting and Finance, University of Tasmania, tel: (03) 6226 2266, fax: (03) 6226 7845}

First cultural atlas of the Pacific

A new cultural atlas of Australia, New Zealand and the Pacific by a University of Queensland academic may be the first to deal with the Oceania region as a separate cultural entity. The *Cultural Atlas of Australia, New Zealand and the South Pacific* looks at Australia as part of Oceania, rather than Asia, exploring and linking the region's Aboriginal, Polynesian, Melanesian and immigrant cultures. The atlas dispels the exotic and romantic view of the Pacific still nurtured by many Europeans, instead revealing the region's vastness, diversity and culturally complex history.

{Contact: Dr Richard Nile, Director, Australian Studies Centre, University of Queensland}

Study informs euthanasia debate

University of Queensland researchers recently completed a study exploring current attitudes and knowledge of the Queensland community and medical practitioners on end-of-life questions. It showed seventy percent of the general public were in favour of laws permitting active voluntary euthanasia, compared with thirty-three percent of Queensland doctors surveyed by the University team. The general public were more concerned about the loss of control or dignity, functional debility and being a burden while doctors considered pain to be more important. Results of the study were published in the *Australian Medical Journal.*

{Contact: Dr Margaret Steinberg, Director of the Healthy Aging Research Unit, Social and Preventive Medicine Department, University of Queensland or Professor Jake Najman, Head, Anthropology and Sociology Department, University of Queensland}

Companies in financial distress?

No longer is the decision making process for companies in financial trouble a black art. Researchers from the University of Tasmania have developed an intelligent computer system which simulates the decision-making behaviour of the human experts in accounting firms. The system is validated and shows a high conformance with the processing and results of actual cases of companies in trouble. This intelligent system can be used to assist stakeholders and other interested parties with an accurate assessment of the prospects of the companies involved.

{Contact: Professor S Leech, Department of Accounting and Finance, University of Tasmania, tel: (03) 6226 2266; fax: (03) 6226 7845}

Early human colonisation of Australia?

University of Wollongong and Australian Museum researchers, working with the local Aboriginal community at Jinmium rockshelter, in the Northern Territory, have found stone artefacts in sediments dated by thermoluminescence to older than 116,000 years. The site also provides a date of about 60,000 years for 'cupule' art - a widespread tradition of marking the landscape using circular engraved depressions on sandstone. Further

research is being undertaken to test this obviously controversial scenario. The results have significance for understanding human evolution, initial and subsequent colonisation of Australia and the long-term associations between Aboriginal people and landscape.

{Contact: Dr Lesley Head and Dr David Price, Department of Geography, University of Wollongong, tel: (042) 21 3124, tel: (042) 21 3632, fax: (042) 21 3764}

High fuel costs in rural areas

A study undertaken by Charles Sturt University has found that the market power of oil companies, not local factors, is the reason for high fuel prices in rural areas. A number of recommendations from the study were adopted by the Australian Competition and Consumer Commission in late 1996. Researchers found country petrol retailers effectively pay a significantly higher wholesale price for fuel than their city counterparts after fees, charges and differences in price support are taken into account. While country motorists may pay approximately ten cents more per litre, delivery costs make up only a small fraction of the total.

(Contact: Mr Tom Murphy, School of Marketing and Management, tel: (063) 38 8435, fax: (063) 84 769}

European Union helps Australian wheat growers!

Research at the University of Western Australia has shown that recent reform of the European Union's (EU) Common Agricultural Policy will have unexpected beneficial effects for Australian wheatgrowers. The EU has partially switched from price support towards compensatory payments within the Common Agricultural Policy. The research revealed that this policy switch has encouraged EU wheat producers to shift from high to low quality land, reducing yields and production and the role of the EU in world wheat markets.

{Contact: Associate Professor Rob Fraser, tel: (09) 380 2531}

Determining the minimum wage

After reviewing Australian wage norms over the last ninety years, researchers from the University of Western Australia and Data Analysis Australia developed criteria for contemporary minimum wage rates for single, adult, unskilled workers in Western Australia.

(Contact: Professor David Plowman, tel: (09) 380 1950, fax: (09) 380 1072}

Language contact in early settlement

University of Western Australia linguists have discovered evidence of a short-lived pidgin language developed by Aboriginal people in the first years of the Pilbara pearling industry. Ironically, the evidence for the pidgin comes from Italian documents relating the adventures of survivors of a shipwreck on North West Cape in 1875. This new material gives linguists a rare insight into early Aboriginal responses to the problems of cross-cultural communication during the period of social change following first European settlement.

{Contact: Dr A C Dench, tel: (09) 380 2865,fax (09) 380 1154}

Aboriginal contact with the criminal justice system

The Royal Commission into Aboriginal Deaths in Custody has led to the Crime Research Centre at the University of Western Australia developing an Integrated Numerical Offender Identification System, which has been adopted by all criminal justice agencies in the State. This has enabled the Centre to present regular and comprehensive reports on Aboriginal contact with the criminal justice system.

{Contact: Professor Richard Harding, Director, tel: (09) 380 2830, fax: (09) 380 1034}

Industries and employees negotiate creatively

A study of changing patterns in employment relations in key Australian industries has revealed a diversity of approaches. In sectors such as banking, information technology and telecommunications, University of Sydney researchers found that the role of trade unions was of continuing importance in achieving negotiated outcomes that promoted productivity and preserved equity in the workplace. Australia has followed the general international trend towards more decentralised bargaining, which emphasises greater labour market flexibility to negotiate wages and conditions.

{Contact: Professor Russell Lansbury, tel: (02) 9351 3119}

Applied Sciences and Technologies

Is air conditioning always better?

Naturally ventilated buildings can achieve higher levels of thermal comfort than fully air-conditioned buildings. Researchers in the University of Sydney's Department of Architectural and Design Science have demonstrated that a naturally ventilated building provided with user-controlled supplementary cooling and heating equipment can give superior thermal comfort. In addition, the annual energy expenditure is about a quarter of that required for full air conditioning of the same area.

{Contact: Mr David Rowe, tel: (02) 9351 2490}

Reef shipping risks are assessed

The risk of a ship colliding with another vessel or grounding on the Great Barrier Reef is approximately twice as great on the inner route than on the outer, according to a report from James Cook University. A second finding is that the risk of a major oil spill on the Reef largely depends on external factors, particularly the presence of pilots. That, together with the greater risk of a spill once an incident occurs on the outer route, led to the conclusion that the outer route may actually become the more dangerous of the two routes.

(Contact: CRC Reef Research Centre, James Cook University of North Queensland, tel: (077) 81 4976}

Remote community-based hydroelectric power

The University of Technology, Sydney (UTS), has completed technical implementation of a village-scale 50 kW micro hydroelectric system for a remote community in the Pacific Islands. The system employs design

philosophies developed specifically for the Melanesian social and physical environment, using predominantly Australian components. Electronic control and protection modules are a result of ten years of development at UTS' Renewable Energy Laboratory, in consultation with Pacific communities.

{Contact: Dr Paul Bryce, Faculty of Engineering, University of Technology, Sydney}

Magnetic resonance imaging technology

New technology makes it possible to control eddy currents in large magnets, resulting in clearer magnetic resonance images in the diagnoses of human diseases. The University of Queensland and UniQuest Limited have recently signed licence agreements for use of the new technology by medical imaging and telecommunications companies in Germany and the United States.

{Contact: Professor David Doddrell, Director, Centre for Magnetic Resonance, University of Queensland}

University invention goes into orbit

Due to low gravity, astronauts experience a shift in body fluid that can cause changes in physiology and metabolism that affects their health. Body fluids of Russian and German astronauts aboard a space craft launched in late November 1996 were monitored using analysers developed by the University of Queensland, the Queensland University of Technology and Brisbane-based electronics company SEAC. The astronauts' space suits contained multiple-frequency bio-impedance analysers in four locations to continuously measure changes in bodily fluid volume.

{Contact: Associate Professor Leigh Ward, Biochemistry Department, University of Queensland}

Ultrafine powders

Ultrafine powders are important in advanced ceramics, high density recording media, catalysts and quantum limited materials which exhibit unique optical and electronic behaviour. Researchers at the University of Western Australia have developed a novel process for producing ultrafine powder particles with dimensions of a few nanometres. The process uses a ball mill to activate chemical reactions which cause the nano-sized particles to form. With this process, it will be possible to produce large quantities of ultrafine powders at a fraction of current costs.

{Contact: Professor Paul McCormick, tel: (09) 380 3122, fax: (09) 380 1116}

Kettle design

The Centre for Design at the Royal Melbourne Institute of Technology has designed an energy efficient kettle which uses up to twenty-five percent less energy than previous models. Research found that most kettle users boil water then return to reheat the same water at a later stage. A double-walled kettle which keeps water hot for longer, and indicates whether the water needs re-boiling was developed by the Centre's researchers. The design reduced the body weight of the kettle by sixteen percent and increased the amount of recyclable material used from thirty-six to sixty-six percent. This

eco-design kettle is now on the international market.
{Contact: Professor Chris Ryan, Centre for Design, tel: (03) 9660 2364, e-mail: cryan@rmit.edu.au}

Global dishwasher

Researchers from the Royal Melbourne Institute of Technology have designed an ecologically advanced dishwasher, which has a six-star energy rating, the highest ever for an Australian designed and manufactured dishwasher. The design also achieved a AAA water rating, with each machine using less than a sink and a half of water for each wash. The new machines are, on average, seven and a half kilograms lighter than previous models, more easily disassembled and have potential for recycling materials. The wash program allows consumers to use enzyme based detergents and colder wash cycles, thereby saving more energy per wash. The dishwasher is now on the international market.
{Contact: Professor Chris Ryan, Centre for Design, tel: (03) 9660 2364, e-mail: cryan@rmit.edu.au}

Engineering

Solar ice-maker

Monash University researchers have built an ice-making prototype capable of producing more than two kilograms of ice a day using only solar radiation. The ice-maker may eventually be used to help preserve vaccines and other medical products in remote and underdeveloped areas.
{Contact name: Dr Eric Hu, tel: (03) 5122 6833}

Diesel engine efficiency and emissions

Researchers at the University of New South Wales, in cooperation with HALTECH Pty Ltd, have developed a new diesel injector. It allows much higher pressures (to 230 MPa compared with a conventional 70 MPa) and control of timing, pressure and pulse shape from the engine management system. In addition, it is compact and light and can control the flow rate to less than one percent of the maximum. As well as improving efficiency, the smoke and emission levels will be lowered.
{Contact: Professor B E Milton, tel: (02)9385 4088}

Iron smelting process

Researchers at the University of New South Wales and BHP Research Newcastle laboratories have developed a model to evaluate the efficiency of new ironmaking processes. The model incorporates heat and mass balances for the bath, heat transfer phenomena in the gas phase, and chemical reactions between the gas and the dispersed iron and slag droplets. It also predicts coal consumption for processing of raw materials of different properties and for different blast parameters.
{Contact: Associate Professor O Ostrovski, tel: (02) 9385 4439}

Computer software for power station design

Researchers at the University of New South Wales, in conjunction with Pacific Power, have developed a suite of computer programs to predict the detailed behaviour of hot, particle laden combustion gases in power station boilers. The software is designed to produce more efficient boilers which require less maintenance and can be used by existing power stations to bring down the cost of electricity.

{Contact: Professor C Fletcher, tel: (02) 9385 5745}

Steel sleepers - manufactured to specification

A monitoring system has been developed by researchers at the University of New South Wales for quality control of trie manufacture of steel railway sleepers. The system uses multiple video cameras and image processing to monitor the geometry of the sleepers against design specifications.

{Contact: Professor J C Trinder, School of Geomatic Engineering, tel: (02) 9385 4197}

Timber seasoning

The results of over ten years of timber seasoning research at the University of Tasmania are being implemented by the Tasmanian timber industry. A semi-commercial scale, fully instrumented, research kiln has been built and is being operated by the University. The research team at the University is working closely with industry to promote the adoption of best practice in timber seasoning technology.

{Contact: Associate Professor P Doe, Department of Engineering, University of Tasmania, tel: (03) 6324 3576, fax: (03) 6324 3011}

Wave effects on high speed ships

The University of Tasmania, INCATS Tasmania and the Australian Maritime CRC have developed a method of computing the motions and structural loads that high speed ships experience, especially large catamaran ferries. It will enable ship designers to optimise design and performance of ride control systems in the high speed ferries now being built.

{Contact: Professor M R Davis, Department of Civil and Mechanical Engineering, University of Tasmania, tel: (03) 6226 2074, fax: (03)6223 4611}

Wear and corrosion resistant surfaces

A plasma nitriding system designed and constructed by researchers at the University of Wollongong, has been used to produce material with a wear resistance almost 300 times greater than stainless steel. Moreover, the corrosion resistance of the surface was enhanced 20 times. The process is currently being commercialised and transferred to Australian industry.

{Contact: Dr. Masoud Samandi, Institute for Steel Processing & Products, University of Wollongong, tel: (042)21 4247, fax: (042) 21 3662}

Solar-powered water purifier

Murdoch University, in collaboration with its industrial partner Venco Products, have developed a solar-powered brackish water purifier. The unit operates on a reverse osmosis process which separates dissolved salts and water-borne particles including pathogens. It is powered by low-voltage photovoltaic panels. A licensing agreement has been signed with Venco

Products for the commercial development of the purifier, and four demonstration units have been installed in Indonesia.
{Contact: Associate Professor Goen Ho, Department of Environmental Science, tel: (09) 360 2167, e-mail: ho@central.murdoch.edu.au}

New wireless communications technologies
Researchers from the University of Queensland have patented a flat profile antenna which matches the performance of large dish antennas. The Flat Direct Broadcast Satellite antenna could replace current TV dishes, particularly as it is less than 5cm thick and inexpensive to produce. Systems may even be fitted to aircraft for live in-flight pay TV or military applications. The new antenna can be formed completely into the skin of an aircraft without disturbing its original surface and thus carries a zero drag penalty on the aircraft.
{Contact: Associate Professor Marek Bialkowski, Wireless Communications Group, Electrical and Computer Engineering Department, University of Queensland}

Computer recognises connected handwriting
Current computer technology for recognition of handwriting relies on individual numerals being unconnected to those next to it. Each numeral has to be written into its own separate box. Now Sydney University researchers have developed computer recognition of connected handwritten numerals. This enables automated processing of handwritten documents such as tax return forms and bank cheques.
{Contact: Professor Hong Yan, Electrical Engineering Department, tel: (02) 9351 3515; Professor Greg Hancock, tel: (02) 9351 2144}

Reinforced piles stabilise buildings during landslides
Landslides endanger the pile foundations of buildings, especially on hillsides, while movements of the seabed are as real a threat to the stability of offshore oil and gas platforms. Civil engineers at the University of Sydney have designed piles that substantially withstand the pressures exerted by these events. A consulting organisation has now designed slope reinforcing piles for highway projects in Australia and Canada.
{Contact: Professor Harry Poulos, tel: (02) 9351 3640}

Mine tailings
Researchers at the University of Western Australia have completed a study of the evaporation behaviour of gold-mine tailings. The study found the rate of evaporation is affected by factors such as tailings salinity and type. A computer model was developed to show how tailings increase in strength and density after deposition. This information is crucial in planning rehabilitation strategies for tailings storage.
{Contact: Associate Professor Martin Fahey, Geomechanics Group, tel: (09) 380 3519, fax (09)380 1044}

PRODuctivity on the seabed

The Portable Remotely Operated Drill (PROD) is a robotic drill for sampling of the sub-seabed. PROD has the capacity to routinely obtain 100 metres of rock and sediment core in water depths up to 2000 metres. Benthic GeoTech Pty Ltd is marketing PROD globally.

{Contact: Professor Peter Davies, tel: (02) 9351 2038, and Professor John Carter, tel: (02) 9351 2109}

Agricultural Sciences

Timber for better, safer buildings

The University of Melbourne has developed a fire retardant that can be applied directly to finished wood panels without swelling or loss of strength. This will create new market opportunities for wood and wood-based products which need more demanding performance requirements.

{Contact: Professor Peter Vinden, School of Forestry, tel: (03) 5321 4150}

Herbicide residues in soil

The most widely used herbicide in the world, and perhaps the most environmentally safe, is glyphosate, the active ingredient in Roundup^{R} and Zero^{R}. A chance observation led a researcher at the University of Western Sydney to suspect that residues of glyphosate could be persisting in sandy soils, causing damage to plants. Further research determined when damaging concentrations can occur in soil and what can be done to protect plants from damage. The finding that damaging residues can persist in some soils has led to changes in the recommended use-patterns for this important herbicide.

Are crop yields improving?

It is difficult to judge if crop yields in Australia are improving as a result of heavy investments in breeding and improved management. Superficially, yields appear to have risen little in 25 years. In a joint project with the Queensland Department of Primary Industry, researchers from the University of Western Sydney have used a modelling approach to remove the effect of rainfall trends from the long term yield data. The result is that wheat yields in the 'rich' grain belt of northern NSW and Queensland have not improved since the introduction of 'green revolution' crop varieties in the 1960s. It appears that farmers are cropping their land more often and the same rainfall is being shared amongst more crops. So, whilst wheat yields are static, overall farm productivity is up.

Effects of heat stress on grain quality

Researchers in the University of Melbourne have screened 75 wheat varieties to determine the effect of heat stress on yield, grain protein content and dough strength. Wheat breeders can now select for heat tolerance in cultivars to provide farmers with wheat varieties able to resist yield losses and quality problems resulting from exposure to high temperatures during

the critical growth phase. The work also produced a simple flour sedimentation test which can be used to detect heat damaged grain at silos.
{Contact: Dr Marc Nicolas, Department of Agriculture and Resource Management, tel: (03) 9344 5034}

Cheaper fertiliser for eucalypt plantations

Nitrogen, an essential element for plant growth, is present in low concentrations in the soils used for hardwood plantations in Australia. Application of nitrogen fertiliser to eucalypt plantations is a major cost to forestry companies. New research at the University of Tasmania has shown that ammonium is the preferred source of nitrogen for E. *nitens* (the most important commercial eucalypt species). Urea, which converts to ammonium soon after application, is therefore the most appropriate fertiliser to apply to these commercial plantations. Urea is also cheaper, and has less of an acidifying effect on the soil, than alternative ammonium fertilisers. The research has also shown that application is most effective when the trees are two years old in contrast to the conventional practice of application at planting.
{Contact: Dr P Smethurst, CRC for Temperate Hardwood Forestry, tel: (03) 6226 7953, fax: (03) 6226 7901}

Fooling eucalypt beetles

The eucalyptus leaf beetle can consume up to fifty percent of the new leaf growth produced by a eucalypt plantation in a single year. Field research at the University of Tasmania has shown that *E. regnans*, which is not a commercial eucalypt species, is preferred by the eucalyptus leaf beetle. This means that *E. regnans* can be planted within commercial *E. nitens* plantations as 'trap trees' to deflect damage away from the commercial species.
{Contact: Dr J Madden, CRC for Temperate Hardwood Forestry, University of Tasmania, tel: (03) 6226 2732, fax: (03) 6226 2642}

Ryegrass plants resistant to herbicide

Researchers at Charles Sturt University have discovered annual ryegrass plants which have a natural plant-based resistance to glyphosate. Glysophate is one of the most important and commonly used herbicides in the world. The research has recorded that the ryegrass is resistant to commercial rates of the herbicide with a proportion of plants surviving up tofour times the normal application rate. This finding has significant implications for agriculture as glyphosate use is a key component of modern conservation farming systems.
{Contact: Professor Jim Pratley, Dean, Faculty of Science and Agriculture, tel: (069) 33 2864, fax: (069) 33 2868}

Racehorse shin soreness scratched

Preventing shin soreness in racehorses could save the racing industry millions of dollars in lost training days. A new technique, developed by a veterinary scientist at the University of Melbourne, uses x-ray images of racehorses' leg bones and an index to predict the speed a horse can exercise at without risking shin soreness.
{Contact: Dr Helen Davies, Faculty of Veterinary Science, tel: (03) 9742 8338}

Chemical Sciences

Promising new anti-cancer compounds
La Trobe University has signed an agreement with an Australian pharmaceutical company, Biota Holdings, for the exclusive worldwide rights to newly synthesised anti-cancer chemical compounds. The new compounds, developed by the Department of Chemistry, have shown encouraging results in reducing the growth of colon cancer cells in tests conducted on animals. They may also be useful in treating other solid tumours such as cancers of the lung and stomach. A lead compound is expected to begin Phase 1 human trials in 1998.

Artificial muscles
The University of Wollongong, BHP, CRA and MM Cables have pioneered the use of functional polymers capable of intelligent performance. Structures and devices, such as polymeric artificial muscles can be made. There is international interest in the commercial development of these materials.

New mass spectrometer
A research group at the University of New South Wales has created a new direction for the mass spectrometry industry. The group has pioneered a new technique based on the principle of orthogonal acceleration time-of-flight mass spectrometry. This will provide instruments with exceptional ability for fast analysis and analysis of very heavy molecules. The analysis speed is 10 to 100 times faster than conventional technology and the mass range is up to that of large biological molecules. The technology is licensed to an Australian instrument manufacturer and is also undergoing extensive commercialisation world-wide.
{Contact: Associate Professor M Guilhaus, School of Chemistry, tel: (02) 9385 4717}

Reactions behind photosynthesis utilised
Researchers at the University of New South Wales are probing the secrets of long range photo induced electron transfer processes, such as photosynthesis. The researchers have synthesised giant molecular assemblies that effectively mimic photosynthesis. Such assemblies may eventually function as commercially useful transducers of light into chemical and electrical energy.

Charging towards better catalysts
Metal catalysts are composed of very fine particles with high surface area which help accelerate or catalyse chemical reactions. These include the reduction of water to form hydrogen, for use as a commercial fuel. To convert water into hydrogen, catalyst particles must store electrons they pick up from chemicals in solution. Good catalysts must be able to store lots of electrons but how to count them on particles only a few nanometres in size? Chemists at the University of Melbourne have found a novel way to pass electrons to catalyst particles using high surface area gold mesh electrodes. By measuring the current flowing through the electrode, they can count how many electrons a particle can store. Their results, to be published in the international chemical journal, *Langmuir*, show that even a particle made up

of only a few thousand metal atoms can store up to 1500 electrical charges (electrons) at once in solution.
{Contact: Dr Paul Mulvaney, Department of Chemistry, tel: (03) 9344 6486}

Drug library
The University of Queensland and GlaxoWellcome have announced a $1.76 million collaboration to build a library of 10,000 synthetic chemicals for the purposes of drug development. This approach will enable the testing of millions of potential drug therapies in the time previously taken to design and synthesise one drug.
{Contact: Professor Peter Andrews, Director, Centre for Drug Design and Development, University of Queensland}

Cyanide analysis at gold mines
Researchers at the University of Tasmania have built a liquid chromatographic instrument for the measurement of free cyanide and other cyanide-containing species present in gold processing solutions. The levels of these species in leaching solutions must be known accurately in order for the extraction of gold from its ores to proceed efficiently with minimal levels of cyanide being added. The new instrumentation provides the first reliable method for these analyses and when employed on an operating gold mine, has been shown to reduce the consumption of cyanide and the release of cyanide wastes into the environment. Trials with the instrumentation have been conducted at the Telfer Mine in Western Australia.
{Contact: Professor A] Canty, Department of Chemistry, University of Tasmania, tel: (03) 6226 2162, fax: (03) 6226 2858}

Wastewater
University of Queensland researchers have completed a project on land use of treated sewage effluent. Researchers used a sophisticated network of equipment to measure water and nutrient balances. The aim was to try to discover the capacity of trees to take-up nutrient from the effluent in a sustained manner. The project will provide scientific information to help councils conform with increased legislative requirements, and to establish suitable methods for sustainable disposal and treatment of wastewater.
{Contact: Dr Peter Dart, Department of Agriculture, University of Queensland}

Unlocking the secret of wine flavours
Research at Charles Sturt University is unlocking the secrets of why some wines have better flavour than others, and why some grape varieties are more suited to good wine flavour development. Although key flavour components come from the grape berry, these may be trapped in a flavourless form by chemical linkage to a sugar unit. The flavour may then be released during winemaking and storage. For the first time, researchers have identified the enzyme that attaches the sugar unit to the flavour components. Other research has identified that not one but several forms of a bound

flavour component can exist and can be responsible for the formation of one particularly potent flavour component. This research contributes to improvements in wine quality.

{Contact: Associate Professor Malcolm Allen, Director, Centre for Grape and Wine Research, tel: (069) 33 2433, fax: (069) 33 2107}

Battery for a cleaner future

Researchers at Murdoch University and commercial partners, ZBB Technologies Ltd, have developed a battery that offers a solution to the problem of storing power for times when the wind is not blowing or the sun is not shining. Current batteries have very limited applications in this field. The zinc-bromine battery could save millions of dollars for generating utilities, enabling them to store power during times of low demand. In mid-1997, the battery will be commissioned for trials in Victoria by United Energy Ltd.

{Contact: Associate Professor Pritam Singh, Department of Chemistry and Mineral Science, tel: (09) 360 2379, e-mail: singh@central.murdoch.edu.au}

Lung cancers in metal workers

An investigation into the effects of chromium compounds on lung cells in mammals has contributed to understanding the origin of certain cancers. In collaboration with the University of Melbourne and the Brookhaven National Laboratories in the United States, University of Sydney scientists have looked at the interaction of lung cells and common industrial chemicals that cause lung cancers They have determined the quantity of chromium that enters a cell, how quickly it is transported into a cell, its distribution within the cell, as well as what happens to its structure when metabolised. The team has also investigated potential beneficial effects of anti-oxidant vitamins C and E in minimising the risk of cancers caused by long-term exposure to metals.

{Contact: Professor Peter Lay, tel: (02) 9351 4269}

Super tough polypropylene

A super tough polypropylene material has been designed in the CRC for Polymers at the Royal Melbourne Institute of Technology. In general, such materials require both toughness and rigidity. However, in the past, one has been achieved at the expense of the other. A novel technique has been developed in which the microstructure is modified at the surface level to give the required levels of both toughness and rigidity.

{Contact: Professor Bob Shanks, Department of Applied Chemistry, tel: (03) 9660 2122, e-mail: shanksra@rmit.edu.au}

Eliminating side-effects from anti-cancer drugs

Researchers at the University of Sydney have shed light on the mysterious nerve damage caused by platinum-based anti-cancer drugs. At present, a new series of these drugs is being used to attack colon cancer. In collaboration with the University of Auckland, the researchers have shown that the degree of nerve damage is related to the detailed three-dimensional structure of the drug. This discovery, which will hopefully lead to a new

drug design to minimise or eliminate the drug's present destructive side-effects, has been patented provisionally.
{Contact: Dr Trevor Hambley, tel: (02)9351 2830}

Test developed to identify lupus disease
Using a purified toxin from the venom of the Taipan snake, a researcher at the University of Sydney has created a new screening test for lupus, an autoimmune disease that attacks one in 500 women and one in 5000 men. Lupus can cause deep vein thrombosis, organ damage and spontaneous abortion. The test not only identifies the condition but also establishes the severity of the disease. With this information, the patient can be given drug therapy to suppress the autoimmune antibodies or the tendency to form blood clots.
{Contact: Professor Richard Christopherson, tel: (02) 9351 6031}

Developing new sensors for clinical diagnostics
Chemists at the University of Sydney have developed advanced chemical and biochemical sensors. The sensors have a wide range of applications, especially in the area of clinical diagnostics. For example, sensors can be used to measure the cardiac drug digoxin in the blood, or the large blood protein ferritin. The research has been patented and published in the British journal, *Nature.*
{Contact: Professor Leslie Field, tel: (02) 9351 2060}

Medical and Health Sciences

Breakthrough diabetes test
Monash University researchers are developing a test to predict the onset of diabetes in patients several years before symptoms emerge. The test detects antibodies to an enzyme in the pancreas known as glutamic acid decarboxylase which is known to be an early predictor of diabetes.
{Contact: Professor Paul Zimmet, tel: (03) 9258 5049; Dr Merrill Rowley, tel: (03) 9905 3780}

Understanding arthritis
Arthritis is a major cause of pain and disability in people of all ages. Research at St Vincent's Hospital and the University of New South Wales has identified an important role for proteins known as transcription factors in the development of arthritis, especially rheumatoid arthritis. These transcription factors are found in the nucleus of cells and act as regulators, or gatekeepers, for turning on the effects of genes. This finding has changed the way investigators think of arthritis and opens up a new range of options for the development of arthritis therapies.

Treating diabetes with genetic engineering
Researchers at the University of New South Wales and the University of Technology, Sydney have used genetic engineering to make an insulin-producing liver cell. These cells, called betacytes, act both as normal

insulin-producing cells (beta cells) and as liver cells (hepatocytes) in the laboratory. Experiments are underway examining the ability of these cells to function when transplanted into diabetic animals.

{Contact: Associate Professor B Tuch, Pancreas Transplant Group, Prince of Wales Hospital, Randwick 2031}

Helcobacter pylori transmission

The University of New South Wales and the Sun Yat-sen University of Medical Science, People's Republic of China, have shown that faecal-oral transmission of the gastric pathogen *Helcobacter pylori* via community wide consumption of faecally contaminated water is NOT a route for transmission of *H. pylori.* The study also showed that the development of atrophy (a pre-malignant change in the stomach), rather than age of acquisition and/or prevalence of *H. pylori* appears to be a marker for gastric cancer.

Long-term cannabis use

The National Drug and Alcohol Research Centre, the University of New South Wales, Southern Cross University, and the Northern Rivers Health Service have conducted the first Australian study on long-term cannabis use, the most commonly used illicit drug in Australia. While long-term cannabis users were similar to the general population, half had experienced symptoms of cannabis dependence, and many reported having had respiratory and memory problems.

Mapping the brain's responses to hearing

Detecting and evaluating hearing disability soon after birth is crucial if treatment is to begin early, when it will have greatest impact. Research at the University of Melbourne has mapped how hearing nerves respond to sound at birth and throughout childhood development. This information improves ways of presenting sound information to hearing impaired infants so that speech is easily interpreted.

{Contact: Professor Barbara Cone-Wesson, Department of Otolaryngology, tel: (03) 9283 7548}

Alzheimer's disease

The major cause of age-related dementia is Alzheimer's disease. The two main abnormalities of an Alzheimer-diseased brain are globular deposits called β-amyloid plaques and filamentous changes in nerve cells referred to as neurofibrillary pathology. Studies at the University of Tasmania have provided new information on the link between the formation of plaques and the neurofibrillary changes that ultimately lead to the death of nerve cells. Plaques cause persistent physical damage to nerve cells at the microscopic level, which leads to reactive changes within the neurons that finally result in neurofibrillary pathology. The study should facilitate the identification of therapeutic strategies to prevent the neuronal degeneration in humans that leads to dementia.

{Contact: Dr J Vickers, Division of Pathology, University of Tasmania, tel: (03) 6226 4803; fax: (03) 6226 4833}

Indicators of obesity in children

A study undertaken at the University of Tasmania will for the first time provide paediatricians and general practitioners with a standard to determine whether children and adolescents are so overweight that their health may be affected. The study demonstrated that boys aged 9-15 with more that twenty percent fat and girls aged 9-15 with more than thirty percent body fat have an increased level of cardiovascular disease risk factors. The study showed that above that figure the body is starting to have changes in blood fat levels and blood pressure that will affect the individuals' health. The advantage of such standards is that they're directly related to health, rather than simply being based on what the average is for height and weight.

{Contact: Professor T Dwyer, Menzies Centre for Population Health Research, University of Tasmania, tel: (03) 6226 7700; fax: (03) 6226 7704)

Researchers isolate key cancer gene

A team of researchers from the University of Queensland and the Queensland Institute of Medical Research, Yale University and the National Cancer Institute, Maryland, in the US, and the Karolinska Institute in Sweden, recently announced a world breakthrough in the understanding of cancer biology. The team isolated the gene responsible for predisposition to the most common form of cancer, a skin cancer known as basal cell carcinoma, and also demonstrated that the same gene, known as patched, is likely to be responsible for many other forms of cancer, including the commonest brain tumour in children, medulloblastoma. The discovery, reported in the prestigious international scientific journal, *Cell*, has diagnostic implications and may one day allow more directed therapy against the tumours in which it is involved.

{Contact: Associate Professor Brandon Wainwright, Centre for Molecular and Cellular Biology (CMCB), University of Queensland}

Organ rejection

Researchers from the University of Queensland have discovered one of the genes that controls tissue and organ rejection during some transplant operations. The researchers have isolated, characterised and patented the gene and its potential therapeutic value. The gene's discovery will help researchers understand more about the molecular biology of transplant rejection and may help develop methods of controlling specific immune responses rather than having to suppress the body's entire immune system, which increases susceptibility to infection.

(Contact: Dr Peter Koopman, Centre for Molecular and Cellular Biology, University of Queensland}

Gene associated with hearing loss

Researchers at the Edith Cowan University have identified a novel form of peripheral neuropathy associated with the development of hearing loss. The research group localised and identified the gene and the mutation responsible for the disease., This will reveal important information on the basic mechanisms of myelin formation and maintenance and on cell-cell

interactions in the nervous system. The results of these investigations have been published in the international journal, *Nature Genetics.*

{Contact: Dr Luba Kalaydjieva, Centre for Human Genetics, tel: (09) 400-5808, e-mail: L.Kalaydjieva@cowan.edu.au}

Breakthrough in battling waterborne threat

Researchers at Murdoch University have developed a novel DNA test to detect a waterborne parasite which poses a serious health threat. The parasite is *Cryptosporidium parvum*, small enough to pass through the water filters of most water authorities and resistant to chlorination procedures for disinfecting water. The test is a significant advance on time-consuming and insensitive conventional techniques and is an international first in that it can differentiate directly between human and animal sources of *Cryptosporidium.* This will greatly assist in tracing the source of a particular outbreak of cryptosporidiosis. The University has filed a patent on the invention.

{Contacts: Professor Andrew Thompson, Institute for Molecular Genetics and Animal Disease, tel: (09) 360 2466; e-mail: andrew_t@numbat.murdoch.edu.au; Dr Una Morgan, tel: (09) 360 2457/6101, e-mail: morgan@numbat.murdoch.edu.au}

Chronic wound healing

Researchers from the University of Western Australia have evaluated the cause of the poor healing in chronic leg ulcers. They have identified factors present in the ulcers that cause an excessive process of inflammation. In addition, a number of naturally occurring toxic substances have been observed in these wounds. These findings have dramatically changed the scope of potential therapeutic substances that could speed up the healing process. Clinical evaluations are now underway looking at several substances that could lead to improved healing.

{Contact: Associate Professor Michael Stacey, Department of Surgery at Fremantle Hospital, tel: (09) 431 2500, fax: (09) 431 2623}

Safety of prenatal ultrasound examinations

Almost all pregnant women in the developed world now have at least one ultrasound examination during pregnancy. A randomised controlled trial of 2900 pregnant women conducted by researchers at the University of Western Australia revealed that a protocol of five ultrasound scans increased the number of babies in lower birthweight ranges when compared with a protocol of a single scan. This small but significant reduction in weight was not accompanied by any other deleterious features. Measurements at one year of age have revealed catch-up growth and the weight differences observed at birth have now disappeared. This study is the only controlled trial of repeated prenatal ultrasound examinations to have been performed, and provides evidence for a small, transient and apparently harmless effect on foetal growth.

{Contact: Clinical Professor John Newnham, Department of Obstetrics and Gynaecology, tel: (09) 340 1393,fax: (09) 381 3031}

Sydney researchers get the whole picture

The Mayo Clinic in the United States has successfully trialled a new method for chest x-rays designed by researchers at the University of Sydney. The Sydney scientists used computer simulation to develop a novel twin cassette

for films that expands diagnostic contrast over the whole chest image, particularly in regions previously obscured by the heart, sternum and diaphragm. A commercial company is also testing Sydney's method of chest x-rays with a view to its release in the North American market.
{Contact: Donald McLean, School of Medical Radiation Technology, tel: (02) 9351 9645}

Information, Computer and Communication Technology

World's first laptop guide to the rainforest

Park rangers, naturalists and tourists can now enter the Australian rainforest with a laptop computer and identify any of the 1,750 trees and shrubs growing in this rich environment. The world's first interactive rainforest key was developed by a La Trobe University botanist and a CSIRO researcher. It is the most comprehensive plant identikit ever developed for computer. Rainforest plants can be identified using such features as leaves, bark and seedlings which are close to ground level. The system, due for release on CD-ROM, combines photographs, x-ray images of leaves, text distribution maps and a multi-entry key.
{Contact: Dr Tony Sloane, Department of Computer Science, James Cook University of North Queensland, tel: (077) 814 618}

Computer power puts out fires

A novel computer system has been developed at the University of South Australia which will help fight bushfires. The system allows information to be fed in on the fire's current position and possible scenarios, such as changes in wind speed and direction. The resulting immediate information will help position firefighters in the optimum position to combat the fire.

Speech compression for Low Earth Orbiting satellites

Current cellular telephone systems are geographically limited by the need for economical cell coverage. Motorola's Iridium is a Low Earth Orbit satellite constellation consisting, eventually, of 66 satellites and providing global communications coverage. The University of Wollongong is developing speech coding algorithms suitable for an integrated cellular and Iridium system. In Australia, this will provide seamless telecommunications from the outback to the major cities.
{Contact: Professor Gary Andio, Director, tel: (042) 21 4650, fax: (042) 21 3236}

Urban bus model network

The private bus industry and the Victorian state government are entering a new relationship, where private bus operators will be rewarded for the number of passengers carried and the distance for which they are carried, in contrast to earlier bus-kilometres-travelled based agreements. The Transport Research Centre at the Royal Melbourne Institute of Technology has developed a model of urban bus operations applicable to the entire private bus network in Melbourne. The model is now in use by private bus companies in Victoria, enabling them to model bus routes, networks and

usage. The Department of Infrastructure is seeking adaptation of the model for use in train networks.
{Contact: Professor Tony Richardson, Transport Research Centre, tel: (03) 9629 4836}

Innovative software technology for computing giant
University of Queensland computer scientists and Oracle Corporation have developed technology for old software packages to be revamped to meet new performance standards. Design recovery can now be performed on an entire software system through a few computer commands. Negotiations with Oracle are underway to determine commercial release dates for tools based on the technology.
{Contact: Professor Paul Bailes, Director, Centre for Software Maintenance and Head of the Computer Science Department, University of Queensland}

Framing parliamentary legislation
The Multimedia Database Systems group at the Royal Melbourne Institute of Technology has developed a database system for drafting legislation. The system incorporates the formal parliamentary drafting system to ensure the structural integrity of all documents, and in a world-wide first, automatically consolidates related legislation such as principal acts with amending acts, saving valuable time for the parliament while ensuring accuracy under law. It also accelerates the necessary research process by providing point-in-time searches, enabling parliamentary councils to find the status of any act at any given date. The system is currently being trialled and implemented by the Tasmanian parliament.
{Contact: Professor Ron Sacks-Davis, Multimedia Database Systems Group, tel: (03) 9282 2420, e-mail: rds@mds.rmit.edu.au}

Up in the air to assess Murray River water quality
Charles Sturt University is assessing water quality in the Murray River. A small aircraft fitted with four cameras was used to rapidly estimate and map turbidity along the Murray River. The results highlight the potential of airborne video as a cost-effective means of estimating and mapping water quality along vast inland river systems.
{Contact: Dr David Lamb, School of Science and Technology, tel: (069) 33 2552, fax: (069) 33 2737}

Very low bit rate video coding
Video communications will be an essential feature in any future communication system, complementing the current voice and data communications. To enable video transmission over the existing telephony networks, very low bit rate is required. Research at the University of Western Australia on very low bit rate video coding has solved the problems of video transmission over the public switched telephony network and the highly error-prone mobile telephony network. This enables the video to be transmitted and received with minimum errors and with good quality. It is envisaged that such a system will revolutionise the telephony market in the next decade.
{Contact: Associate Professor King N Ngan, Department of Electrical and Electronic Engineering, tel: (09) 380 1245, fax: (09) 380 1065}

Australia's first marine soils map

The University of Sydney has constructed the first national marine soils map for the Australian Exclusive Economic Zone (EEZ). The maps are being used in naval databases, sonar development, studies of Great Barrier Reef nutrients, sea pipelines development, and in national biodiversity zonations. The database structure, which is attracting international interest, may be applied to the EEZ of other nations. As a signatory to the Law of the Sea, by 2004 Australia must demonstrate good management of the EEZ, so construction of these maps is a crucial national, economic and environmental goal.

{Contact: Dr Chris Jenkins, tel: (02) 9351 4068}

Mathematical Sciences

Prawn larvae

The University of Adelaide has developed computer software for predicting the dispersion of prawn larvae in Spencer Gulf, a significant aid to the fishing industry.

Maths model helps surgeons

A statistical model developed by the University of Queensland and Prince Charles Hospital is helping surgeons plan major heart surgery. The model quantifies the relative benefits of biological and mechanical heart valves according to particular patient needs or circumstances. The model uses data on about 30 variables (including patient age at the time of the operation, health record before and after the procedure and lifespan) for each of the 2000 patients who had undergone cardiac surgery at the hospital over the past 20 years.

{Contact: Dr Geoff McLachlan, Mathematics Department, University of Queensland}

Physical Sciences

Splitting hairs

The Centre for Lasers and Applications at Macquarie University has developed a laser ideal for micromachining applications, and especially for the machining of plastics. The laser system drills precise, microscopic holes useful for microelectronic circuits, the nozzles for inkjet printers and vents in medical catheters.

New polar observatory opened

The Automated Astrophysical Site Testing Observatory (AASTO) was officially opened at the South Pole on January 9, 1997 by Senator the Hon. Robert Hill. The AASTO, a joint project between the University of New South Wales' School of Physics and The Australian National University, is Australia's first major facility on the high antarctic plateau. Operating autonomously and creating negligible environmental degradation, the

AASTO represents a whole new way of doing antarctic science. Over the next few years, it will be deployed to a variety of remote locations, gathering data that will determine where on the antarctic plateau is the most favourable location for a major new international astronomical observatory.
{Contact: Professor J Storey, tel: (02) 9385 5460}

Space weather forecasting
Massive energy bursts from the sun can sear communication satellites worth millions of dollars and knock them out of service. This destroys communications and television services. Space energy bombardments can also trigger shutdowns in electricity grids, blackout communities and disrupt economic production. Plasma wave studies by the Space Physics group at the University of Newcastle, in conjunction with research groups in Norway, USA and Antarctica, have led to much improved space weather forecasting so that satellites can be rotated to shield sensitive components and power grids can be protected from solar energy disturbance.
{Contact: Professor Brian Fraser, Department of Physics, University of 'Newcastle, tel: (049)21 5445}

Robotic gas sniffers
New sniffing devices have been constructed at the University of Tasmania for a wide range of chemical applications. The devices comprise semiconductor gas sensors in a portable monitor that is left operating as a robotic sniffer. Applications include monitoring the odours of beers and wines, and fats and oils in food technology, air pollution testing, and detecting car exhaust emissions.
{Contact: Professor P Alexander, Department of Physical Sciences, University of Tasmania, tel: (03) 6324 3824, fax: (03) 6324 3839}

Innovative double-layer dielectric stack
Victoria University of Technology has fabricated a double-layer dielectric stack coated on a prism. The new structure can generate an evanescent wave 6000 times stronger than that from an uncoated prism, and is being used to

develop a novel near-field optical microscope.
{Contact: Dr. Min Gu, tel: (03) 9688-4284, e-mail: ming@dingo.vut.edu.au}

Improved plastics manufacture
Researchers at the Royal Melbourne Institute of Technology have built a melt extensional rheometer. The instrument can measure properties of melts of polymers and composites for application in a range of polymer processes, and has benefited a number of local polymer industries.
{Contact: Associate Professor John Ball, Rheology and Materials Processing Centre, tel: (03) 9660 2080}

A new phase in x-ray imaging
X-ray imaging in medicine and industry is a step closer to significant new capabilities as a result of innovative research at the University of Melbourne. Researchers have shown that data obtained from observing the deviations of x-rays passing through a target material can be processed and interpreted to

produce a very sensitive new form of image. The x-rays do not need to be absorbed as in conventional imaging.
{Contact: Professor Keith Nugent, Head, School of Physics, tel: (03) 9344 5420}

Institute of Advanced Studies, The Australian National University

Role *To be one of the world's great basic research institutions, distinguished also by outstanding teaching, guiding students to the frontiers of knowledge and the best standards of scholarship.*

The Institute of Advanced Studies aims to maintain and enhance the University's world class standing and excellence by:

- engaging in research and scholarship at the highest international standards;
- strengthening Australia's capacity to undertake fundamental research both generally and in relation to subjects of national importance;
- providing outstanding post-doctoral and graduate training in all areas of the Institute's research activity;
- encouraging collaborations which allow other Australian universities to benefit from the concentration of research resources available at the Institute;
- fostering international exchanges and collaborations which enable Australia to contribute to and benefit from the latest advances in front-line research;
- encouraging links which make the scholarship and research resources of the Institute accessible to the Australian community, industry and government;
- being well-placed to respond rapidly to a changing environment and new opportunities; and
- optimising use of its resources by promoting internal links, including those with the Faculties, based on shared or complementary technologies and interests.

The Institute of Advanced Studies (IAS) of The Australian National University consists of eight research schools and two research centres. In addition, staff of the Institute participate in several cross-campus research groupings and centres. The Institute's fields of academic inquiry include biological sciences, chemistry, bio-medical sciences, physical sciences including mathematics, astronomy and the earth sciences, information

technology and cognate areas of engineering and broad interests in the social sciences and environmental sciences.

The Institute has a distinctive place in the Australian higher education system. Uniquely, it is block funded to undertake full-time research at the highest international standards and to provide post-graduate and post-doctoral research training. Approximately $153 million of The Australian National University operating grant can be regarded as block funding for the research schools and centres of the IAS. From 1997-98, funding for the John Curtin School of Medical Research will be provided through the ANU operating grant through the Employment, Education, Training and Youth Affairs portfolio.

The Institute has a special responsibility to be a resource for the Australian higher education system and for Australian research as a whole. In part fulfilment of the Institute's role as a resource for the Unified National System, about 10.5 percent of the recur rent budgets of the schools and centres of the Institute is spent on collaborative research activities with other Australian universities.

The Institute is in the process of implementing those recommendations arising from the 1995 Review of the Institute which are the responsibility of the University, including the recommendations relating to a review of the Institute's strategic development planning procedures. Effective strategic planning processes have ensured that the Institute is a world-wide player in every field in which it has well-established scholarly and research activity. More integrated strategic planning is in process to determine priorities for the next decade.

Recent Achievements

Cracking the gene for cellulose synthesis
The Research School of Biological Sciences has isolated and sequenced the gene for the catalytic centre of the enzyme that makes the world's most abundant and valuable biopolymer, cellulose. A mutant plant was discovered which provided the breakthrough needed to find the gene for cellulose synthesis. The mutant plant's root cell walls were so weak they indicated a defect in cell wall synthesis. Patents for this gene have attracted significant CRC and industrial support.

Drimentines
The Research School of Chemistry completed research on the molecular structures and interconversions of the drimentines, a group of novel natural products isolated from an as yet unidentified soil bacterium. The drimentine antibiotics are just one outcome of the collaboration between the Research School and the new Australian company Microbial Screening Technologies Pty Ltd, who isolated the producing bacterium from a soil sample collected near Dungog, New South Wales. The collaboraf ion also involves Ciba-Geigy Australia Ltd and its Swiss parent company, Ciba-Geigy AG, Basel, who are

currently assessing the activity of the drimentines in a wide range of biological screens. A European Patent Application has been filed.

Treatment of Ecstasy overdoses
The John Curtin School of Medical Research has shown that the disease malignant hyperthermia, the most common cause of anaesthesia-induced death, is related to an elevation of calcium within muscle cells. The clinical features of the disease include a high temperature, muscle cell breakdown, a destruction of platelets and possible renal failure. These are the same clinical features found in Ecstasy overdoses. Elevation of calcium in muscle cells also occurs in these cases. The drug dantrolene is effective in the treatment of malignant hyperthermia and it is also likely to be effective in treating Ecstasy overdoses.

Greenhouse change and flooding
The Centre for Resource and Environmental Studies, the Queensland Institute of Technology and CSIRO have costed the effects of greenhouse change on urban flooding. The study used greenhouse rainfall intensity scenarios as a basis for rainfall-runoff modelling to establish the likely change to flood frequencies. The provisional studies indicated that mean annual damage could increase by a factor of three. This has major implications for all aspects of floodplain management.

Climate change record and consequent sea-level changes
The Research School of Earth Sciences has developed techniques for measurement of environmental changes recorded in annual growth cycles in corals, in cave deposits (speleotherms), in marine and lake sediments and in sea-level rise and fall. These techniques allow analysis of growth or deposition features with resolution of weekly to monthly intervals, with the possibility of achieving histories of 100's to 10,000 years. The work provides detailed records of past climate change, including both short-term variations and longer cycles. This information is essential for the disentangling of human-induced effects on climate and on vegetation patterns from natural cycles.

Plasma fusion studies
Experiments on fusion plasma confinement in the Research School of Physical Sciences and Engineering are helping to shed light on why sudden and very dramatic improvements in the confinement of the plasma occur. This is a very important phenomenon which occurs in large-scale fusion research using very high heating power levels, but which has now been observed in the School using much lower heating power levels.

How galaxies evolve
How many galaxies were there at different epochs in the history of the universe, and how rapidly were these galaxies forming stars? Astronomers from Mount Stromlo and Siding Spring Observatories showed that different types of galaxies evolve in very different ways. Their study of a sample of 1700 galaxies revealed that, around the time the Sun was formed, the numbers of red elliptical and spiral galaxies was essentially the same as it is today, while the numbers of blue spiral galaxies were much higher. This is

consistent with a picture in which giant ellipticals and spirals formed the bulk of their stars at high redshift and have since been largely quiescent, while the smaller spirals and dwarf galaxies were undergoing more vigorous star-formation in the comparatively recent past. These results sketch out the timetable for star-formation in galaxies in a way that provides strong constraints for theoretical models.

Quantum wires
Recent research in electronic materials engineering in the Research School of Physical Sciences and Engineering has led to the development of one-dimensional semi-conductor materials systems, called quantum wires. Multiple quantum wires emitting light simultaneously form laser arrays which will play an important role in future optical communications.

Modelling financial markets
Researchers at the School of Mathematical Sciences were able to identify and explain important properties of fluctuations in financial time series, such as exchange rates, stock prices and market indices. These assets exhibit larger random movements than traditional theories would predict. This phenomenon was found to be a consequence of the interaction between traded assets. The result allows the development of efficient and precise risk management strategies for superannuation funds, security derivatives and general financial instruments.

The Anglo-Australian Telescope Board

Role *The Anglo-Australian Telescope Board (AATB) provides world class facilities for the Australian and British astronomical communities through its operational arm, the Anglo-Australian Observatory, to enable astronomers to undertake research for the advancement of scientific knowledge.*

The Anglo-Australian Telescope Board operates under an agreement between the Governments of the United Kingdom and Australia and is equally funded by them. The Australian Government will contribute $3.5 million in 1997-98. The facilities include the Anglo-Australian Telescope (AAT) and the UK Schmidt Telescope (UKST) at Siding Spring Observatory outside Coonabarabran, and a laboratory in Sydney.

The Anglo-Australian Telescope (AAT) was state-of-the-art when officially opened in 1974. Two decades later, the AAT remains at the leading edge in astronomical research against considerable international competition. Throughout those years many significant astronomical discoveries have been made using the Observatory's telescopes, the Anglo-Australian Telescope and the UK Schmidt Telescope, and as a consequence Australian and British astronomers have a very high standing in the worldwide scientific community. One of the reasons for this continued excellence is the

vision and expertise of the Observatory's scientific and engineering staff, who have constantly upgraded the telescope by incorporating the latest technological developments into instrument design. In fact, staff at the Observatory are considered world leaders in many areas of astronomical instrumentation.

Recent Achievements

Stars with flare
The UK Schmidt Telescope has obtained spectra showing emission lines from T Tauri stars. Strong stellar flare-like events were detected from both classical and weak-line T Tauri stars, showing that these stars exhibit strong stellar flares and are likely to have strong magnetic fields.

Stellar magnetic fields
Images of the complex magnetic field structures on the photospheres of rapidly rotating stars have been made. One of these, the KO dwarf AB Doradus, shows that the magnetic field of the star is essentially radial and occupies approximately twelve regions of alternating magnetic polarities. They also show that, like the sun, the polar regions of AB Doradus rotate more slowly than the equatorial region.

ENVIRONMENT, SPORT AND TERRITORIES

Australian Antarctic Division

Role *To contribute to knowledge of the global environment through research in the Antarctic region; to provide scientific knowledge for the effective management of the Antarctic environment; and to increase Australia's influence in Antarctic matters by participating in international scientific programs and by contributing to international scientific forums.*

Recent Achievements

Conservation of marine resources
Krill biomass estimates from a 1995-96 research cruise of *RSV Aurora Australis* were used to set a Commission for the Conservation of Antarctic Marine Living Resources precautionary catch limit on the krill fishery off most of the Australian Antarctic Territory. The Total Allowable Catch (TAC) for toothfish around South Georgia was increased from 4000 to 5000 tonnes, using assessment methods developed by Australian scientists, and the TAC for toothfish in the region around Heard and McDonald Islands was set at 3800 tonnes based on Australian surveys carried out in 1990 and 1993, using the same assessment method.

Human effects
Antibodies for Infectious Bursal Disease Virus have been identified in Adelie penguins, but only at colonies close to some Australian Antarctic stations. This disease causes death or decreased production in domestic chickens and could have serious consequences on penguin populations. The geographic distribution of the colonies with antibodies is a strong indication that the disease was introduced by human activities.

Global change
A digital elevation model of part of the Antarctic ice sheet has been derived from radar altimeter data and validated against field data. This model provides a major tool for studies of ice sheet dynamics. Other data from drifting buoys and automatic weather stations continue to be used to determine the surface climate of the Lambert Glacier basin, and the pattern of sea ice drift off the Australian Antarctic Territory.

Bureau of Meteorology

Role *To observe and understand Australian weather and climate and provide meteorological, hydrological and oceanographic services in support of Australia's national needs and international obligations.*

To fulfil its research objectives, the Bureau:

- encourages high quality research in-house as a foundation for effective collaboration with the external research community and for the implementation of improved systems and techniques for the provision of services;
- fosters meteorology in the tertiary sector to ensure access to well-trained graduates and maintenance of the national research infrastructure for atmospheric science; and
- ensures effective coordination with the research programs of other relevant institutions both within Australia and overseas.

The main research activities are carried out by the Bureau of Meteorology Research Centre in collaboration with the various operational units of the Bureau. Major research areas are mesoscale meteorology, regional meteorology, medium-range prediction, climate, climate-change modelling and oceanography. The activities involved include theoretical studies, field experiments and mathematical modelling of atmospheric and oceanographic systems, with increasing effort being directed to the practical application of research results to improving the quality of Bureau services. Research is also undertaken into atmospheric constituents including greenhouse gases and atmospheric ozone.

Recent Achievements

Tropical cyclones and climate change

Scientists at the Bureau of Meteorology Research Centre, in collaboration with other international experts, investigated the potential changes in tropical cyclone frequency and intensity that could occur under climate change conditions. The study found that the maximum potential intensity of cyclones over the next few decades was likely to increase but any increase would be small compared with the year-to-year variability of cyclone intensity. No change is expected in the frequency of tropical cyclones. It is also unlikely that the regions of the world in which tropical cyclones form will increase in area as sea surface temperatures increase.

Modelling regional dispersion of bushfire smoke

A numerical model to predict the transport and dispersion of material in the atmosphere has been developed. When interfaced to the Bureau's operational global and regional atmospheric prediction systems, the model

can be used to provide trajectories of pollutants in the case of environmental emergencies. The model has been used experimentally over the last year to predict smoke transport from potential forest fires over southwestern Western Australia and thereby assist authorities in deciding when to undertake hazard reduction burning.

National daily rainfall analyses
A system to analyse the daily rainfall across Australia on a real-time basis has been implemented operationally in the National Meteorological Centre (NMC). Measurements of rainfall over a 24-hour period are recorded at about 2000 stations across the country each day, transmitted to the NMC in Melbourne and analysed automatically to a resolution of about 25 km. The resulting analyses are available immediately and serve a wide range of applications in sectors such as agriculture and water management.

UV index for sun protection
The Bureau of Meteorology, in collaboration with the Cooperative Research Centre for Southern Hemisphere Meteorology, has developed a system to predict the potential loading of UV-B at ground level across Australia each day. The system uses output from the global numerical weather prediction model to estimate the movement of stratospheric ozone, which controls the amount of UV-B radiation reaching the ground. The system is now run operationally by the National Meteorological Centre each day.

Environment Protection Group of Environment Australia (EPG)

Role *The EPG works with all levels of government, business and the community to help find nationwide solutions to Australia's environment problems. The EPG manages Commonwealth environment protection responsibilities, administers Commonwealth environment protection legislation and fulfils our international environment protection obligations.*

Recent Achievements

Predicting the effect of uranium mining on local communities
Research has been undertaken by the Environmental Research Institute of the Supervising Scientist to determine the effects of uranium mining on people living near mine sites. Air has been sampled near the Ranger uranium mine in the Northern Territory to determine the concentration of radon, the most important source of radiation dose for people in local communities. Radon is an inert gas which is a decay product of uranium and which is carried away from the mine by wind. Measurements to date demonstrate

that the radiation dose from mine derived radon is much smaller than that derived from naturally occurring sources. This work has now been extended to determine the rate of radon emanating from the ground at the rehabilitated mine site at Nabarlek in Arnhem Land.

Great Barrier Reef Marine Park Authority (GBRMPA)

Role *The GBRMPA is the principal advisor to the Commonwealth Government on the care and development of the Great Barrier Reef. The Authority's research and monitoring program conducts and supports research to assist in fair and transparent decision making in the Marine Park. Its focus is on obtaining, interpreting, disseminating and applying scientific information on the Great Barrier Reef, in order to manage human use and minimise impacts to the Great Barrier Reef World Heritage Area.*

Recent Achievements

Effects of prawn trawling
The field work component of the research project 'Effects of Prawn Trawling in the Far Northern Section of the Great Barrier Reef Marine Park' has been completed and a final report for the five-year study is to be released in mid-1997. Data from this study will provide an insight into the impact of prawn trawling on the sea-bed, its associated fauna, by-catch species and sea bird populations. The results will provide valuable information for managing the effects of trawling in the Great Barrier Reef Marine Park. A further study has been initiated to determine the recovery of benthic communities after intensive commercial prawn trawling. Preliminary results are expected in mid-1997.

Water quality
Long term nutrient data sets collected in research and monitoring programs of Great Barrier Reef Marine Park Authority and the Australian Institute of Marine Science from 1977 to the present are being analysed to characterise the nutrient status of the Great Barrier Reef. The data include results from river discharge, lagoon and reefal waters. The nutrient status of offshore Great Barrier Reef water does not appear to have substantially changed in the last 20 years.

National Greenhouse Research Program

Role *The National Greenhouse Research Program is aimed at extending fundamental understanding of climate change, through provision of funds for basic and applied scientific research, and at improving confidence levels in predictions of climate change for the Australian region.*

The Program consists of a core component, supporting greenhouse-related science through provision of funding to the CSIRO, Bureau of Meteorology and National Tidal Facility; and a non-core component under which research projects on the science and impacts of climate change are undertaken by a wide range of institutions.

Recent Achievements

Climate change scenarios
With climate modelling and other projects supported by the Program, CSIRO released new climate change scenarios for the Australian region in November 1996, the first since 1992. The scenarios are more advanced than earlier scenarios, as they are based on the 1996 warming scenarios of the Intergovernmental Panel on Climate Change, make allowance for the cooling effect of aerosols and use the results of fully coupled ocean-atmosphere climate models.

FINANCE

Australian Government Analytical Laboratories (AGAL)

Role *To develop analytical methods of suitable precision, accuracy and efficiency to meet demands for emergency testing services related to the protection of public health and safety, threats to Australia's export markets for agricultural produce, and protection of the environment. Investigatory and advisory capability resides with the Scientific Services Laboratory in the areas of fire safety, construction and related activities.*

The Australian Government Analytical Laboratories (AGAL) play an important strategic role in protecting Australian public health and safety and international trade, through its quality services in analytical chemistry, microbiology, fire safety and physical testing. AGAL's operations are aimed at providing support for government and industry and in particular they provide a crisis response capability.

Recent Achievements

Food standards
The recent public health crisis arising from microbiological contamination in salami highlighted the need for a review of standards in the Australian smallgoods industry. AGAL worked with the Australian & New Zealand Food Authority on a survey of goods available at retail outlets. In addition AGAL assisted the Australian Quarantine and Inspection Service with a parallel survey of sampling during production. Standards and procedures have been developed for the industry to minimise the risks from these products.

Food profiling
A new method for DNA profiling of cooked and uncooked meats has been developed by AGAL scientists. Substitution of different species has until now been difficult to detect. The new method provides quick and effective means of detecting fraudulent practice.

DAS Centre for Environmental Management (DASCEM)

Role *To satisfy customers' environmental management needs for independent specialist advice and cost-effective solutions in the areas of: management of ozone depleting substances (halons and CFCs); energy management services; site assessment and remediation; environmental assessments; and audits; and workplace health and safety.*

Recent Achievements

Halon Bank
The DASCEM Halon Bank was established to collect, store, decant and destroy halon which is found in yellow fire extinguishers and fire suppression systems. Although a very effective fire extinguisher, halon severely depletes the ozone layer. On 16 December 1996, the Minister for Administrative Services, the Hon. David Jull MP, officially opened the DASCEM Halon Bank Decanting, Conversion and Recycling facility at Tottenham in Victoria. With the opening of the facility, DASCEM commenced the bulk decanting and destruction of halon and CFC. DASCEM's facility is the only one in the world dedicated solely to the environmentally responsible destruction of ozone depleting substances. At the end of February 1997, DASCEM had collected over 1,600 tonnes of halon.

IPS Radio and Space Services (IPS)

Role *To provide timely radio propagation and space weather advice that customers will rely on to perform their operations; that is appropriate to the needs of the Australasian community; and that uses best technical and business practices.*

Recent Achievements

Real-time correction for ionospheric delay
IPS has developed a real time model of the ionospheric content suitable for upgrading the accuracy of wide area differential GPS navigational applications. Grid-point maps of Total Electron Content have been produced and tested satisfactorily against GPS data supplied by AUSLIG, an operating group in DAS.

HEALTH AND FAMILY SERVICES

National Health and Medical Research Council (NHMRC)

Role *The objective of the National Health and Medical Research Council is to advise the Australian community on the achievement and maintenance of the highest practicable standards of individual and public health and to foster research in the interest of improving these standards.*

In 1997, the NHMRC is providing support for 1175 research projects; 30 large research programs; 5 major research institutes; 6 special units; 488 scholarships and training fellowships; and a number of other research projects and activities in specialised areas.

Recent Achievements

Attention Deficit Hyperactivity Disorder
A study at Prince of Wales Hospital on Attention Deficit Hyperactivity Disorder has found that it is inherited as a behavioural trait with 75 - 90 percent heritability, and has a higher coincidence in twins than siblings. These genetic influences are shared with speech and reading problems. This indicates that speech and reading assessments are essential for children diagnosed with the disorder.

Improving the quality of Australia's blood products
The Red Cross Blood Service (WA), the University of Western Australia, the Commonwealth Serum Laboratories Ltd and Tuta Laboratories have investigated the nutrient needs of blood cells in blood collected by the Blood Service. They have found that stored platelets do not need high levels of glucose or oxygen to maintain their blood clotting properties. They also found that an unidentified substance in plasma is essential for platelet maintenance. Their findings led to the development and manufacture of new blood bags which are now on trial and allow better storage of platelets without plasma.

Skin cancer

The University of Western Australia's Department of Public Health has found that different sunlight exposure factors are important in the development of the two different types of non-melanocytic skin cancer, Squamous Cell Carcinoma (SCC) and Basal Cell Carcinoma (BCC). Both SCC and BCC are curable by early removal, but prevention is preferable to cure. Exposure to sunlight is known to be an important causative factor in the development of both cancers. Studies show that intermittent exposure to sunlight (e.g. recreational exposure) is the most significant type of exposure leading to BCC development. In contrast, SCC development is more closely linked with cumulative sunlight exposure throughout life, with an increasing risk of developing SCC as total hours of exposure of the skin area increase.

Eye cancer - mapping the genes

Intraocular melanoma is the most common form of eye cancer. The Peter MacCallum Cancer Institute in Melbourne has investigated gene mutations in mice which suffer from intraocular tumour similar to that in humans, with a view to developing improved diagnostic markers and better management for the human disease. Work has focused on identification of the genes and the genetic events which give rise to the development of these mouse tumours. They have identified genes called p!6 and p!5 on mouse chromosome 4, which are tumour suppressor genes. It appears that mutations in these genes result in their inactivation and development of intraocular tumours. A similar inactivation of tumour suppressor genes located on an equivalent human chromosome is associated with various human tumours. The mouse model will enable the causative genetic events leading to tumour development to be studied.

A genetic predisposition to heart disease?

Disease of the heart's system of blood vessels, the coronary arteries, is a major cause of premature death in Australians. Studies of large numbers of patients have shown that other factors besides high blood pressure, high blood cholesterol and smoking must exist which contribute to the development of coronary disease. The University of New South Wales has been investigating genetic variations in patients with and without coronary heart disease, to develop coronary disease risk profiles which are genotype specific and environment dependent. It has demonstrated that a variation in a gene which codes for a enzyme called nitric oxide synthase, results in a susceptibility to the deleterious effects of smoking. Another gene variant has been found which results in production of high levels of a substance called angiotensin II, which can lead to growth of cells in the lining of blood vessels and potential blood vessel obstruction. A gene variant which results in reduced activity of an enzyme which breaks down fat particles in the blood has also been demonstrated to be associated with coronary disease, particularly in those patients who have diabetes. The demonstration that these genetic variations can result in increased risk of coronary disease offers the opportunity for development of prevention strategies for those at risk.

Monitoring water supplies for infectious microorganisms
Governments at all levels have responsibility to ensure adequate safeguards to public health from contamination of Australia's water supplies. Advanced capability for high sensitivity detection of disease causing microorganisms is becoming essential. Of particular recent concern is the protozoan *Cryptosporidium* which can cause diarrhoea and may be life threatening in immunocompromised people. Macquarie University's Centre for Analytical Biotechnology has developed technology for the high sensitivity detection of *Cryptosporidium.*

Commonwealth AIDS Research Grants (CARC) Program

Role *To foster research aimed at preventing the spread of human immunodeficiency virus (HIV) and minimising the personal and social impact of HIV infection. It also aims to foster research into those related communicable diseases where there is significant overlap or commonality of risk factors, such as hepatitis C and STDs.*

In 1997, CARG will be supporting 86 research centres; 37 scholarships and 13 fellowships, as well as three national centres undertaking virology, epidemiological and clinical, and socil research into HIV/AIDS.

Recent Achievements

Gene therapy in the treatment of HIV infection
The Institute for Medical and Veterinary Science in Adelaide is investigating the potential of gene therapy in the treatment of HIV infection. Genes which produce molecules inhibitory to a number of critical steps in the replication of HIV have been incorporated into the genetic material of a T lymphocyte cell line. Although the original cell line is highly susceptible to HIV infection, the modified cells have been shown to be fully resistant to HIV for up to 24 weeks *in vitro.*

Similar work is now in progress with human bone marrow cells which are also known to be susceptible to HIV, in an attempt to render them HIV resistant. The ultimate aim is to introduce these genes into cells isolated from the bone marrow of HIV patients, re-introduce the modified cells into the same patient, and allow them to repopulate the patient with HIV resistant blood cells.

INDUSTRY, SCIENCE AND TOURISM

MAJOR POLICY ACTIVITIES

Overview of Policy Advisory Arrangements

Policy advice to ministers, awareness of key issues and the high-level coordination of activities across portfolios is maintained by a combination of the Chief Scientist, the Prime Minister's Science and Engineering Council (PMSEC), the Australian Science, Technology and Engineering Council (ASTEC) and the Coordination Committee on Science and Technology (CCST).

The roles of PMSEC and ASTEC are complementary and together they form a powerful mechanism for ensuring that government decisions on matters involving science and technology are technically well-informed (based on ASTEC's research and analysis) and that relevant ministers have had the opportunity to debate the issues with leading experts (in PMSEC).

CCST brings together Heads of science and technology agencies and Deputy Secretaries of departments with an interest in science and technology to share information about their programs and policies, problems and opportunities. It is chaired by the Deputy Secretary of the Department of Industry, Science and Tourism with science and technology responsibilities.

The Chief Scientist is currently chair of ASTEC, and a member of PMSEC and CCST.

Secretariat support for PMSEC, ASTEC, the Chief Scientist and CCST is provided by the Science and Technology Advisory Branch of the Department of Industry, Science and Tourism.

Prime Minister's Science and Engineering Council (PMSEC)

Role *To provide a major national forum for consideration of issues of national significance in science and technology and to keep the Prime Minister and senior Ministers informed of key issues, thereby enhancing understanding of matters affecting Government policies.*

PMSEC is a high-level discussion forum on national science and technology related issues. Ministers with key portfolio responsibilities for science and technology are members, and there is high level representation from the business, science and technology communities and the trade union movement. The Prime Minister chairs PMSEC and the Minister for Science and Technology is the Deputy Chair. PMSEC gives ministers the opportunity to hear expert presentations and interact directly with leading representatives such as the Presidents of the two science-based Academies. There is a particular emphasis on the application of policy research findings, giving impetus to the resolution of science and technology issues within government.

PMSEC has the following terms of reference:

- to address important issues in science, technology, engineering and relevant aspects of education and training;
- to examine the contribution of science, technology and engineering to the economic and social development of Australia;
- to enhance awareness in the community of the importance of science, technology and engineering for Australia's economic and social development;
- to examine Australia's science and engineering resources and the effectiveness of their organisation and utilisation; and
- to examine Australia's science and engineering infrastructure and the effectiveness with which it achieves the application of science and technology in the economic and social development of Australia.

Recent Achievements

See Section 2.

The Chief Scientist

Role *The Chief Scientist provides policy advice, briefing and support to the Prime Minister and the Minister for Science and Technology on strategic and operational issues affecting the science and technology system and its contribution to national goals.*

The Chief Scientist, Professor John Stocker, provides advice to the Prime Minister and the Minister for Science and Technology on such matters affecting science, technology and engineering as the Prime Minister or Minister request, and on other issues to which science and technology are relevant. Professor Stocker is currently undertaking a review of arrangements for Australian science and technology. He is investigating gaps and overlaps in science and technology arrangements, mechanisms for identifying national priorities for science and technology, and arrangements for provision of science and technology policy advice to Government.

Australian Science and Technology Council (ASTEC)

Role *To advise the Commonwealth Government on the development of a clear, long term strategic approach to maximise the contribution of science, technology and engineering to national well-being.*

ASTEC provides the Government with detailed analysis of issues based on extensive research. It deals principally with issues where a full examination of all relevant facts is needed. ASTEC's advice to Government represents the outcome of deliberation by experts, both on the Council and co-opted to ASTEC working parties.

The functions of the Council are to investigate and to furnish information and advice to the Commonwealth Government in respect of issues relating to science, technology and engineering including:

- the advancement of scientific knowledge;
- the development and application of science and technology in relation to national well-being;
- the adequacy, effectiveness and balance of scientific and technological activities in Australia;

- the identification and support of new ideas in science and technology likely to be of national importance;
- the practical development and application of scientific discoveries;
- the fostering of innovation in industry; and
- the means of improving efficiency in the use of resources by the application of science and technology.

The Government has announced its intention to legislate to change the Council's name to the Australian Science, Technology and Engineering Council.

Dr Don Williams has stepped down as Chairman after completing his term, and Professor John Stocker has been appointed Chairman of ASTEC.

During the past year, ASTEC has concentrated on continuing its studies:

- Matching Science and Technology to Future Needs (completed). One of the components generated through the Future Needs study has been the Snipping Partnership (completed); and
- Science and Technology in Primary Schools (due for completion in May 1997).

New studies that have commenced are:

- International S&T advisory arrangements and comparison of overseas structures with the Australian system. This will form a contribution to the Chief Scientist's review of arrangements for support of science and technology in Australia.
- The ethical issues associated with field experiments in World Heritage and other protected areas.

Recent Achievements

See Section 2.

Coordination Committee on Science and Technology (CCST)

Role *To allow departments and agencies with an interest in science and technology to share information about their programs, policies, problems and work plans. This helps ensure coherence and consistency in the implementation of Government policy for science and technology, and allows an overview by the Committee of that policy.*

The CCST's terms of reference are:

- to provide coordinated advice to the Government through the Minister for Science and Technology on national science and technology issues;
- to improve coordination of administration of government science and technology programs among departments and agencies, including cooperation among departments and agencies on specific science and technology issues and opportunities; and
- to exchange information among departments and agencies on domestic and international science and technology programs, policies, work plans, issues and opportunities.

Recent Achievements

See Section 2.

Genetic Manipulation Advisory Committee (GMAC)

Role *To oversee the development and use of innovative genetic manipulation techniques in Australia so that biosafety risk factors associated with the novel genetics of manipulated organisms are identified and can be managed; and to advise the Minister about matters affecting the regulation of innovative genetic manipulation.*

The Genetic Manipulation Advisory Committee (GMAC) is a non-statutory body established to oversee the development and use of novel genetic manipulation techniques in Australia. GMAC's role is to identify and

manage risks to the safety of workers or potential hazards to the community or environment associated with genetically manipulated organisms. GMAC is supported by a secretariat within the Department.

A review of the management of gene technology, including the role of GMAC, was conducted during 1996-97.

Recent Achievements

New release proposals
During 1996-97, GMAC assessed thirteen new proposals for the planned release of genetically modified organisms into the environment and ten extensions to previous proposals. All of the proposals were for field trials of genetically modified plants. The plants involved were cotton, sugarcane, canola, lupin, potato, tomato, field pea, white clover, and subterranean clover. The genetic modifications included resistance to pests and diseases, resistance to herbicides, and improved quality traits. GMAC also provided advice on the biosafety aspects of a submission to import genetically modified soybean seeds for processing.

Publications
GMAC published a new edition of the *Guidelines for the Planned Release of Genetically Manipulated Organisms* and commenced work on revision of the *Guidelines for Small Scale Genetic Manipulation Work.* Distribution of other publications continued; these included the *Safety Practices in PC2 Laboratories* booklet, a reprint of the *Biotechnology Information Series* produced by Iowa State University of Science and Technology, and a newsletter.

MAJOR RESEARCH ACTIVITIES

The Australian Institute of Marine Science (AIMS)

Role *To generate the knowledge to support the sustainable use and protection of the marine environment through innovative, world-class scientific and technological research.*

Recent Achievements

Underwater laser tool to study reef growth
With some species of coral only growing a few millimetres each year, this new technology offers more rapid assessments of reef health. Researchers at the Australian Institute of Marine Science have developed an apparatus which

uses a beam of laser light to measure the fine skeletal growth of coral, allowing researchers to better understand hourly, daily and annual growth patterns as well as monitor the possible effects of light, temperature, currents and human impacts on coral reef growth. This new, non-destructive technique for measuring even tiny changes in coral growth was featured on the front cover of the international science journal, *Nature*, and has already produced unexpected results, showing that, against conventional wisdom, most coral growth happens at night.

Oil spill forecasting
Predicting the likely path of oil spills is a challenging problem wherever oil might be spilled into the sea. In 1992 the Institute formed a collaboration with a US company, Applied Science Associates (ASA), to combine a user-friendly computer interface with the Institute's mathematical models of ocean circulation to produce OILMAP. The Australian Maritime Safety Authority now uses the OILMAP as the national oil spill management system. Many oil companies now use the system around the Australian coastline to forecast the direction and fate of oil spills, for training personnel in oil spill emergency response and for oil spill contingency planning.

Australian Nuclear Science and Technology Organisation (ANSTO)

Role *To undertake research and development in nuclear science and associated technologies to contribute to Australia's industrial innovation and development, and environmental and health management. Maintain a core of essential nuclear expertise and nuclear facilities, and further Australia's non-proliferation, nuclear safeguards and wider nuclear technology policies.*

Recent Achievements

Treatment of arsenic wastes
The presence of arsenic in ground water is a serious problem in many countries. Arsenic contamination of waters can result from natural processes, the mining of arsenic-bearing ores or agricultural use of arsenic chemicals. ANSTO and the CRC for Waste Management and Pollution Control have patented a process that rapidly converts the highly poisonous form of arsenic known as arsenic(III) to the less harmful arsenic(V). The arsenic can then be readily immobilised in a solid form suitable for direct disposal. A demonstration, funded by the United States Environmental Protection Agency, and carried out by ANSTO scientists in Montana in 1996 was very successful. It showed that solid waste produced by the process satisfies the standard US test for disposal in a municipal landfill.

International nuclear safeguards

Accelerator mass spectrometry measures rare nuclides introduced into the environment by specific nuclear activities, such as fuel reprocessing, reactor operations and uranium enrichment. ANSTO is using this to measure iodine-129 in water, sediments and biological materials, at levels corresponding to isotopic ratios 10^{-14}. The sensitive nature of this new technique was demonstrated when iodine-129 was analysed in samples of waters and sediments collected at various distances from a nuclear reprocessing plant, with concentrations detectable as low as one iodine-129 atom in ten thousand billion atoms.

ANSTO research confirms reduction in airborne lead levels

Recent studies have shown that motor vehicle emissions are responsible for most of the airborne lead in the inner Sydney region. Federal and NSW Government initiatives have aimed to lower atmospheric lead content from motor vehicle emissions. Initiatives include halving lead in super petrol between 1992 and 1995 and increasing substitution of leaded by unleaded fuel as the motor vehicle fleet modernises. ANSTO has monitored fine particulate lead in the atmosphere at sites covering the greater Wollongong, Sydney and Newcastle areas since mid 1991. The results show a definite downward trend for fine particulate lead concentrations in the air around Sydney during the 4-year period 1992 to 1995 inclusive.

Immobilisation of surplus US weapons plutonium

Following super-power decisions to reduce the number of nuclear weapons, Synroc (an Australian developed ceramic) has been short-listed for assessment as one of the immobilisation technologies to be used in the geological disposal of surplus plutonium. ANSTO has demonstrated the capability of Synroc for immobilising plutonium to the Lawrence Livermore National Laboratory, which is the US Department of Energy's lead agency for plutonium immobilisation.

CSIRO

Role *CSIRO's primary functions are to carry out scientific research to:*

- *assist Australian industry;*
- *further the interests of the Australian community;*
- *contribute to the achievement of Australian national objectives or the performance of the national and international responsibilities of the Commonwealth;*
- *encourage or facilitate the application or utilization of the results of this or any other scientific research; and*
- *carry out services, and make available facilities, in relation to science.*

Recent Achievements

Agribusiness

Low fat sausage
CSIRO Food Science & Technology has devised a new low-fat process for manufactured meats such as sausage or salami. The new technology replaces fat in processed meats with proteins made from whey, a by-product of milk processing. The result is a product containing about 75 percent less fat than normal but which retains the palate quality and flavour of the original product. The process has been patented internationally and licensed to food ingredients firm Applied Technology Products Pty Ltd.

World's first gene-modified grapevine
Scientists at CSIRO Horticulture have achieved a scientific advance of international significance with the creation of what may be the world's first gene-modified grapevine. This paves the way for major gains in both productivity and quality for the $1.5 billion a year wine, grape and dried vine fruit industries. Working with the Cooperative Research Centre for Viticulture, CSIRO scientists are presently investigating genes that control the sweetness, flavour and colour development in grapes.

Outsize prawns
Japanese King Prawns, which grow up to 25 percent faster or larger than wild-caught prawns, have been developed by CSIRO Marine Research scientists and a local prawn farmer. The advance has given Australia a chance to lead the world in the selective breeding of crustaceans for the

burgeoning $400 million a year aquaculture industry. Several breeding techniques were combined to produce these prawns, which have a very high value on the Japanese market.

DNA fingerprinting for black sheep
Scientists at CSIRO Animal Production have devised a way to detect the 'black sheep' of the Australian flock; that is, Merino rams that persist in passing on a few black or coloured fibres in an otherwise pristine national woolclip, reducing its market value by millions of dollars. The DNA fingerprinting technique will help producers identify better stud rams and ewes for breeding lambs that will have no pigmented fibres, and will produce finer, stronger wool and heavier fleeces.

Environment & Natural Resources

Port Phillip Bay study leads the way
CSIRO handed over its final report into the environmental health of Port Phillip Bay to the Premier of Victoria in July 1996. The study showed the Bay is in remarkably good condition due to natural ecological processes, but also warned that these are under increasing pressure and identified a number of specific problems. The study was one of the largest multi-disciplinary studies ever run by CSIRO and provides a model for future management of water catchments. It has resulted in CSIRO being asked to provide independent analysis of the scientific assumptions and research that form the basis of Sydney Water's 20-year business plan.

World's best radiometer
CSIRO scientists have built the world's most sophisticated radiometer to measure the heat emitted by clouds. It has the potential to greatly improve prediction of future climate. The instrument, valued at $200,000, was produced under contract to the US Government as part of Australia's contribution to the US Atmospheric Radiation Measurement Program.

CFC replacement working
Scientists at CSIRO Atmospheric Research have produced the first complete atmospheric record of a CFC-12 replacement chemical (HFC-134a). They have shown its appearance in the global background atmosphere in about 1991 and a subsequent 100-fold increase in concentration in 5 years. Records of changing concentrations of CFC replacement chemicals provide useful information on the efficacy of measures undertaken through the Montreal Protocol, aimed at protecting the ozone layer.

Information Technology, Infrastructure & Services

Ultrasound imaging
CSIRO researchers have used ultrasound images to create a plastic 3D model of a live baby in the womb. The world-first model baby was constructed using stereolithography technology which provides an opportunity to obtain the greatest amount of information from a routine ultrasound. The technology is also being used in a range of industrial applications and is helping to revolutionise the design phase of Australian manufacturing industry.

Software goes commercial
CSIRO's award winning software Fastflo was launched onto the commercial market in November by Compumod. Fastflo is specialist software for simulating aspects of industrial processes. It solves important equations underlying complex fluid flows, such as molten metal or air. CSIRO is negotiating with international distributors.

Hunt for hidden galaxies
A new instrument opened in March 1997 at CSIRO's Parkes radio telescope will cut the time taken to scan our skies from decades to years. The Parkes multibeam receiver system is analogous to a wide-angle lens for a camera. Normally the telescope can see only a small piece of sky at a time. The multibeam instrument lets it see 13 times more than previously possible, greatly reducing the time the telescope needs to find hidden galaxies, from the better part of a century to only seven or eight years. The hunt for the hidden galaxies is an international project led by CSIRO. Unlike most earlier surveys it is not biased towards big, bright galaxies.

Manufacturing

Better armour plating
CSIRO and Australian company Martial Armour have together developed stronger and lighter bullet-proof armour. By combining a new epoxy resin system developed by CSIRO with Martial Armour's strengthening technique, a new type of bullet-proof panel has been made that can be moulded into complex curved shapes. This means that armoured vehicles such as pay trucks will look more like ordinary vehicles and be less of a target for hold ups. There is strong international interest in these panels, which should be on the market by late 1997.

Advanced drug design and delivery
Scientists from CSIRO and Sydney's Prince of Wales hospital have made significant advances in the treatment of incurable prostate cancer, the second largest cause of cancer death in males in Australia. CSIRO has developed new drugs that enhance the uptake of DNA into cells seven to ten-fold over existing commercial reagents. Its scientists have also discovered an

adenovirus that can be used to 'taxi' therapeutic genes into tumour cells and a way of controlling suicide genes so that they only work in cancer cells, not healthy cells.

Long lasting contact lens
Scientists at the CRC for Eye Research and Technology have designed a soft contact lens that can be worn continuously for a month without irritating the eye. CSIRO as a member of this CRC has contributed its expertise in polymers, surfaces and coatings to help design this and other new lenses.

Diet discovery aids diabetes
CSIRO Human Nutrition research has demonstrated that the inclusion of special polyunsaturated fatty acids in the diet may help restore the function of damaged nerves for sufferers of diabetes. Impaired nerve function is a characteristic of diabetes and contributes to complications affecting the heart and circulatory system and the gastro-intestinal system.

X-ray breakthrough
Scientists at CSIRO Materials Science and Technology have achieved a world first with a new method for taking x-ray pictures that give sharper images of soft tissue and reduces the x-ray dosage received by patients. The work received international attention through the cover of the journal, *Nature*. The technology should give doctors the means for early detection of breast and lung cancers and will help them target treatments more precisely, using better, safer and cheaper radiography.

Minerals & Energy

Pilot magnesium smelter to use CSIRO technology
The revolutionary Australian Magnesium Process for extracting pure magnesium from ore, developed jointly by CSIRO and Queensland Metals Corporation, has been patented. Commercialisation of the process took a major step forward in January 1997 when four major companies, including Ford Motor Company, commenced a major investment in a pilot magnesium smelter at Gladstone, central Queensland. Construction of a $750 million commercial smelter is expected to begin in 1999. This development is expected to provide a world-class magnesium industry in Australia, where Ford has undertaken to buy up to 45,000 tonnes of the product per year for worldwide use.

Underwater mineral deposits found
CSIRO Exploration and Mining scientists aboard the *RV Franklin* have discovered new mineral deposits in the Bismarck Sea, off Papua New Guinea. They found two major highly active under-sea hot springs that are depositing gold, silver and other metals on the sea floor. Although these deposits are small compared with land-based deposits, they are providing explorers with new insights into how ore deposits form and how they can be located in similar geological environments on land.

CSIRO process reduces Ok Tedi discharge

Researchers front CSIRO Minerals have developed a new process to decrease copper levels downstream from BHP's Ok Tedi mine in Papua New Guinea.

The process will increase profitability, by increasing the amount of copper recovered. The process raises copper recovery by about four percent, and significantly reduces the amount of heavy metals and sludge released into the Fly River system at the minesite. It will also lower energy consumption and maintenance, contributing to increased profitability. Trials at Ok Tedi have been so successful that a processing line which underwent pilot conversion several months ago has been kept operating while full scale conversion of the other parallel line takes place.

Golden savings

Improved ore processing methods developed by CSIRO Minerals have unearthed savings of up to half a million dollars a year for the average-sized Australian gold mine. The research was jointly funded by WMC Resources Ltd and the Australian Minerals Industry Research Association, and focused on the Goldfields of Western Australia, source of 80 percent of Australia's $4.4 billion gold exports. Most of the potential savings come from neutralising the effects of the highly saline underground water used on the Goldfields in the gold leaching process. The CSIRO team also developed minor alterations to the refining process to capture large potential savings from what is discarded to tailings dumps.

The Cooperative Research Centres (CRCs) Program

The objectives of the Program are:

- to contribute to national objectives, including economic and social development, and the establishment of internationally competitive industry sectors through supporting long-term, high quality scientific and technological research;
- to stimulate a broader education and training experience, particularly in graduate programs, through initiatives such as the active involvement of researchers from outside the higher education system, and to enhance the employment prospects of students through initiatives such as involvement in major cooperative, user-oriented research programs;
- to capture the benefits of research, and to strengthen the links between research and its commercial and other applications, by the active involvement of the users of research in the work and management of the Centres; and
- to promote cooperation in research, and through it a more efficient use of resources in the national research effort by building centres of research concentration and strengthening research networks.

The Cooperative Research Centres Committee, which is appointed by the Minister, provides advice on the CRC Program. Government funding, totalling $146.2 million in 1997-1998, will be provided to support the Program.

In 1996, a selection round was conducted in which applications for new Centres competed with proposals from the fifteen Centres that were first established in 1991-92. The outcome of this selection round was that ten of the fifteen existing Centres were successful, together with five new proposals and the extension of one existing Centre. Centres to be funded are:

Existing Centres

CRC for Antarctica and the Southern Ocean
CRC for Sustainable Production Forestry
CRC for Mining Technology and Equipment
CRC for Tissue Growth and Repair
CRC for Advanced Composite Structures
GK Williams CRC for Extractive Metallurgy
CRC for Cellular Growth Factors
Australian Petroleum CRC
CRC for Waste Management and Pollution Control
CRC for Eye Research and Technology

Extensions

Australian Photonics CRC

New Centres

CRC for Aboriginal and Tropical Health
CRC for Sustainable Rice Production
CRC for Sustainable Tourism
CRC for Molecular Plant Breeding
CRC for Discovery of Genes for Common Human Diseases

CRCs are established under formal contracts with the Commonwealth, normally for seven years, to undertake long-term strategic research focusing primarily on the natural sciences, engineering and their application. By their very nature, CRCs do not achieve significant results in their early years. In a number of cases, the benefits of the research will not be apparent for many years. Nevertheless, many promising achievements are now in evidence.

Recent Achievements

Airborne electromagnetic systems
The CRC for Australian Mineral Exploration Technologies has developed and is transferring to industry a low-cost airborne electromagnetic system for geological mapping and mineral exploration optimised for Australian conditions. The system can be adapted for exploration in different environments with improved acquisition methods and reliability of interpretation, contributing to a reduction in exploration costs and increased discovery rate of mineral resources. The CRC has a commercialisation agreement with the Australian company, World Geoscience Corporation.

UV forecast
A UV forecast system has been developed by the CRC for Southern Hemisphere Meteorology in consultation with the Anti-Cancer Council of Victoria. UV radiation is dangerous to health, causing sunburn, skin cancer, eye cataracts and suppression of the immune system. The system (described under the Bureau of Meteorology) involves analysis that will alert the public and the media to the likely UV situation 24 hours ahead. Australia has the highest incidence of melanoma in the world and UV levels are anticipated to increase over the next 20 years so that in the absence of effective preventative measures the incidence of skin cancer will increase.

Novel nasal decongestant
The CRC for Biopharmaceutical Research has developed a decongestant which has undergone preliminary clinical trials. The decongestant allows air to pass through the nose to relieve any 'stuffy' feeling. Unlike many nasal decongestants on the market, it does not cause 'rebound' congestion as it wears off. An Australian company, Peptech Ltd, is one of the CRC's partners, and will progress development of the drug to market, initially as a Joint Venture with the CRC. The market for such a product is enormous, amounting to almost $3 billion per annum worldwide.

Manufacture of growth factors for industrial cell culture

The CRC for Tissue Growth and Repair has developed growth factors which are being commercialised by the Centre's commercialisation company, GroPep Pty Ltd. The growth factors support the growth of animal cells in bioreactors. These cells can then be used to furnish protein pharmaceuticals, avoiding the need for animal products. This is increasingly demanded by regulatory agencies to avoid any risk of contamination by viruses or prions (such as BSE - 'mad cow' disease). Currently GroPep sales of the Growth Factors have achieved $1 million, with projected sales of $5 million by 2002.

Co-curing technology for carbon fibre aircraft parts

The CRC for Advanced Composite Structures has developed the capability to design and manufacture aircraft components in a more cost-effective way, based on co-curing technology. This technology enables complex components to be produced in a single manufacturing step. One of the participants of the Centre, Hawker de Havilland, has won a $10 million contract from Boeing Aircraft Company to manufacture aileron-tabs based on this technology. This tab is the most advanced of its type in the world.

Enhanced optical fibre telecommunications

In collaboration with Siemens and Telstra, researchers from the Australian Photonics CRC have developed a totally new device which will significantly enhance the performance of future telecommunications links in Australia, with large global market potential. The new device, a dispersion compensator, has the capacity to increase dramatically the capacity of installed optical fibre networks, thus overcoming the need to install new networks. There has been 100 million kilometres of optical fibre networks installed to date worldwide. For just the 900 kilometre optical fibre link between Sydney and Melbourne, installation of the new device together with optical fibre amplifiers will result in potential savings in the order of $100 million.

Coal bed methane - friend and foe

Research conducted by the CRC for Mining Technology and Equipment has developed two novel drilling systems for the coal mining industry, using high pressure water jets as the cutting tool. These systems drill at ten times the rate of conventional drills and have a natural tendency to drill straight holes and to remain in-seam. The systems enable methane, which is both a source of clean energy and a hazard to explosions and outbursts, to be recovered from coal seams. The Centre is also developing geophysical sensors which are mounted behind the drilling head to provide real-time information on the position of the drill with respect to the top and bottom of the seam. The sensor will allow the drill to be steered to remain within an often undulating seam horizon.

Management of the Great Barrier Reef World Heritage area

Research by the CRC for the Ecologically Sustainable Development of the Great Barrier Reef has produced a shipping risk analysis for the Great Barrier Reef and Torres Strait, which provided the basis for a policy decision to move current concentrations of bulk shipping away from the inner route of the Great Barrier Reef. Other research of the Centre has enabled tourism

associations to improve marketing and provide better services to domestic and international Reef visitors. Supporting studies into the effects of tourists on the reef - for example, the effects from scuba diving, wildlife interaction and fish aggregation at pontoons demonstrates existing management practices are adequate to minimise visitor impact.

Development of new disease resistant plant cultivars

The CRC for Tropical Plant Pathology has conducted research on sunflower and Stylo (cattle fodder) which are severely affected by rust and anthracnose respectively. DNA markers for rust resistance genes in sunflower have provided new cultivars that will greatly assist industry in reducing losses in production. Resistant cultivars of Stylo, Australia's major tropical forage legume, have also been developed, allowing a potential 70 percent increase to beef production. The disease-resistant lucernes produced in CRC-associated work are estimated to allow up to $150 million production increase per year in Eastern Australia.

Vineyard management decision support software

A computer-based, vineyard management decision support system has been developed by the CRC for Viticulture. The AusVit software incorporates a suite of approaches to promote the production of high-quality, contaminant-free grapes for each sector of the Australian viticultural industry. The AusVit management package is at the commercialisation negotiation stage, with release planned for June 1997.

Industry Research and Development Board

Role *Through the operation of various programs, to facilitate wealth creation by the development of internationally competitive Australian industries; by the encouragement of successful innovation; and improving Australian firms' awareness of the role of innovation in business growth.*

The Industry Research and Development (IR&D) Board was established on 1 July 1986 under the *Industry Research and Development Act 1986.* Under this Act the Board has responsibility for administering several innovation programs including the Tax Concession for Research and Development, and the *R&D Start* (Strategic Assistance for Research and Development) program.

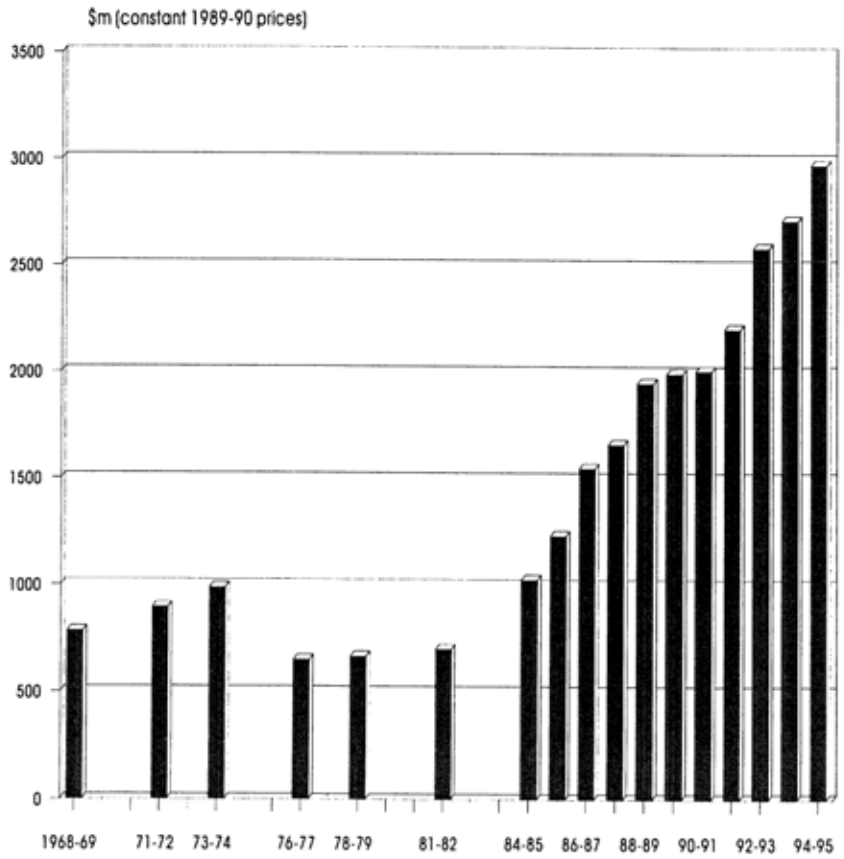
Innovation Programs

R&D Tax Concession

The tax concession for R&D aims to encourage increased investment in R&D by Australian companies in order to make them more innovative and increase the international competitiveness of Australian industry. The

Figure 10

BUSINESS EXPENDITURE ON R&D



Source: DIST based on ABS data

program is effectively market driven, being structured in a manner which is neither industry nor product specific, allowing companies to determine both the area of innovation and the direction of their R&D activities.

Changes to the tax concession were announced in a joint statement by the Treasurer, the Hon. Peter Costello, and the Minister for Industry, Science and Tourism, the Hon. John Moore on 23 July 1996. Other changes were announced in the 20 August 1996 Budget. The legislation implementing these changes took effect on 19 December 1996, although some of the changes have dates of effect earlier than this. The combined effect of these changes is to provide a more cost effective approach to meeting the Government's commitment to R&D, particularly by seeking to induce new R&D rather than subsidising expenditure in past years. The changes:

- amend the premium rate of deduction for the R&D tax concession to 125 percent;
- introduce deadlines for the lodgment of registration applications;
- require the registration of companies in relation to particular R&D activities;
- provide for advance registration of individual companies;
- clarify the definition of eligible R&D;
- restrict retrospective access to the R&D concession;
- end the Board's power to register R&D syndicates; and
- modify the deduction rules for expenditure in respect of interest, feed stock, core technology and pilot plant.

The tables below show, as at 24 March 1997, the number of companies registered and the expenditure on R&D by State and by the year expenditure was undertaken, from 1985-86 to 1995-96. It should be noted that the 1995-96 details show the number of companies that have applied for registration for the 1995-96 year and the expenditure on R&D in that year. Not all of these companies will be registered by the IR&D Board as some may not meet eligibility criteria. The details for the 1992-93 and previous years may change in the future, as the 19 December 1996 amendments allow limited opportunities for companies that are not registered for certain years to apply for registration in respect of expenditure incurred in those years.

Table 11: Number of registrations by year of expenditure and State as at 24 March 1997

	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	TOTAL
1985-86	14	772	1	199	142	31	545	133	1837
1986-87	12	634	3	171	88	22	379	102	1411
1987-88	13	856	5	230	121	26	563	139	1953
1988-89	15	861	5	255	130	33	579	142	2020
1989-90	16	934	6	295	140	34	599	170	2194
1990-91	18	993	6	305	152	31	666	176	2347
1991-92	26	1053	7	336	159	28	711	185	2505
1992-93	23	1016	9	340	141	36	692	181	2438
1993-94	33	1262	8	445	192	39	920	259	3158
1994-95	34	1195	4	472	200	41	946	278	3170
1995-96	34	1350	8	531	220	43	1041	480	3707
TOTAL	**238**	**10926**	**62**	**3579**	**1685**	**364**	**7641**	**2245**	**26740**

Table 12: R&D expenditure by year of expenditure and State as at 24 March 1996 ($ million)

	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	TOTAL
1985-86	0.0	60.7	0.0	16.1	0.0	0.1	21.3	0.1	98.4
1986-87	1.1	291.9	0.0	63.7	16.7	3.8	275.7	31.1	684.1
1987-88	2.8	457.1	0.3	111.4	32.8	7.3	388.2	44.9	1044.8
1988-89	3.8	516.6	0.8	118.0	38.1	11.1	496.5	63.2	1248.1
1989-90	3.8	553.1	1.6	166.5	47.1	12.6	658.3	92.0	1535.0
1990-91	4.5	667.8	1.6	239.4	50.7	11.9	971.6	126.0	2073.4
1991-92	7.8	716.3	1.8	198.3	59.5	16.3	1172.8	132.9	2305.9
1992-93	9.4	704.4	2.2	387.2	67.0	12.5	1062.2	138.1	2383.1
1993-94	11.4	881.5	2.0	436.5	116.6	26.6	1534.0	198.6	3207.3
1994-95	12.8	1020.4	0.8	315.7	116.7	28.7	1756.1	304.4	3555.7
1995-96	20.2	1241.5	6.5	614.5	132.8	33.2	1868.4	352.7	4269.9
TOTAL	**77.7**	**7111.5**	**17.6**	**2667.5**	**678.0**	**164.2**	**10205.1**	**1484.0**	**22405.8**

Monitoring

The Board's focus on monitoring of syndicates has been extended over the past year through the joint activities of AusIndustry and the Australian Taxation Office (ATO) establishing separate teams for syndicate monitoring, introducing standardised quarterly reporting of progress and for Final Reports, upgrading of the Management Information System computer data base and selected investigations of particular syndicates.

The development of formal risk management strategies (RMS) by AusIndustry and the ATO and their integration into a joint RMS - as proposed by the Auditor-General's Report 12 of 1993-94 - now provides the basis for monitoring the general R&D Tax Concession. Pre-registration assessment of

applicants for the concession allows for monitoring ahead of claims being made which complements the ATO and Board generated requests for company investigations and audits.

Joint investigations by both authorities administering the R&D Tax Concession as well as coordination of data bases and activities has increased effectiveness and efficiency of monitoring for compliance.

R&D Start program

As foreshadowed in the 1996 Budget, the *R&D Start* program was introduced in November 1996 to replace the R&D Syndication program, following extensive industry consultation. It has been designed to encourage and support industry R&D by providing a range of assistance programs to encourage business to invest in R&D and innovative activity, particularly by assisting small to medium enterprises (SMEs) which have limited capacity to fund R&D. *R&D Start* provides funding of half a billion dollars over four years, including $340 million in new funding.

R&D Start builds on existing grants and loans programs, and has been developed to achieve increases in:

- the number of research and development projects with high commercial potential undertaken by firms;
- the commercialisation of such projects; and
- private sector investment in research and development.

The program also assists those small firms which may find the cost of applying for the R&D Tax Concession high compared with its financial benefit.

R&D Start targets projects with a clearly defined product or service and which:

- demonstrate a clear commercial focus with high realistic potential rates of return;
- link leading industrial research with commercialisation and financial capability; and
- provide net national economic benefits.

Grants are available for research conducted in Australia by companies which are non-tax exempt, are incorporated in Australia, and can demonstrate an annual turnover of less than $50 million over the previous three years. Proposals are assessed against published selection criteria, with the most meritorious being offered support. Funding, for up to 3 years' duration, is provided for eligible expenditure of up to 50 percent of the cost of the project.

The *R&D Start* program is competitive and not an entitlement as was the case with R&D Syndicates and the R&D Tax Concession. Government sees the advantages of competition as ensuring strong support for the best projects,

encouraging private sector participation and eliminating low-value projects built around artificial tax minimisation schemes. As in the wider marketplace, firms compete against each other for support.

Detailed technological, managerial, commercial and financial assessments are conducted on each proposal. Applicant firms need to demonstrate they have the technological expertise to succeed with the project and that they have the management skills and industrial capacity to commercialise the product, service or system. Just as important is a strong (and realistic) market potential for the product along with an effective commercialising strategy. Scrutiny is also given to the financial arrangements and financial viability of applicants. Funding decisions are made by the IR&D Board (whose members are drawn principally from the private sector, their qualifications and experience covering a wide range of commercial and technical areas in various industries). The Board does not approve applications which it considers are driven by artificial company structures or dubious financial arrangements. Applicant firms are required to contribute significant funds to the project or arrange equivalent private sector financing.

The Board has the flexibility to vary the level of support to take account of variations in spillovers, closeness to market, nature of the technology and capacity to attract private finance. Grants for research and development do not normally rise above 50 percent.

The *Concessional Loans for Commercialisation of Technological Innovation* element of *R&D Start* supports technological innovation in small to medium sized firms with up to 100 employees. Concessional loans are provided for specified early stage activities in the commercialisation of technological innovation in goods, systems or services. The maximum loan is 50 percent of eligible project costs and all applications that meet the eligibility criteria are assessed on relative merit.

Applications for grants of less than $1 million and loans for commercialisation can be received at any time and are considered every six to eight weeks.

Applications for grants of $1 million or more are considered in three funding rounds each year. A total of 21 projects have been offered up to $67.6 million towards projects valued at around $140 million in the first round of funding, with the successful projects covering a broad range of technologies and applicants ranging in size from small firms to larger companies. Applications for round two closed early in March, and the IR&D Board is expected to announce the successful projects in June 1996. Applications for round three will close on 6 August, with funding decisions to be announced by the Board in December. Rounds four and five will close in January and April 1998 respectively, with subsequent announcements of successful applications expected to be made in May and August 1998.

Recent Achievements

Luxury boats for export
Minera Pty Ltd received a concessional loan of $246,000 in January 1996 to assist in the development of an advanced technology, super luxury, marine export vessel. One patented innovation is the ingraining of a woodgrain finish into the fibreglass, creating a finish usually associated with much more expensive boats. The loan assisted with building a prototype boat, outfitting it to display standard, extensive trialling and demonstration to potential clients. Since the proving of the prototype, two production units have been built and immediately sold at around $400,000 each. The company has appointed agents in nine overseas countries.

Communications in underground mines
Mine Site Technologies Pty Ltd received a concessional loan of $92,840 in January 1996 to assist with the development of improvements to a 'Personal Emergency Device' (PED). This device allows one way communication from the ground to miners in underground mines. The loan assisted with the miniaturisation of the electronics and the redevelopment of the plastic case. The result was a smaller and cheaper unit which could be worn on the belt of a miner. The new unit recently received approval in the USA for use in coal mines. This approval will spur the acceptance of the PED world wide. The company has reported good sales in Australia, (including BHP's Crinum mine in Queensland), Canada, USA and more recently China.

Recycling of tyres
Van Gelder Stubbeng Pty Ltd received a competitive grant in May 1994 of $249,600 to develop a pilot plant to separate tyres into constituent parts, namely rubber, steel and nylon. The company developed a cryogenic tunnel and a heavy duty hammer mill and trialled them as a system. Cryogenics had not previously been successful in this type of application. The company did succeed, and did produce probably the first tyre processing plant in the world. Van Gelder Stubbeng has sold two systems to date. One of the plants was sold to Tyre Recycling Pty Ltd which, through separate concessional loan support went on to prove a full scale plant which has begun producing rubber crumb to *a* commercial standard. Both companies have raised international interest, as the disposal of automotive tyres is one of the intractable environmental problems in the world.

Electrical power supply for railways
Energy Controls Pty Ltd received a competitive grant in May 1995 of $300,000 for prototype development, trial and demonstration of high powered inverters. In particular, their development of a single phase inverter with pulse width modulator for rail had a unique attraction for the rail industry in Australia in that it eliminates harmonics generated from getting back into the power supply. Although this project is still under development, several Australian and export contracts for the single phase inverter have already been signed, with a value of over $1 million. Energy Controls was a start up high-tech company which has grown to $2.5 million turnover in 3 years.

PRIMARY INDUSTRIES AND ENERGY

Australian Bureau of Agricultural and Resource Economics (ABARE)

Role *To efficiently and effectively provide high quality economic information of direct relevance to Australia's primary and energy industries in order to enhance their economic performance and that of Australia as a whole.*

Recent Achievements

River environment modelling
A modelling system for analysing resource trade-offs in a multiple use river environment is being developed. The system makes use of modular optimisation and river flow networks to integrate physical and biological relationships which determine resource use options. This framework has been applied to multiple resource issues in the Murray-Darling Basin. The model represents the demand for use of water for hydrological generation, the interaction of hydro-generation with thermal generation in a national electricity market and the demand for irrigation water downstream. Alternative policy options such as environmental flow restrictions and water trading arrangements are being considered.

Electricity market modelling
ABARE has developed a model of the south east Australian electricity market and the lower Murray-Darling Basin. The modelling approach incorporates individual optimising units interacting in a system wide context, and is capable of representing the 'externalities' inherent in many resource use tradeoffs. The power market component allows for a wide range of bidding strategies by major power suppliers to be modelled. The model was used to analyse the scope for, and potential impacts of non-competitive behaviour in the National Electricity Market. The study was published in *Australian Commodities* and raised substantial interest from governments, industry and the public in general.

Forest Resource Use Model (FORUM)
A modelling system for analysing the direct impacts on regional forest based industries of changes in wood flow has been developed. FORUM is used to simulate the complex interactions between regional forest resources, wood based forest industries and final product markets using data for a range of forest areas.

Bureau of Resource Sciences (BRS)

Role *To support the sustainable development of Australia's agricultural, mineral, petroleum, forestry and fisheries resources and their industries by providing high quality scientific and technical advice to government, industry and the community. BRS undertakes scientific analysis and reports on the status of the resources on which these industries depend, with special reference to trends in resource quantity, quality and distribution.*

Recent Achievements

Exceptional circumstances of drought
BRS provided scientific advice on exceptional circumstances of drought in regions of Australia during 1995-96 that helped determine whether Commonwealth assistance was given through the Rural Adjustment Scheme. In September 1996, a BRS workshop looked at how methods for determining exceptional circumstances might be improved. The methods included rainfall analyses, modelling the impact of rainfall on pasture and crop growth, remote sensing of rangeland quality, and economic criteria.

National Plantation Inventory
BRS completed the first National Plantation Inventory, which is a component of the National Forest Inventory. All major public and private growers contributed information on species, locations, area and five-year age classes for this plantation estate. For the first time, plantation data are provided in 15 economic regions determined by the industry. Projected wood flows from each region are also reported.

Contemporary issues covered in Geographic Information System
BRS has developed a unique menu-based Geographic Information System (GIS) that brings together information on a diverse range of natural resources and related socioeconomic and biophysical factors. It allows users to place their own values on particular aspects of land use to explore, and help find solutions to contemporary issues arising from different viewpoints and aspirations.

Christmas Island GIS

BRS completed an innovative Geographic Information System (GIS) covering the Indian Ocean Territory of Christmas Island and assessed phosphate resources and mining techniques for recovering remnant areas of high grade ore. The GIS incorporates a range of thematic layers dealing with mining, nature conservation, environmental management, infrastructure development and land use planning. It provides powerful data management and imaging capacity for mining and rehabilitation work on the island. Many of the feature of the GIS could apply to other regions where land-use decisions and management require complex data analysis.

Australia's mineral resources

BRS published *Australia's Identified Mineral Resources 1995*, a definitive, comprehensive assessment of Australia's mineral resources. The publication provides the basis for advice to the Commonwealth Government on industry and land access issues, and information for exploration, mining and financial sector companies, academic institutions and other governments.

Animal health

BRS developed and implemented the National Animal Health Information System in support of Australia's animal industries and their large international trade. The system provides a comprehensive overview of animal health status and will assist Australia's reporting of animal diseases on the international scene.

Australian Geological Survey Organisation (AGSO)

Role *AGSO is the national leader in geoscience mapping and information services. AGSO's primary mission is to build a vigorous, client-driven national geoscientific mapping effort to encourage economically and environmentally sustainable management of Australia's minerals, energy, soil and water resources.*

AGSO's research outputs underpin informed Government, industry and public decision making by satisfying client needs for high quality geoscience information and innovative research so as to enhance:

- the development of a more productive, competitive and diversified Australian mineral and petroleum exploration industry;
- the management of Australia's land, groundwater and ocean resources consistent with the principles of sustainable development;
- the development of effective strategies to mitigate the effects of natural geological hazards.

Recent Achievements

New information for mineral explorers

AGSO completed extensive airborne geophysical and land seismic data acquisition in the Broken Hill area. The data will enable mineral explorers to determine priority areas of exploration potential. Mineral explorers in New South Wales have also been provided with new data with which to focus their exploration effort following the publication of AGSO's new geophysical data set in the Lachlan Fold Belt along with a comprehensive Geographical Information System package for the Bathurst 1:250 000 Sheet area. In Northern Australia, the application of sequence stratigraphy techniques, widely used in the oil industry, to the mineral rich Precambrian stratigraphy of northern Queensland and the Northern Territory has led to a major revision of the geology of the region that challenges previous geological correlations. The revisions provide new insights into the controls of lead and zinc mineralisation in the region.

Major map releases

Three major maps illustrating aspects of the geophysics of Australia were released during 1996. The maps are a Magnetic Map of Australia, a Gravity Map of Australia and a Digital Elevation Model of Australia, and were developed in cooperation with AUSLIG. The data contained in the maps represent over 40 years of data acquisition and will play a key role in interpretations of geological structures and evolution of the Australian continent.

Groundwater resources in Aboriginal lands

A study of groundwater resources in Aboriginal lands in the southwest of the Northern Territory has been undertaken jointly with the Northern Territory, the Central Land Council, and ATSIC. Groundwater resources assessment is facilitated by integration of relevant data into a Geographic Information System to assist planning and management, and decision making by community groups. A bicultural model has been developed for a regional water program that will enable Aboriginal communities to determine priorities and strategies for water resources development.

Fisheries Research and Development Corporation (FRDC)

Role *The FRDC is a national organisation responsible to its stakeholders (the fishing industry, the Government and the people of Australia) for: planning, funding and the dissemination, adoption and commercialisation of the results of research and development.*

The national network of Fisheries Research Advisory Bodies and individual FRDC Subprograms identify priorities for R&D funding, and using a combination of public calls and communication with industry organisations, invites applications for R&D funding. This process ensures the relevance of fisheries R&D, minimises duplication and ensures maximum returns on investment.

In 1995-96 the FRDC spent $12.1 million on R&D and managed 240 R&D projects worth over $29 million.

Recent Achievements

Fish stock assessments
Leading national and international population dynamicists are now working in every State and Territory in Australia in an effort coordinated by the FRDC, to increase the level of stock assessment to the highest of international standards. This detailed knowledge of the status of various fish and crustacean stocks is a vital step in ensuring sustainable management. Projects dealing with Rock Lobster, Southern Bluefin Tuna, and Pilchards have provided a much clearer picture of population sizes and therefore sustainable harvests.

Live fish transport and holding systems
The demand for live fish has grown rapidly and so has the need for information on how to transport them long distances. This form of value adding seafood requires the product arriving at its destination in top condition and with minimum stress, while keeping the costs of transportation down. An analysis of current techniques in the USA has revealed that fish can be in transit for over 5 days and remain in good condition.

Grains Research and Development Corporation (GRDC)

Role *The GRDC plans and invests in innovative research and development for the greatest benefit to graingrowers and the Australian community. Its R&D programs are committed to developing a profitable, internationally competitive and ecologically sustainable Australian grains industry.*

The GRDC's research portfolio covers 25 leviable cropping industries spanning temperate and tropical cereals, oilseed and pulses, worth over $7 billion a year in farm production alone. The Corporation is a statutory research investment body which operates as a partnership between growers and government. Its operations, which are planned to involve a total budget of $80 million in 1997-98, are funded jointly by a levy on grain production and matching Commonwealth contributions.

Since its establishment in October 1990, the grains industry operating environment has been marked by dynamic global economic shifts, price volatility and climatic extremes. Nevertheless, the GRDC's research investments have underpinned the grains industry's ability to move forward strongly against the odds since 1990 as a growth sector in the Australian economy.

Recent Achievements

Innovation leap

Australia's graingrowers are embracing more scientific and profitable farming systems. Surveys commissioned annually by the GRDC have shown the industry's 'leaders and innovators' segment grew from 34 percent of all growers in 1994 to 41 percent in late 1996. In the past three years, use of scientific crop-checking packages by graingrowers has increased from 16 percent of the industry to 24 percent. Thousands of growers have become involved in hundreds of production-oriented grower discussion groups in the GRDC coordinated TOPCROP Australia network. These growers now compare their measures of Water Use Efficiency, nutrient measurements, predicted grain protein, sustainability factors, crop yield per unit rainfall and pasture dry-matter estimates.

Pasta twist

The Australian durum wheat industry's long-term growth has continued at around 5 percent annually. Overseas interest in Australian quality durum grain, semolina and pasta products has grown strongly, along with steady growth in the domestic market. In a coals to Newcastle twist, durum growers

are exporting to Italian pasta makers. To satisfy domestic and export demand, expansion of production to around 300,000 tonnes within 5-10 years has been forecast.

Safer bait for mice plagues
The GRDC led the national process which identified zinc phosphide as a safe, effective in-paddock management tool during mouse plagues. Working with state agencies, the Corporation is collecting the necessary efficacy and environmental data for National Registration Authority permits which will allow baiting campaigns to protect crops against mice during Australia's periodic and costly plagues.

Grape and Wine Research and Development Corporation (GWRDC)

Role *To improve the production efficiency, the competitiveness in domestic and international markets and the profitability of the Australian grape and wine industry, by managing and funding a research and development program to reduce production costs and improve product quality and purity.*

Recent Achievements

Delivery of training in Integrated Pest Management (IPM)
Recognising that much excellent research in disease and pest management has not been readily adopted by industry, a regionally delivered training program 'Viticulture IPM : Research to Practice' has been developed and is being delivered. The course is targeted at developing the knowledge, skills and confidence of product suppliers, consultants, managers and operators to adapt and apply R&D results to their particular circumstances.

Less water for better quality
A 5-year large scale field trial employing carefully managed scheduling of water supply, has demonstrated potential to improve grape quality and reduce water inputs. The procedure, Regulated Deficit Irrigation, applies less than full demand irrigation which reduces vine vigour but has less severe effects on fruit yield, if carefully timed. Berry size, colour and flavour concentration can be manipulated to improve wine quality yet use 40 percent less water than standard practice.

Reducing impact of grapevine powdery mildew disease
In a project supported by 3 State departments of agriculture, and with international collaboration from the USA and Europe, a refined management strategy for the ubiquitous powdery mildew disease has been achieved. Utilising the traditional sulphur spray as a base, but with more modern products as adjuncts, the research focused on the early season. Early

treatment suppresses rate and severity of the disease, requires fewer treatments and uses less agrochemicals. Less expensive treatments, higher yields and greater productivity can be achieved with this message conveyed via 19 regional workshops involving more than 1300 growers.

Sugar Research and Development Corporation (SRDC)

Role *To foster an internationally competitive and sustainable Australian sugar industry through directed funding to meet the strategic research and development needs of the industry.*

Recent Achievements

Improved harvesting efficiency
A major industry-wide three year campaign by the Bureau of Sugar Experiment Stations to reduce losses of sugarcane during mechanical harvesting was completed in 1996. A major achievement of the campaign was a greatly increased awareness of harvesting losses, which averaged 6 percent across the industry. Demonstration of commercial losses and factors contributing to them has resulted in significant improvement in harvester componentry and surveys indicate that annual losses have been reduced by more than one third. This represents an annual gross benefit of $38 million to the industry.

Economics of irrigation methods
An intensive program of irrigation research and extension over the past four years has delivered a significant benefit to canegrowers and the environment. In 1995-96, the Bundaberg Cane Productivity Committee was funded to obtain an economic evaluation of various irrigation methods. The project identified the most efficient and profitable irrigation method for representative soil types, topography, water supply source, quantity applied, application rates and power cost. Commercial results have demonstrated that water use efficiency has improved to 10.5 tonnes of cane per ML of water in 1996 from 8.5 tonnes per ML in 1993.

Dried Fruits Research and Development Corporation (DFRDC)

Role *To enhance the dried fruits industry's competitiveness and profitability in a manner harmonious with the social and ecological climate of the community by effectively investing in research the funds provided by dried fruits producers and the Commonwealth.*

The Council aims to achieve this by developing and funding research strategies, managing research programs and facilitating industry adoption of research outcomes.

Recent Achievements

New varieties
The breeding programs in the dried vine fruit and dried tree fruit sectors are commercialising new varieties. The Sunmuscat grape variety is a seedless muscat grape that has achieved strong acceptance by dried vine fruit producers. The CSIRO Division of Horticulture evaluation of the variety showed it to be the best performing of the seedless muscats selected. In trials, high yields and disease resistance were favourable characteristics of Sunmuscat. Approximately 7 percent of growers have registered an interest in the variety and all available planting material has been allocated in the past two years. The aim is to develop a 5,000 to 10,000 tonne market for the variety at high returns for producers.

Chemical residue testing program
The dried vine fruit industry has implemented a thorough chemical residue testing program based on new antibody assay tests developed by the CSIRO Division of Plant Industry. The testing program has enabled the industry to put in place a more comprehensive testing program whilst significantly reducing the overall cost. The reduced delay in clearing fruit is also a valuable benefit of this research.

New dried grape harvester
A new dried vine fruit harvester developed specifically to pick dried grapes from swingarm trellises, considered to be the basis of future mechanised production systems, has been successfully Mailed in season 1997. The harvester's commercial release will be managed during the next year.

Horticultural Research and Development Corporation (HRDC)

Role *To fund and co-ordinate research and development projects for Australian horticultural industries, including fresh and processed fruits, vegetables, turf, nuts, nursery products and cut flowers and foliage.*

Recent Achievements

Disease resistant Australian banana cultivars
Bananas are a major industry in Australia. Many diseases are capable of destroying this crop. This project has used advanced genetic engineering techniques to develop an efficient transformation system for bananas. This is a key step in producing plants with in-built resistance to diseases such as bunchytop virus. A $3.5 million research and eradication project is underway to stamp out this disease in Australia. Transformation techniques may make it almost impossible for such diseases to recur in the future.

Removing bugs from export oranges
An important new export market for Australian oranges to the USA has developed in recent years. In order to avoid the need for chemical fumigation, the fruit must be free of certain pests. Some of these are difficult to detect when fruit is packaged but quite obvious by the time it arrives overseas. This work has been successful in developing an oil formulation effective against lightbrown apple moth and mealybug when used in bulk dipping tanks. This leaves no harmful residues and maintains the high quality status of Australian navels in the USA. The formulation is due to be registered for this winter's shipments.

Development of a pesticide rating index
An accreditation scheme, known as 'PESTDECIDE,' has been developed to compare the effects and benefits of various pesticides. The system rates the chemicals in terms of activity, application site, application time, persistence, efficacy, cost, environmental effects, mammalian toxicity, availability of alternatives and compatibility with Integrated Pest Management(IPM). It also integrates these features using a weighting system. This will enable growers to make informed decisions when selecting pesticides. The rating system could also be used as a means of accreditation for fruit produced under an IPM system. The index will initially be tested for apples and pears.

Turf
The HRDC has supported the development of a mesh element reinforced turf profile for use in the racing industry. The research assessed implementation of the technology at five test locations around the Mooney Valley race track, over a two year test period, to evaluate the performance, strength and durability of the surface under various weather conditions. This technology

has resulted in an Australian company being successful in winning a contract to supply technology, product and machinery for the construction of a free draining, reinforced sand root zone profile for the two grassed tracks at the new Kranji facility in Singapore.

Land and Water Resources Research and Development Corporation (LWRRDC)

Role *To provide national leadership in utilising R&D to improve the long-term productive capacity, sustainable use, management and conservation of Australia's land, water and vegetation resources.*

LWRRDC will establish directed, integrated and focused research and development programs where there is clear justification for additional public funding to expand or enhance the contribution of R&D to sustainable management of natural resources.

Recent Achievements

LWRRDC research - worth nine times the cost
The Australian community is receiving a 900 percent return on its public investment in selected LWRRDC-supported R&D projects, according to two recent independent studies by ACIL Economics and Policy and the University of Queensland. The studies indicated the costs and likely benefits of randomly selected LWRRDC research projects. LWRRDC will continue to study the progress of the same 15 projects selected (which cover various natural resources issues such as the effects of salinity of river ecosystems; practical management systems for wetlands and floodplains; sharing water between the needs of the environment and the demands of human activity; managing groundwater discharge in dryland agriculture areas; on-site monitoring of agrochemical residues as a valuable tool for irrigation managment; and compaction control and repair practices for sub-tropical cropping lands) to determine whether the benefits are being delivered as predicted.

Fix it or buy new?
With major items of farm machinery costing hundreds of thousands of dollars, Australian farmers now have the benefit of new commercial software to take the guesswork out of deciding how and when to replace expensive machinery. Funded by the National Climate Variability R&D Program, supported by LWRRDC, other R&D corporations and the Kondinin Group, the software was developed by NSW Agriculture and the University of Sydney. Farmers can enter their own details into the software package which then examines all the costs of replacing farm machinery, including

interest payments, depreciation rates and taxation implications, as well as breakdown and operating costs. A commercial partner is currently being selected to distribute and support the software.

Energy Research and Development Corporation (ERDC)

Role *To stimulate and facilitate investment in effective energy innovation for Australia.*

ERDC's objectives for its investments are to increase the

- efficiency of energy use and supply;
- development of competitive Australian industries; and
- diversity of energy supply options

while reducing

- the environmental impacts of energy use and supply;
- the need for energy through proper design; and
- customers' energy costs.

ERDC was established in 1990 to facilitate and stimulate effective energy innovation for the benefit of Australia. At the end of 1995-96, ERDC was managing investments in 153 projects. ERDC's commitment to these projects was nearly $60 million, while the total cost of the projects was approximately $324 million.

Recent Achievements

Vacuum glazing windows
Researchers at Sydney University, with support from ERDC, have developed a revolutionary insulating window. The new technology has already been licensed for manufacture in Japan. The new glazing technique uses two sheets of glass, separated by a vacuum. It is more efficient and less cumbersome than traditional double glazing because the panes are closer together, meaning window frames do not have to be modified.

Solar hay-drying
Solartec Australia Pty Ltd has installed an innovative hay-drying plant in the Lockyer Valley, Queensland, which uses solar energy. The hay-drying plant recently exported its first large commercial shipment of solar-dried hay to Japan. The early success augurs well for the future of Australian hay in an Asian market worth close to $1 billion a year.

Forest and Wood Products Research and Development Corporation (FWPRDC)

Role *To promote effective research and development which advances an internationally competitive, sustainable and environmentally responsible forest and wood products industry in Australia.*

Recent Achievements

Quality certification for hardwood timber
This project is being carried out by the Timber Promotion Council of Victoria, with assistance from the Commonwealth agribusiness program. It is designed to increase the value of hardwood in the market. The first companies to have their timber accredited under the scheme have reported major improvements in quality, and high demand for the certified product. The major advantage is that the customer can rely on the consistent quality of the end product.

Meat Research Corporation (MRC)

Role *To deliver and manage customer focused, research based initiatives and translate them into benefits for individuals and industry.*

The MRC was established in 1985 as part of a restructuring of the meat industry. The Corporation funds and manages research, development and adoption of innovation in the cattle, sheep and goat sectors of the industry. It is funded jointly by levies on livestock producers and meat processors. These funds are matched by the Federal Government. Expenditure in 1997-98 will be approximately $48 million.

In March 1997, the Federal Minister for Primary Industries & Energy announced that a producer-owned and funded company will replace the Meat Research Corporation and the Australian Meat and Livestock Corporation. Responsibility for jointly funded R&D will be undertaken within an operating unit together with marketing, food safety and grading. These units will operate under a single board.

Recent Achievements

The perfect steak
The Sizzler restaurant chain has launched a new national program which will deliver perfectly cooked steaks to customers' specification. Meat Research Corporation research showed 2 years ago that 30 percent of customers were not getting the degree of doneness they expected. This is because there is no agreed definition of the various levels of cooking. With MRC assistance, Sizzler has developed a six degrees of doneness guide for customers. The guide will be used by all Sizzlers restaurants in Australia by the end of the year.

Cattle handling equipment
Two cattle handling devices which significantly reduce mustering costs are now commercially available to cattle producers in Northern Australia. The first, a cow/calf separator, is available as a set of blueprints for on-property construction, or it can be assembled by engineering firms. The second, a one-way spear trap, achieved drafting accuracies of between 95 and 100 percent. Both devices reduce mustering costs in comparison with helicopters and significantly reduce stress in the animals.

Pig Research and Development Corporation (PRDC)

Role *A profitable, world competitive, and environmentally sustainable Australian pig industry which maximises returns on research and development funds invested through programs consistent with stakeholders' and market priorities.*

In pursuit of these goals, the Corporation has identified the following major goals:

- Sustain the skilled scientific and industry staffing required to maintain the viability and improve the profitability of the Australian pig industry;
- Provide solutions to production, feed supply processing, manufacturing, environmental animal welfare research and development issues which constrain profitability and sustainability of the Australian pig industry;
- Provide research and development requirements for the marketing of Australian pig products and technology;
- Enable the industry to capture the benefit of new technology through a program in technology adoption and skills enhancement; and
- Manage the Corporation in an efficient and effective manner.

Recent Achievements

PrimeGRO - a breakthrough in genetic selection
PrimeGRO is a commercial blood test which has been made available to Australian pig breeders (and will be released internationally once patent applications have been approved) which provides an easier way to detect superior boars and gilts. This livestock selection method was developed after research determined that superior production traits of feed efficiency, carcass quality (ratio of lean meat to fat), growth rate and reproductive capacity are linked to the concentration of a protein found in pig's blood. The discovery has the potential to increase the overall productivity of the Australian pig industry and be of major significance for the selection of breeding pigs around the world. Other livestock industries will also benefit from this breakthrough in selection of efficient animals.

Pigrade - grading for quality
Pigrade is a meat grading system based on calculated lean meat yield (CaLMY). The grading system results in superior knowledge about the meat content of any given carcass. Individual wholesalers and processors will use the grading system according to their needs. For example, a processor who wants to improve the quality of pigs being offered will be able to use CaLMY and pay producers on the basis of the grade of carcass and meeting market requirements. Alternatively, CaLMY grading by itself will allow carcasses to be sorted into usage categories as they leave the scales and enter the fresh pork or processing channels. This information can then be used to target markets according to quality and price.

All quiet in the pigsty
The Professional Handling of Pigs Training Course, or ProHand, is a multi-media training program for stockpersons in the pig industry that encourages the use of correct stock handling techniques. These techniques create a herd of animals that does not fear humans. The training course includes using CD-ROM, videos, printed material and face-to-face teaching time. The course uses multi-media to reinforce changes in attitude of stockpeople, leading to modified behaviour. Research has shown improvements of 7 percent in reproductive performance in those herds where pigs display a low level of fear. Besides enhancement of animal performance, job satisfaction and retention rate of stockpeople is improved.

Australia declared free of disease
Porcine reproductive and respiratory syndrome (PRRS), a cause of reproductive failure in sows and respiratory disease in young pigs, appeared as a new disease in the mid to late 1980's. It is a debilitating disease that is common in many parts of the world. A study undertaken by the Bureau of Resource Sciences, and funded by PRDC, during the past twelve months has found the Australian pig industry to be free of the PRRS virus. The testing regime used to demonstrate Australia's freedom of PRRS was agreed by trading partners. Demonstration of Australia's superior health status is an important step in establishing export markets.

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Cotton Research and Development Corporation (CRDC)

Role *CRDC's mission is to increase the contribution that R&D makes to the well-being of the cotton industry and the community in general. Its major goals are to: develop efficient, sustainable production systems, to improve fibre quality to better meet market needs, and to develop efficient handling, transport and marketing systems and infrastructures.*

In pursuit of these goals, the Corporation has identified the following major objectives:

- reduce chemical protection of crops against pests, diseases and weeds;
- develop, and have adopted, environmentally sound, sustainable farming practices;
- develop new, improved cultivars;
- reduce post-harvest costs and better meet market requirements;
- maintain the effectiveness of the R&D effort;
- improve the transfer of technology; and
- improve and support human involvement in the R&D effort.

Recent Achievements

Transgenic cotton - reduced pesticide use
Some 30,000 hectares of INGARD^{R} cotton, containing genes to express the naturally insecticidal *Bacillus thuringiensis*, have been grown in trials this year. Controlled by the National Registration Authority, this season's experience indicates a two-thirds reduction in the use of traditional Lepidopteran pesticides on INGARD^{R} cotton.

Rural Industries Research and Development Corporation (RIRDC)

Role *To make and manage research and development investments on behalf of government and industry for the benefit of the people of Australia.*

RIRDC has three core businesses:

- fostering the development of new industries, both prospective and emerging (such as new animals and plants, agroforestry, Asian foods, deer, rare natural animal fibres);
- managing research and development investments for established industries (chicken meat, eggs, honeybee, horses, rice, fodder crops and pasture seeds); and
- addressing strategic cross sectoral issues facing the rural sector (global competitiveness, resilient agricultural systems and human capital).

The Corporation also provides services for the semi-independent Dried Fruits Research and Development Council.

Recent Achievements

New chicken vaccine
A vaccine for chickens against *Mycoplasma synoviae* was commercialised. Previously, the impact *of Mycoplasma synoviae* infection in Australian poultry flocks varied considerably with the infecting strain of the organism, some strains causing minimal impact, others causing clinical disease in up to 70 percent of birds in affected breeder flocks. Sales of the vaccine suggest that the vast majority of Australian broiler breeder flocks and a proportion of layer breeder flocks are being vaccinated with the new vaccine.

Water use efficiency for rice
Electromagnetic mapping technologies have been developed for application in rice paddy fields. The technologies are being used to identify very specific problem areas of water permeability and provide a simple and inexpensive basis for improving water use efficiency.

Fodder
Fodder crops are an industry central to many aspects of Australian agriculture and are valued in excess of $1 billion. Laboratories around Australia have developed a common standard for assessing metabolisable energy content of primary fodder species. Previously, hay was sent to the US for testing.

Dairy Research and Development Corporation (DRDC)

Role *The Dairy Research and Development Corporation's mission is "to maximise the economic, environmental and social benefits for our stakeholders through targeted, innovative and energetic R&D."*

To realise this mission, the DRDC objectives are to:

- 1. increase industry competitiveness and profitability;
- 2. improve social and environmental sustainability of dairying;
- 3. improve the human resource capability of the dairy industry.

Recent Achievements

Genetic improvement
Funded by the DRDC and the Meat Research Corporation, researchers at Monash University have created almost 500 genetically identical embryos which could lead to healthy pregnancies. Until recently, no research group in the world had reported producing more than 100 embryos from a single cell. Six calves, including one set of twins have been born using this technology. This technique should make it possible for farmers to fertilise an elite cow's eggs with a prize bull's sperm, then produce hundreds of genetically identical offspring. Australian and Danish scientists are now trying to clone cows with DNA extracted from the cells of cattle.

Value-added dairy ingredients
A major dairy processor and researchers at the Australian Ingredient Centre have developed a new range of value-added dairy products, based on milk powders, for chocolate manufacturers. One ingredient in particular is crucial for making chocolate because of its ability to enhance the flavour and texture of the final product. In the past, smaller manufacturers were being forced to import around 600 tonnes a year of this ingredient, at more than $3,500 a tonne. The replacement of the imported ingredient with a locally made ingredient could save the industry more than $2 million in imports as well as expand the market for.value-added Australian dairy products.

Tobacco Research and Development Corporation (TRDC)

Role *The TRDC is a national organisation responsible to its stakeholders (industry and Government) for planning, funding and managing research and development programs applicable to tobacco leaf farming. It has a strong focus on facilitating the adoption of research and development by tobacco farmers, and in fostering ecologically sustainable farm practices.*

The TRDC is guided in its R&D planning by both industry and Government stakeholder input on industry and community R&D objectives and priorities.

Recent Achievements

New tobacco variety
TRDC supports a tobacco plant breeding variety development program based at Southedge Research Station in Mareeba, Queensland. This program has generated a family of progressively improved plant varieties, assisting the Australian growers to achieve productivity improvements and meet international competition for manufacturer leaf requirements. A new variety, Walsh, generated through this program has been approved for limited release in the 1997 growing season. Walsh has improved leaf quality attributes, and allows a reduction in nitrogen fertiliser applications, with resultant lower production costs.

TRANSPORT AND REGIONAL DEVELOPMENT

Federal Office of Road Safety(FORS)

Role *To enhance the safety of Australian roads by providing leadership and coordination in the areas of road safety research and public education, and by developing and implementing vehicle safety design and construction standards.*

The Federal Office of Road Safety (FORS), in its role as the Government's adviser on national road safety policy, relies heavily on strategically applied research. This is to ensure that resources are directed towards achieving the most appropriate, cost-effective measures to minimise the national road toll.

Recent Achievements

Simulator validation

FORS and the New South Wales Roads and Traffic Authority have jointly funded a program on the effectiveness of low cost perceptual road treatments. These are road markings designed to slow down vehicles by influencing the speed perception of drivers. A central component of the program involves the use of a mid-range driving simulator to develop and evaluate appropriate treatments. Driving simulators provide a safe and controlled environment for testing driving performance. Yet the on-road relevance of their test results has rarely been subjected to formal validation. A rigorous validation study undertaken as part of the current research program confirmed the suitability of the driving simulator as a test environment for the evaluation of perceptual road treatments.

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Benefits of airbags

FORS carried out a research program to examine the effectiveness of airbags in reducing head injury. A series of popular small and large passenger cars were crashed tested with and without airbags. Previous research on head injury tolerance was used to relate head acceleration to the probability of head injury. This program showed that the addition of an airbag reduced the likelihood of head injury in a severe frontal crash between 2 and 4 times.

Side impact standard
Research into the benefits of introducing a dynamic side impact standard to replace the static door strength Design Rule introduced in 1977, saw the gazettal of Australian Design Rule (ADR) 72/00 in December 1996. This will require passenger cars to comply with either the proposed European or American regulation from 1999. These two test procedures are quite different although FORS research showed that they would provide similar injury reduction benefits. Further work is being carried out to assist in the development of a harmonised regulation which draws the best features of the two standards together.
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Australian Road Research Board (ARRB) Transport Research Ltd

Role *ARRB TR undertakes contract research and consulting, develops and markets instrumentation, and provides information and training services to a wide range of public and private sector clients, both within Australia and internationally.*

ARRD TR undertakes the majority of the contracts under the National Strategic Research Program (NSRP) in road transport, which is administered by AUSTROADS and is currently funded to a level of approximately $3.8 million per annum by the Australian Federal, State and Territory road authorities, the largest share (approximately $1.2 million) coming from the Department of Transport and Regional Development.

Recent Achievements

Major economic benefits from improved road management
A detailed study of national average life-cycle costs, derived from extensive data on Australian roads, has demonstrated that annual savings of around $800 million on road maintenance and rehabilitation are possible nationally. The study identified the upper and lower bounds on these expenditures and demonstrated that measures to ensure optimum combinations of the design, construction and continuing management of roads provide the potential to save 35 to 45 percent of the more than $2 billion national annual expenditure on road maintenance and rehabilitation.

Standards for asphalt mix
More than six years of research by ARRB TR in close cooperation with AUSTROADS and industry has culminated in the draft *Australian Guide to Asphalt Mix Design.* Incorporating several features recognised as world's

best practice, and drawing on the use of high quality, low cost Australian equipment, the draft Guide has completed the review process and final copy will be passed to AUSTROADS for publication before the end of the 1996-97 financial year.

Bureau of Transport and Communications Economics (BTCE)

Role *To assist policy development and informed public debate on transport and communications issues through relevant, high quality and timely research.*

Recent Achievements

Greenhouse gases
The BTCE has undertaken research into greenhouse gases with funding allocated from the National Greenhouse Research Program. This research has developed long-term forecasts of greenhouse gas emissions from the Australian transport sector. A final report was published in November 1996 giving costs for implementing 16 separate measure to the year 2015..

Australian Maritime Safety Authority (AMSA)

Role *To enhance the safety of seafarers and shipping and to protect the marine environment from pollution.*

AMSA was established under the *Australian Maritime Safety Authority Act 1990*. Its primary functions are to:

- enhance maritime safety;
- provide a national system of navigational aids and services;
- coordinate maritime (and aviation) search and rescue services;
- administer programs to prevent and respond to marine pollution; and
- provide services to the maritime industry on a commercial basis.

Recent Achievements

Selective message transmission

To avoid the need for dual reporting to the Australian Ship Reporting System (AUSREP) and the Queensland ship reporting system (REEFREP), an interface has been developed to allow the reports to be sent seamlessly between the two systems. Using a combination of operator procedures and computer software the systems recognise when messages should be passed to the other authority and this is achieved via the AMSA wide area network.

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This Statement was prepared by the Science and Technology Analysis Section, Department of Industry, Science and Tourism, based on contributions from many Commonwealth agencies.

The Section also produces a number of other publications designed to promote informed public discussion on science, technology and innovation issues. If you require more information on these publications, please contact the Section by telephone (06) 213 6417 or email mavila@dist.gov.au.

Australia is one of the most inventive countries in the modern world. This is illustrated by the prolific list of publicly funded scientific and technological achievements presented in this *Statement*. These achievements reflect the vision, talent and diversity of the Australian research community and profoundly affect the quality of all Australians' lives.

Australian research has shown that the parasite responsible for malaria belongs to the plant kingdom æ it is not an animal, as previously thought. Other scientists have developed a UV index forecasting system to help protect sensitive skins against the sun

In other health-related research, scientists have identified "gatekeeper" proteins that may lead to new therapies for arthritis, developed a new drug that clears stuffy noses, and discovered a biological "taxi" for transporting therapeutic genes into cancer cells.

In the resource industries, Australian durum wheat products are now being exported to Italian pasta makers. Scientists at CSIRO have created the world's first gene-modified grapevine. This advance is expected to improve productivity and quality in the Australian wine, grape and dried fruit industries.

In engineering, advances in refrigeration have led to a prototype that makes two kilograms of ice per day using solar radiation alone. A new window glazing technique enables vacuum double glazing without the need to modify existing window frames.

It is important to raise Australians' awareness of the important contribution by science and technology to economic and social wellbeing. Descriptions of Australia's research accomplishments, and the Government funding arrangements which underpin them, will continue to attract the interest of journalists, policy-makers, peak organisations, business interests and many others in the community.

Cover photograph:

Scanning electron microscope photograph of a pie-like diatom — about 18 nanometres across — found in the lining of a yabby (shrimp) burrow. The diatom is filled with iron sulphide crystals like the filling in a pie. These crystals contain concentrations of trace metals such as copper.

Photograph courtesy of Southern Cross University, Lismore, New South Wales.

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