

CHAPTER 25

SCIENCE AND TECHNOLOGY

Overview

Much of the early history of Australian science was based largely on the individual achievements of a few outstanding scientists.

During and after World War I, governments in various parts of the world took initiatives aimed at encouraging scientific research and applying it to economic growth and national development; Australia was no exception. In 1926 the Council for Scientific and Industrial Research (CSIR) was established by the Commonwealth Government. Initially, it concentrated its efforts on the primary industries, typifying the trend of research in Australia at that time, when most major research initiatives were taken by Government and aimed at the primary industries. The level of research in the universities and industries remained much as before.

With the approach of World War II, however, moves were made to extend scientific support for secondary industry. In the CSIR, Divisions created in the period 1937-40 were to play an important part in the rapid development of Australian industry that occurred under the stimulus of war-time needs.

Expansion of scientific research in general, and industrial research in particular, continued after the war. This expansion extended beyond government into the universities and industry.

Though even today agricultural research absorbs a significant proportion of Australia's research effort, industrial, medical and defence research are now of major importance also. The volume of research in the social sciences and humanities remains small, although in Australia, as elsewhere in recent years, there has been increasing support for the view that adequate weight must be given in governmental policy-making to the social aspects of national proposals.

In 1978-79, the most recent year for which data are available, total expenditure on research and experimental development (R & D) was estimated at \$1,054 million, approximately 1 per cent of Gross Domestic Product. This was about the same percentage as for 1976-77.

Governments provided approximately 76 per cent of the funds devoted to R & D and undertook in their own agencies about 45 per cent (in terms of expenditure) of the overall national R & D effort in 1978-79.

Whilst these data serve to illustrate the dominant position occupied by governments in Australian scientific and technological R & D activities, they do not provide a complete picture since comprehensive information is not available on resources devoted to other scientific and technological activities in Australia.

Advice and co-ordination

Australia does not have a single central body with overall policy and funding responsibilities for science and technology. In order to achieve at the national level integration of advice, relative assessment of priorities and the development of criteria and broad strategies for future directions, several national advisory bodies, in addition to government departments such as the Department of Science and Technology and the Department of National Development and Energy have been established:

- The Australian Science and Technology Council (ASTECC), which is responsible to the Prime Minister and advises on science and technology matters including research, development and the application of new and existing knowledge.
- The National Energy Advisory Committee (NEAC), which advises the Minister for National Development and Energy on matters relating to national energy policy.
- The National Energy Research, Development and Demonstration Council (NERDDC) which advises the Minister for National Development and Energy on the co-ordination of the national energy research, development and demonstration effort. The Council also advises the Minister on the disbursement of funds for energy research.
- The Australian Manufacturing Council (AMC), which advises the Minister for Industry and Commerce on matters of industry policy.

Australian Science and Technology Council (ASTEC)

ASTEC was established as a statutory authority in February 1979 under the *Australian Science and Technology Council Act 1978*. The Council reports to the Prime Minister and is the Government's principal source of independent advice on science and technology matters. As part of this role, it maintains a broad overview of the science and technology activities of Commonwealth Government departments and agencies, universities and private enterprise.

The functions of the Council are to investigate, and to furnish information and advice to the Commonwealth Government in respect of matters relating to science and technology including the following:

- the advancement of scientific knowledge;
- the development and application of science and technology in relation to the furtherance of the national well-being;
- the adequacy, effectiveness and overall 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 scientific and technological innovation in industry; and
- the means of improving efficiency in the use of resources by the application of science and technology.

To discharge these functions, the Council is provided with appropriate powers under its Act. The Council is able to form committees, engage consultants, conduct inquiries and collect information on any matter within its functions arising either from its own initiative or at the direction of the Prime Minister. The Council's reports to the Government are made public.

In addition to its overview report *Science and Technology in Australia 1977-78*, ASTEC has provided reports to Government on industrial research and development, the interaction between industry, higher education and government laboratories, basic research, marine sciences and technologies, micro-electronics, medical research, the Office of the Supervising Scientist, earth resources satellites, new telescopes for Australian astronomy, and science and technology in international co-operation and development assistance. The Council also provides comment at the request of the Government on reports prepared by specialist groups and advises the government on new proposals related to science and technology.

Following a recommendation of the Committee of Inquiry into Technological Change in Australia, the Technological Change Committee (TCC) was established in May 1981 as a standing committee of ASTEC. Its functions are to review the processes and trends in technological change in Australia and elsewhere and to evaluate and report on the direct and indirect effects of technological change at the national level. A report on robotics has been sent to the Government and reports are in preparation on information technology and on technological change and employment.

ASTEC also maintains a continuous program of development of its 'strategic' role of matching Australia's science and technology effort to its resources, problems and goals. This involves studies of policy developments in Australia and overseas, reviews of the relevance of existing Australian science and technology programs, and assessments of methods used overseas in areas such as identifying priority areas for research and development.

National Energy Advisory Committee (NEAC)

For information on NEAC see Chapter 18, Energy.

National Energy Research, Development and Demonstration Council (NERDDC)

For information on NERDDC see Chapter 18, Energy.

Department of Science and Technology

The Department of Science and Technology has general responsibility for science and technology while other Commonwealth Departments including National Development and Energy, Defence Support, Transport and Construction, Health, Primary Industry and Education have lead roles in providing policy advice and funding or in carrying out research in support of their specific objectives.

In addition to the provision of policy advice on science and technology, the Department of Science and Technology provides information about science for the use of decision makers and to the public. Its role enables it to provide a scientific and technological perspective at the interdepartmental level. The Department's responsibilities includes the fostering of closer working relationships and consultation among government agencies, tertiary institutions, scientific associations, the private sector and the community.

The Department's administrative functions in relation to certain scientific services and research activities (such as the Bureau of Meteorology, the Australian Government Analytical Laboratories, the Antarctic Division, the Australian Research Grants Scheme and Australia's science agreements with other countries), help to ensure that its policy advice is tempered with an awareness of practical problems in science and technology.

Committee of Inquiry into Technological Change in Australia (CITCA)

For information on CITCA see Year Book No. 65 pp. 661, 666 and 667.

Other Organisations

Advice to government on scientific and technological issues comes also from various learned and professional bodies. Such counsel may be offered on the initiative of the organisation itself or in response to an official request. For example, the Australian Academy of Science maintains a number of national and standing committees which specialise in selected broad fields of science; ad hoc advisory committees are appointed by the Academy from time to time to examine and report on specific matters. In addition, the Academy has maintained since 1967 a Science and Industry Forum which brings together leading scientists and industrialists to discuss topics of national significance, and a complementary Science and Society Forum was inaugurated in 1973. Communication between government and the technology area of the science-technology spectrum is facilitated by the Australian Academy of Technological Sciences.

The most broadly based of the learned and professional bodies is the Australian and New Zealand Association for the Advancement of Science (ANZAAS). The Association has established a Science Policy Commission for giving increased attention to policy issues.

In recent years, matters of scientific and technological policy have received much discussion among such learned and professional organisations as well as in academic circles. Increasingly, other professional bodies with more specific charters are giving attention to matters of science and technology policy. Such bodies include the Royal Australian Chemical Institute (RACI), the Institution of Engineers, Australia, the Australian Institute of Physics, and the Federation of Australian University Staff Associations (FAUSA) which concentrates on issues specifically affecting the university sector.

There are a number of groups within the industry sector—e.g. the Australian Industrial Research Group (AIRG) and some specialist panels (Industry Advisory Councils) of the Australian Manufacturing Council (AMC)—which, from time to time, provide advice to government on industrial research and development.

Intergovernmental co-ordination is affected through bodies established for the purpose. While certain of these are concerned with promoting research and scientific and technical services, these are secondary objectives pursued in tandem with economic, social or environmental goals. Typical of these bodies are the Australian Agricultural Council, the Australian Minerals and Energy Council, the Australian Water Resources Council, and the Australian Environment Council.

The intergovernmental ministerial councils are assisted by standing committees of officials. Frequently, expert working groups and sub-committees are established to consider particular specialised aspects of a Council's broad field of interest and to advise the council through the relevant standing committee.

Councils do not directly undertake research or the provision of services, although such activities are commonly pursued within agencies coming under the control of individual ministerial members. In some instances, councils have control of research funds and provide grants or arrange for projects to be undertaken in particular fields of interest.

In some scientific and technical fields not coming directly within the purview of the Ministerial councils, there are standing arrangements at agency level for consultation and promotion of co-operation (the Electricity Supply Association of Australia is an example).

In addition to intergovernmental agencies, official advisory bodies have been established to deal with activities, interests and responsibilities of the Commonwealth Government and its agencies, and to advise on Government support of higher education and of industry. Amongst these bodies are the Australian Research Grants Committee (ARGC); the National Health and Medical Research Council (NHMRC); the Australian Industrial Research and Development Incentives Board (AIRDIB); the CSIRO Advisory Council and its State Committees; the Rural Industry Research Fund Advisory Committees; the Commonwealth Tertiary Education Commission and its Councils; and the National Energy Research Development and Demonstration Council.

The Prime Minister announced the establishment of the Antarctic Research Policy Advisory Committee in February 1979 to advise the Government, through the Minister for Science and Technology, on the development of an effective and balanced program of scientific and exploration

activity in the Antarctic and sub-Antarctic region. In particular, the Committee advises priorities for scientific and technological research in areas such as mineral and living resources, and on the potential environmental effects of exploitation of resources.

It also advises on the scientific merit and adequacy of Australian Antarctic research programs, on the organisational arrangements for implementation of programs, and on the role of the Antarctic Division of the Department of Science and Technology in this effort. From time to time, it will undertake reviews of existing programs and provide advice on new programs, taking into account current government policy in these areas.

Development of a marine sciences and technologies program has been identified by the Commonwealth Government as a high priority task. Accordingly the Australian Marine Sciences and Technologies Advisory Committee (AMSTAC) was established in February 1979 and advises the Government, through the Minister for Science and Technology, on all aspects of Marine Sciences and Technologies (MST). With the publication of its major report, *Towards a Marine Sciences and Technologies Program for the 1980s*, AMSTAC has essentially completed its initial review of MST in Australia. AMSTAC is now investigating particular priority issues and formulating recommendations to the Government on specific actions to ensure the balanced development of MST. AMSTAC is trying to stimulate community participation in the development of Government policy by obtaining views of MST at public meetings in regional centres.

The Queen's Fellowships and Marine Research Allocations Advisory Committee advises the Minister for Science and Technology on the allocation of grants under the Marine Sciences and Technologies Grants Scheme and on the award of Queen's Fellowships in Marine Science. An amount of \$2.5 million was allocated to these schemes in 1982-83.

The Australian Industrial Research and Development Incentives Advisory Committee is a statutory body established as a source of advice on matters relating to the operation of the *Industrial Research and Development Incentives Act 1976* including, in particular, matters relating to the Act's public-interest provisions. These provisions enable the contracting out to industry of industrial research projects aimed at the commercial development of major research breakthroughs achieved in the public sector and non-profit research institutions.

At its initial meeting, in August 1982, the Committee recommended that the Government support a detailed feasibility study of STARLAB, a joint Australian-Canadian-American proposal to place a one-metre-diameter telescope in earth orbit, using the NASA Space Shuttle. Subsequently the Government allocated \$3.3 million for such a feasibility study.

In October 1981 the Government established the Recombinant DNA Monitoring Committee, with a Scientific Sub-committee, following advice from the Australian Academy of Science. The Academy had operated a voluntary monitoring system for DNA research work from 1975 to 1981 in the wake of concern, in the international scientific community, about the possibilities of moral biological hazards associated with genetic manipulations using the newly developed recombinant DNA technique. When it became apparent that industry would soon be using this technology the Academy recommended that the Government take over the monitoring function. The Recombinant DNA Monitoring Committee will assess the potential hazards associated with the technique and accordingly establish voluntary guidelines for the conduct of this work.

The Building Research and Development Advisory Committee is the main link between private industry and the principal Commonwealth research groups, the CSIRO Division of Building Research, the Department of Transport and Construction, and the Physical Working Environment Branch of the Department of Employment and Industrial Relations.

The Committee advises the Commonwealth Government organisations concerned in building research and development on the technical problems of industry and where research, investigation, development work or technical liaison activity is required. It also assists in the dissemination of knowledge of the activities of organisations undertaking research and development work, and investigates the nature and extent of both government and privately funded research in the Australian building industry and advises all parties concerned of any overlapping or duplication of research effort.

The Technology Transfer Council (TTC) was established initially for a three-year pilot period in 1979 to provide a technical referral program aimed at utilising the technological expertise resident in academic, government and private research institutions and to assist in the effective use of existing technology in Australian industry. A network of eight centres in the five major mainland capitals is operating initially in the metals manufacturing industry. The prime focus is on small-to-medium-size firms which usually do not have the in-house technical expertise to devote to problem solving and which lack awareness of technologies available. With continuing Commonwealth support over the next three years, the TTC is expanding its operations from the pilot stage towards a viable long-term program.

Activities include a range of practical courses and workshops, company visits and provision of process and product development packages which identify new products and processes suitable for the individual company to assist in business improvement and diversification.

TTC officers are a direct link between companies and the vast amount of technical information available from local and overseas experts and data bases.

The National Information Technology Week Committee was established in 1979 as an initiative of the Department of Science and Technology in conjunction with the Australian Computer Society Inc. The Committee conducts an annual Information Technology Week throughout Australia, designed to focus public attention on the present and future uses of information-handling equipment and systems including communications, computers, videotex, word processors and micrographics.

For some years the Government has given recognised research associations grants which match industry research contributions within certain criteria. Research associations arrange scientific or industrial research and technology transfer for the benefit of member companies in the industry sector. There are currently five associations (Australian Welding Research Association, Bread Research Institute of Australia, Brick Development Research Institute, Radiata Pine Research Institute and Sugar Research Institute) receiving grants which totalled \$1.2 million in 1981-82. The program is jointly administered by the Department of Science and Technology and the CSIRO.

Established in 1963, the Australian Water Resources Council (AWRC) is a Commonwealth and State Ministers' forum for dealing with water resources matters of mutual interest. Commonwealth and State collaboration through the AWRC initially concentrated on resources assessment and research, but more recently the Council's functions have been expanded to include management and planning. The AWRC and its committees have provided an important contribution to the development of Commonwealth water policies and programs and, in many cases, provide the means of implementing them.

As part of its Secretariat role, the Department of National Development and Energy publishes reports and documents, and also arranges seminars and workshops on behalf of the AWRC.

The Commonwealth established the Water Research Fund in 1968 to provide support for a research program developed through the AWRC. The fund is administered by the Department of National Development and Energy. Funds have been committed on a triennial basis, currently running at \$600,000 annually.

The program covers basic and applied research into all aspects of water resources with the aim of providing a better basis for the assessment, planning, development and management of Australia's water resources. It complements research work carried out by government agencies, universities and other organisations and, in general, is used to stimulate new work not handled within existing programs.

The program for the current triennium beginning in 1980-81 is based on a series of priority areas identified by the AWRC; including flood plain management, water storage management, non-point sources of pollution, salinity, waste-water disposal and reuse, drinking water quality, aquatic biology, groundwater, evapotranspiration, and instruments and techniques.

The Commonwealth Government has now decided to establish a National Water Research Council to advise the Minister for National Development and Energy on national research goals, needs and priorities. It will recommend programs and projects as well as appropriate levels of funding. The membership of the Council is now being formulated, and the program recommended by the Council will replace the Australian Water Resources Council's research program as projects being funded in the current triennium are completed.

Expenditure and manpower

Project SCORE

Project SCORE (Survey and Comparisons of Research Expenditures) provides details of Australian expenditure on research and experimental development activities. It should be noted, however, that it does not provide comprehensive data on all resources devoted to scientific and technological activities in Australia. Programs not covered by Project SCORE, some of which involve large expenditures, are those which have no research and development component; such programs include many of those aimed at providing scientific or technological services.

Coverage and Methodology. The first comprehensive survey of expenditure on research and experimental development (R & D) was carried out for the 1968-69 financial year. This survey, known as Project SCORE, covered R & D expenditure and manpower in the natural and social sciences in all sectors of the Australian economy. The Project was carried out principally by means of

questionnaires and, in order to provide direct comparison with other OECD countries, followed (with some exceptions) guidelines laid down by the OECD. In addition to a summary report dealing with the overall national situation, separate Project SCORE reports cover the following sectors: Commonwealth Government, Private Enterprise, State Government, Higher Education, and Private Non-profit. A summary of the results for 1968-69 is given in Year Book No. 60 pp. 995-1005.

The results of the second survey, for the 1973-74 financial year (1974 calendar year for the Higher Education sector), were published in two volumes: Volume 1 contains the reports for the Commonwealth Government, State Government, and Private Non-profit sectors, while Volume 2 presents an all-sector summary together with the reports for the Private Enterprise and Higher Education sectors. A summary of the results is given in Year Book No. 61 pp. 989-998.

The results of the third survey, for the 1976-77 financial year (1976 calendar year for the Higher Education sector), were published with reports for all-sectors presented in the one volume. A summary of the results is given in Year Book No. 64 pp. 703-713. A fourth survey was conducted in respect of the 1978-79 financial year (1978 calendar year for the Higher education sector), and comprehensive results are contained in the ABS publications: *Research and Experimental Development, Business Enterprises, Australia, 1978-79* (8104.0); *Research and Experimental Development, General Government Organisations, Australia, 1978-79* (8109.0); *Research and Experimental Development Higher Education Organisations, Australia, 1978* (8111.0); *Research and Experimental Development, All Sector Summary, Australia, 1978-79* (8112.0).

In April 1981, the Commonwealth Government decided that, as a result of the Review of Commonwealth Functions future Project SCORE surveys would be conducted triennially instead of biennially. The current Project SCORE surveys are being held in respect of 1981-82.

For the purposes of the surveys, *research* was defined as original investigation directed towards increasing the general body of knowledge about, or understanding of, the subject studied. Within this category, *basic research* was taken to be original investigation of which the primary aim was more complete knowledge or understanding of the subject under study, while *applied research* was taken to be original investigation of which the primary aim was the solution of a recognised practical problem. Work was defined as *experimental development* where it involved the systematic use or adaptation of research results directed towards the production of new or improved products, processes, systems or methods. The physical, chemical, biological, earth, engineering and applied, agricultural and medical sciences were included in the natural sciences, which together with the social sciences, were covered in all the surveys. R & D in the humanities, which was excluded in 1968-69, has been included in each subsequent survey.

The estimate of Gross Expenditure on Research and Experimental Development (GERD) carried out in Australia during 1978-79 was \$1,054m at current prices. This represents a 21 per cent increase in expenditure compared with 1976-77. At *constant (average 1974-75)* prices there was no change in GERD between those two years.

Of the \$1,054m *current* price estimate of 1978-79 GERD, business enterprises accounted for \$246m (23 per cent), general government organisations \$470m (45 per cent), higher education organisations \$326m (31 per cent), and private non-profit organisations \$13m (1 per cent). General government sources funded \$806m (76 per cent), business enterprises sources funded \$217m (21 per cent), and other Australian and overseas sources funded \$30m (3 per cent).

The total manpower effort devoted to R&D carried out in Australia during 1978-79 was 40,684 man-years. This represents a decrease of 4 per cent compared with 1976-77. Of the total manpower effort, business enterprises accounted for 8,626 man-years (21 per cent), general government organisations 15,462 man-years (38 per cent), higher education organisations 16,050 man-years (39 per cent) and private non-profit organisations 546 man-years (1 per cent).

A summary of the data incorporated in *Research and Experimental Development, All Sector Summary, Australia, 1978-79* (8112.0) is shown below.

**GROSS EXPENDITURE ON RESEARCH AND EXPERIMENTAL DEVELOPMENT (GERD) CARRIED
OUT IN AUSTRALIA, 1976-77 AND 1978-79
GERD BY SECTOR AT CURRENT AND CONSTANT (AVERAGE 1974-75) PRICES
(\$m)**

| Sector | 1976-77 | 1978-79 |
|---|--------------|----------------|
| AT CURRENT PRICES | | |
| Business enterprises | 202.8 | 245.8 |
| General government— | | |
| Commonwealth | 289.5 | 321.2 |
| State | 126.3 | 148.7 |
| Higher education | 244.1 | 325.5 |
| Private non-profit | 10.7 | 12.6 |
| Total | 873.4 | 1,053.8 |
| AT CONSTANT (AVERAGE 1974-75) PRICES | | |
| Business enterprises | 157.5 | 157.3 |
| General government— | | |
| Commonwealth | 228.1 | 217.3 |
| State | 99.8 | 92.8 |
| Higher education | 213.7 | 229.5 |
| Private non-profit | 8.4 | 8.4 |
| Total | 707.5 | 705.3 |

**GROSS EXPENDITURE ON RESEARCH AND EXPERIMENTAL DEVELOPMENT (GERD) CARRIED
OUT IN AUSTRALIA, 1976-77 AND 1978-79
GERD BY SECTOR BY TYPE OF EXPENDITURE
(\$'000)**

| Sector | 1976-77 | | | | 1978-79 | | | | Total | |
|--------------------------------|--------------------------|--------------------------------------|--------------------------|--------------------------------------|--------------------------|--------------------------------------|--------------------------|--------------------------------------|----------------|------------------|
| | Land and buildings | Other capital expen- diture | Wages and salaries | Other cur:ent expen- diture | Land and buildings | Other capital expen- diture | Wages and salaries | Other current expen- diture | | |
| Business enterprises | 6,411 | 12,809 | 134,632 | 48,962 | 202,815 | 4,731 | 21,353 | 153,246 | 66,510 | 245,841 |
| General government— | | | | | | | | | | |
| Commonwealth | 12,364 | 19,054 | 194,896 | 63,174 | 289,488 | 31,821 | 17,638 | 200,122 | 71,605 | 321,187 |
| State | 6,979 | 5,990 | 88,820 | 24,540 | 126,329 | 3,720 | 7,937 | 107,764 | 29,282 | 148,703 |
| Higher education | 8,500 | 10,007 | 184,190 | 41,358 | 244,053 | 8,064 | 24,177 | 239,917 | 53,356 | 325,514 |
| Private non-profit | 104 | 844 | 7,098 | 2,667 | 10,712 | 260 | 837 | 8,044 | 3,424 | 12,566 |
| Total | 34,358 | 48,704 | 609,636 | 180,701 | 873,397 | 48,596 | 71,942 | 709,093 | 224,177 | 1,053,811 |

**RESEARCH AND EXPERIMENTAL DEVELOPMENT (R&D) MANPOWER EFFORT IN AUSTRALIA,
1976-77 AND 1978-79
R&D MANPOWER BY SECTOR BY TYPE OF MANPOWER
(man-years)**

| Sector | 1976-77 | | | 1978-79 | | | Total | |
|--------------------------------|---------------|---------------|------------------------------|---------------|---------------|------------------------------|--------------|---------------|
| | Researchers | Technicians | Other supporting staff | Researchers | Technicians | Other supporting staff | | |
| Business enterprises | 4,080 | 3,677 | 1,586 | 9,343 | 3,649 | 3,171 | 1,806 | 8,626 |
| General government— | | | | | | | | |
| Commonwealth | 4,284 | 3,632 | 2,508 | 10,423 | 4,054 | 3,315 | 1,960 | 9,329 |
| State | 2,662 | 1,963 | 1,980 | 6,605 | 2,401 | 1,941 | 1,790 | 6,133 |
| Higher education | 11,285 | 3,189 | 815 | 15,290 | 11,894 | 3,132 | 1,024 | 16,050 |
| Private non-profit | 260 | 160 | 158 | 579 | 265 | 148 | 133 | 546 |
| Total | 22,571 | 12,621 | 7,047 | 42,240 | 22,263 | 11,707 | 6,713 | 40,684 |

**GROSS EXPENDITURE ON RESEARCH AND EXPERIMENTAL DEVELOPMENT (GERD) CARRIED
OUT IN AUSTRALIA, 1978-79
GERD BY SECTOR BY SOURCE OF FUNDS
(\$'000)**

| Sector | Source of funds | | | | | | Other Australian sources and overseas | Total |
|----------------------|----------------------------|---------------------|------------------------|---------------------|-----------------------|---------------|--|-------|
| | Commonwealth government | State government | Business enterprise | Higher education | Private non-profit | | | |
| Business enterprises | 25,308 | 1,368 | 209,486 | 26 | 459 | 9,193 | 245,841 | |
| General government— | | | | | | | | |
| Commonwealth | 316,166 | 362 | 2,263 | 54 | 64 | 2,278 | 321,187 | |
| State | 10,456 | 132,946 | 2,468 | 66 | 1,040 | 1,726 | 148,703 | |
| Higher education | 309,412 | 3,879 | 2,865 | — | 7,574 | 1,784 | 325,514 | |
| Private non-profit | 4,644 | 1,551 | 389 | 234 | 3,945 | 1,803 | 12,566 | |
| Total | 665,986 | 140,106 | 217,471 | 380 | 13,082 | 16,784 | 1,053,811 | |

**GROSS EXPENDITURE ON RESEARCH AND EXPERIMENTAL DEVELOPMENT (GERD) CARRIED
OUT IN AUSTRALIA, 1978-79
GERD BY SECTOR BY TYPE OF ACTIVITY
(\$'000)**

| Sector | Type of activity | | | | Total |
|----------------------|------------------------|--------------------------------|---------------------|-----------------------------|------------------|
| | Pure basic research | Strategic basic research | Applied research | Experimental development | |
| Business enterprises | 3,781 | 7,005 | 81,364 | 153,692 | 245,841 |
| General government— | | | | | |
| Commonwealth | 15,651 | 83,027 | 169,776 | 52,733 | 321,187 |
| State | 4,237 | 8,152 | 122,035 | 14,279 | 148,703 |
| Higher education | 165,239 | 59,354 | 80,566 | 20,355 | 325,514 |
| Private non-profit | 3,482 | 1,773 | 7,262 | 48 | 12,566 |
| Total | 192,390 | 159,311 | 461,003 | 241,107 | 1,053,811 |

**GROSS EXPENDITURE ON RESEARCH AND EXPERIMENTAL DEVELOPMENT (GERD) CARRIED
OUT IN AUSTRALIA
1978-79
GERD BY SECTOR BY STATE
(\$'000)**

| Sector | State | | | | | | | | | Total |
|----------------------|----------------|----------------|----------------|----------------|---------------|---------------|--------------|----------------|--------------|------------------|
| | N.S.W. | Vic. | Qld | S.A. | W.A. | Tas. | N.T. | A.C.T. | Overseas | |
| Business enterprises | 90,644 | 106,257 | 20,690 | 15,527 | 5,851 | 3,752 | 2,670 | 449 | — | 245,841 |
| General government— | | | | | | | | | | |
| Commonwealth | 82,184 | 104,678 | 22,981 | 45,484 | 9,743 | 2,451 | 883 | 50,241 | 2,542 | 321,187 |
| State | 46,514 | 28,191 | 34,708 | 10,473 | 23,774 | 5,011 | — | 9 | 23 | 148,703 |
| Higher education | 101,291 | 69,766 | 35,723 | 30,562 | 21,672 | 6,536 | — | 59,964 | — | 325,514 |
| Private non-profit | 4,047 | 8,350 | 57 | 30 | 19 | 16 | 5 | 34 | 8 | 12,566 |
| Total | 324,680 | 317,242 | 114,159 | 102,076 | 61,059 | 17,766 | 3,558 | 110,697 | 2,573 | 1,053,811 |

**RESEARCH AND EXPERIMENTAL DEVELOPMENT CARRIED OUT IN AUSTRALIA, 1978-79
RESEARCH EFFORT BY STATE
(man-years)**

| Sector | State | | | | | | | | | Total |
|----------------------|--------------|--------------|--------------|--------------|--------------|------------|-----------|--------------|-----------|---------------|
| | N.S.W. | Vic. | Qld | S.A. | W.A. | Tas. | N.T. | A.C.T. | Overseas | |
| Business enterprises | 1,269 | 1,636 | 345 | 244 | 70 | 61 | 1 | 9 | 14 | 3,649 |
| General government— | | | | | | | | | | |
| Commonwealth | 981 | 1,327 | 208 | 588 | 115 | 25 | 9 | 782 | 20 | 4,054 |
| State | 679 | 504 | 576 | 233 | 307 | 102 | — | — | — | 2,401 |
| Higher education | 3,617 | 3,358 | 1,339 | 1,129 | 871 | 247 | — | 1,332 | — | 11,894 |
| Private non-profit | 86 | 173 | 2 | 2 | 1 | 1 | — | 1 | — | 265 |
| Total | 6,632 | 6,998 | 2,470 | 2,196 | 1,364 | 436 | 10 | 2,124 | 34 | 22,263 |

**RESEARCH AND EXPERIMENTAL DEVELOPMENT CARRIED OUT IN AUSTRALIA(a), 1978-79
R&D EXPENDITURE AND R&D MANPOWER BY SOCIO-ECONOMIC OBJECTIVE BY SECTOR**

| Socio-economic objective | Expenditure (\$'000) | | | | | Manpower (man-years) | | | | |
|---------------------------------------|----------------------|-----------------|----------------|--------------------|----------------|----------------------|-----------------|---------------|--------------------|---------------|
| | General government | | | | | General government | | | | |
| | Common-wealth | State education | Higher | Private non-profit | Total | Common-wealth | State education | Higher | Private non-profit | Total |
| <i>National security (defence)</i> | 89,166 | - | 270 | - | 89,436 | 3,826 | - | 10 | - | 3,836 |
| Economic development— | | | | | | | | | | |
| Agriculture | 50,971 | 102,268 | 25,837 | 30 | 179,106 | 1,193 | 4,129 | 1,384 | 1 | 6,707 |
| Forestry and fisheries | 11,315 | 13,834 | 1,982 | 75 | 27,206 | 254 | 659 | 114 | 1 | 1,028 |
| Mining (prospecting)— | | | | | | | | | | |
| energy sources | 1,866 | 447 | 325 | - | 2,638 | 58 | 12 | 17 | - | 87 |
| other | 10,047 | 25 | 1,059 | - | 11,131 | 269 | 1 | 61 | - | 331 |
| Mining (extraction)— | | | | | | | | | | |
| energy sources | 827 | - | 317 | - | 1,144 | 24 | - | 18 | - | 42 |
| other | 5,548 | 144 | 1,787 | - | 7,479 | 134 | 6 | 94 | - | 234 |
| Manufacturing | 47,038 | 1,133 | 11,177 | - | 59,348 | 1,029 | 42 | 657 | - | 1,728 |
| Construction | 6,498 | 36 | 1,979 | - | 8,513 | 204 | 2 | 97 | - | 303 |
| Energy | 19,667 | 319 | 8,981 | 10 | 28,977 | 462 | 9 | 411 | 1 | 883 |
| Transport | 1,580 | 5,648 | 2,301 | 68 | 9,597 | 29 | 172 | 131 | 3 | 335 |
| Communications | 360 | - | 2,223 | - | 2,583 | 15 | - | 125 | - | 140 |
| Economic services n.e.c. | 11,152 | 890 | 12,177 | 169 | 24,388 | 321 | 50 | 612 | 6 | 989 |
| <i>Total economic development</i> | <i>166,870</i> | <i>124,743</i> | <i>70,146</i> | <i>352</i> | <i>362,111</i> | <i>3,991</i> | <i>5,082</i> | <i>3,721</i> | <i>13</i> | <i>12,807</i> |
| Community welfare— | | | | | | | | | | |
| Urban and regional planning | 1,153 | 200 | 2,519 | 35 | 3,907 | 30 | 10 | 152 | 4 | 196 |
| Environment | 28,405 | 6,651 | 4,681 | 9 | 39,746 | 616 | 242 | 230 | - | 1,088 |
| Health | 10,364 | 5,864 | 56,894 | 9,979 | 83,101 | 334 | 299 | 2,284 | 448 | 3,365 |
| Education | 212 | 1,619 | 11,411 | 1,554 | 14,796 | 7 | 65 | 585 | 65 | 722 |
| Welfare | 877 | 284 | 3,262 | 61 | 4,484 | 42 | 15 | 157 | 4 | 218 |
| Community services n.e.c. | 1,081 | 957 | 8,084 | 2 | 10,124 | 38 | 45 | 365 | 1 | 449 |
| <i>Total community welfare</i> | <i>42,092</i> | <i>15,576</i> | <i>86,851</i> | <i>11,641</i> | <i>156,160</i> | <i>1,067</i> | <i>675</i> | <i>3,773</i> | <i>522</i> | <i>6,037</i> |
| Advancement of knowledge— | | | | | | | | | | |
| Earth, ocean and atmosphere n.e.c. | 3,597 | 4,358 | 17,587 | 150 | 25,692 | 132 | 213 | 996 | 3 | 1,344 |
| General advancement of knowledge | 19,462 | 4,027 | 150,658 | 422 | 174,569 | 313 | 163 | 7,551 | 9 | 8,036 |
| <i>Total advancement of knowledge</i> | <i>23,059</i> | <i>8,385</i> | <i>168,245</i> | <i>572</i> | <i>200,261</i> | <i>445</i> | <i>376</i> | <i>8,547</i> | <i>12</i> | <i>9,380</i> |
| Total | 321,187 | 148,703 | 325,514 | 12,566 | 807,970 | 9,329 | 6,133 | 16,050 | 546 | 32,058 |

(a) Excludes business enterprises.

**RESEARCH AND EXPERIMENTAL DEVELOPMENT CARRIED OUT IN AUSTRALIA (a), 1978-79
R&D EXPENDITURE AND R&D MANPOWER BY FIELD OF SCIENCE BY SECTOR**

| Field of Science | Expenditure (\$'000) | | | | Manpower (man-years) | | | | | |
|--|----------------------|------------------------|--------------------|---------------|----------------------|------------------------|--------------------|---------------|------------|---------------|
| | General government | | | | General government | | | | | |
| | Common-wealth | Higher State education | Private non-profit | Total | Common-wealth | Higher State education | Private non-profit | Total | | |
| Natural sciences— | | | | | | | | | | |
| Physical sciences | 34,754 | 1,131 | 34,437 | 105 | 70,427 | 819 | 48 | 1,496 | 2 | 2,365 |
| Chemical sciences | 19,921 | 1,429 | 23,919 | 112 | 45,381 | 484 | 48 | 1,202 | 2 | 1,736 |
| Biological sciences | 30,424 | 13,137 | 56,485 | 2,277 | 102,323 | 664 | 568 | 2,771 | 83 | 4,086 |
| Earth sciences | 36,451 | 4,901 | 13,585 | 21 | 54,958 | 887 | 220 | 741 | — | 1,848 |
| Engineering and applied sciences | 134,885 | 7,192 | 36,161 | 187 | 178,425 | 4,756 | 229 | 2,007 | 6 | 6,998 |
| Agricultural sciences | 52,323 | 111,118 | 24,706 | 36 | 188,183 | 1,225 | 4,554 | 1,274 | 2 | 7,055 |
| Medical sciences | 4,458 | 4,895 | 45,217 | 7,898 | 62,468 | 180 | 240 | 1,649 | 370 | 2,439 |
| Total natural sciences | 313,217 | 143,803 | 234,511 | 10,636 | 702,167 | 9,013 | 5,905 | 11,140 | 465 | 26,523 |
| Social sciences and humanities— | | | | | | | | | | |
| Economics | 2,343 | 659 | 12,122 | 134 | 15,258 | 120 | 37 | 469 | 3 | 629 |
| Education | 464 | 1,661 | 10,989 | 1,557 | 14,671 | 18 | 64 | 777 | 65 | 924 |
| Management | 1,409 | 262 | 1,034 | — | 2,705 | 42 | 11 | 52 | — | 105 |
| Political science | — | 68 | 4,775 | — | 4,843 | — | 3 | 236 | — | 239 |
| Sociology | 925 | 474 | 4,660 | 91 | 6,150 | 29 | 23 | 264 | 8 | 324 |
| Information science | 1,152 | 398 | — | 9 | — | 47 | 20 | — | — | — |
| Other social sciences and human-ities | 1,677 | 1,378 | 57,421 | 138 | 62,173 | 59 | 68 | 3,112 | 5 | 3,312 |
| Total social sciences and human-ities | 7,970 | 4,900 | 91,003 | 1,930 | 105,803 | 316 | 227 | 4,910 | 81 | 5,534 |
| Total | 321,187 | 148,703 | 325,514 | 12,566 | 807,970 | 9,329 | 6,133 | 16,050 | 546 | 32,058 |

(a) Excludes business enterprises.

**PAYMENTS AND RECEIPTS FOR TECHNICAL KNOW-HOW, AUSTRALIA, 1978-79
PAYMENTS AND RECEIPTS BY SECTOR BY TYPE OF TECHNICAL KNOW-HOW
(\$'000)**

| Sector | Payments for technical know-how | | | Receipts for technical know-how | | |
|--------------------------------|-----------------------------------|--------------------------|----------------|-----------------------------------|--------------------------|---------------|
| | Patent licence fees and royalties | Other technical know-how | Total | Patent licence fees and royalties | Other technical know-how | Total |
| Business enterprises | 71,008 | 59,170 | 130,178 | 5,322 | 10,078 | 15,399 |
| General government— | | | | | | |
| Commonwealth | 251 | — | 251 | 174 | 9 | 183 |
| State | 1 | — | 1 | 10 | — | 10 |
| Higher education (a) | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| Private non-profit | — | 28 | 28 | — | 15 | 15 |
| Total | 71,260 | 59,198 | 130,458 | 5,506 | 10,102 | 15,607 |

(a) Not collected.

**PATENT ACTIVITY, AUSTRALIA, JULY 1977 TO JUNE 1979
PATENT APPLICATIONS LODGED AND PATENTS GRANTED BY SECTOR**

| Sector | Patent applications lodged in Australia | Patents granted in Australia | Patent applications lodged abroad | Patents granted abroad |
|--------------------------------|---|------------------------------|-----------------------------------|------------------------|
| | Business enterprises | 985 | 497 | 2,536 |
| General government— | | | | |
| Commonwealth | 108 | 60 | 373 | 159 |
| State | 3 | 2 | 7 | 1 |
| Higher education (a) | n.a. | n.a. | n.a. | n.a. |
| Private non-profit | — | — | — | — |
| Total | 1,096 | 559 | 2,916 | 1,380 |

(a) Not collected.

Energy Research and Experimental Development Statistics. For information on these statistics see Chapter 18, Energy.

Resources and services

Although power to regulate the development and utilisation of Australia's natural resources rests largely with the States, the Commonwealth Government, in part because of its jurisdiction in the control of Australia's overseas trade, also plays an important role. Extensive machinery exists for consultation and collaboration between the Commonwealth and State governments in relation to the development and management of natural resources.

Several important resources and services are dealt with elsewhere in this Year Book and are thus not included in this chapter. These include health (Chapter 10), agricultural industries (Chapter 13), forestry and fisheries (Chapter 14), water resources (Chapter 15), mineral industry (Chapter 16), transport and communications (Chapter 20) and environment (Chapter 26).

Soil resources

A Standing Committee on Soil Conservation was established in 1946. It comprises the heads of soil conservation bodies in the States and representatives of relevant Commonwealth agencies. The Committee co-ordinates activities of interest to its member bodies such as the survey of erosion throughout Australia which was carried out in the late 1960s, and the development of co-operative arrangements for in-service training of technical personnel.

Meteorology

The Bureau of Meteorology, which is a Division of the Department of Science and Technology, is the national authority for providing weather forecasting and warning services, and general meteorological information and consultative advice. Users of these services include the general public, defence forces, civil aviation and marine authorities, and specialist groups in primary and secondary industries.

Programs of research are carried out in support of these services, often in co-operation with other institutions concerned with meteorological science including universities and the CSIRO. The Australian Numerical Meteorology Research Centre, which specialises in the development of numerical model techniques for predicting atmospheric behaviour, is operated jointly by the Department of Science and Technology and CSIRO.

Total expenditure by the Bureau in 1981-82 was approximately \$53 million.

Ionospheric Prediction Service

The Ionospheric Prediction Service (IPS) Branch of the Department of Science and Technology exists to assist users of radio communications to achieve the most effective and efficient use of radio communication influenced by or dependent on the ionosphere. The Branch operates ionospheric and solar observatories in Australia and Papua New Guinea, produces radio propagation predictions and warnings of ionospheric and magnetic disturbances.

Research into physical phenomena affecting the ionosphere and into radio wave propagation forms part of the regular activity of the IPS.

Satellite remote sensing

In 1978 the Commonwealth Government decided to establish facilities for receiving and processing information from the U.S. National Aeronautics and Space Administration's series of Landsat satellites. The Department of Science and Technology manages the project. A data acquisition station has been established at Alice Springs and a data processing facility has been installed in Canberra. Additional information on Landsat stations is provided at pages 722-4 of Year Book No. 64.

Scientific and Technological Information Services

Scientific literature and technical information for scientists and technologists is provided through library and information services provided by the Commonwealth of Australia, State instrumentalities, tertiary institutions and industrial organisations. The more important scientific libraries and information services within the Commonwealth sector are the National Library of Australia, the CSIRO Library network and information services, the library and information services maintained by the Department of Health and that of the Australian Atomic Energy Commission.

Several Commonwealth Agencies including the Australian Atomic Energy Commission, the CSIRO, the Department of Science and Technology and the National Library of Australia are now offering Australian users access to overseas bibliographic and factual data bases and to the Australian Information Network (AUSINET). The National Library of Australia and the Department of Health operate a national health information network, the Australian Medline Network. The Overseas Telecommunications Commission is operating an international data transmission service known as MIDAS (Multi-mode International Data Acquisition Service) which has facilitated low-cost access to international data stores in North America and Europe.

Another overseas trend now arousing interest amongst Australian scientists is the development of numerical data bases which provide quick access to factual data. The CSIRO is currently operating Thermodata, a metallurgical thermodynamic data base and other similar data bases for crystallography and mass spectra data. Similar numeric and factual data bases are at present being evaluated by other Commonwealth agencies.

A number of Australian scientific and technological indexes and directories now exist or are in the course of production by Commonwealth Government departments and agencies. Recent initiatives are:

- a machine based register of Australian energy research, development and demonstration projects providing a technical description of each project. Initiated by the Department of National Development and Energy as part of a National Energy Information System (NEIS) the register is now being operated by CSIRO;
- a national directory of current Australian marine research. Entitled the *Directory of Australian Marine Research in Progress*, it is a joint publication by the Department of Science and Technology, the Victorian Institute of Marine Sciences and the Great Barrier Reef Marine Park Authority. The Directory identifies individuals and organisations undertaking marine research and provides details of their objectives, methodology, publications, current status, funding, etc;
- a computerised bibliographic data base, STREAMLINE, providing references to published and unpublished documents and current research projects on all facets of water and wastewater in Australia, has been established by the Department of National Development and Energy;
- an Australian Bibliographic Network (ABN), launched by the National Library of Australia late in 1981, is a national, shared cataloguing system which provides access to a data base of more than 2.5 million records for books, periodicals and other materials such as films, pictures and manuscripts, etc., covering the whole field of knowledge including science and technology. ABN, potentially available for use by any library in Australia, covers publications produced in the last decade, increasingly is covering earlier publications and provides information retrieval and document location facilities.

Units and Standards of Physical Measurement

The National Standards Commission advises on weights and measures, particularly on units and standards of physical measurement and the suitability of measuring instruments for use in trade.

Currently, additional legal units of measurement are being prescribed, and the hierarchy of Australian standards is under review. Electronics, particularly load-cell technology in weighing, so increases the versatility of trade-measuring instruments that they now function in manners not previously possible. Development of trade-measuring instrumentation is so rapid that models are being superseded in four to five years, whereas the older mechanical instruments were a once-in-a-lifetime purchase.

The Commission is involved with the rate of change and the technology which is being introduced.

Major government research agencies

Expenditure on research and experimental development carried out by general government organisations in 1978-79 was estimated to be \$470 million at current prices. This represents a 13 per cent increase in expenditure compared with 1976-77. For additional information see Project SCORE paragraphs in this chapter.

Commonwealth Scientific and Industrial Research Organization (CSIRO)

The CSIRO is the largest scientific research organization in Australia. It has a total staff of some 7,500 people located in more than 100 laboratories and field stations throughout Australia. About one-third of the staff are scientists.

It is a statutory body established by the *Science and Industry Research Act 1949*. Under the Act, CSIRO replaced the former Council for Scientific and Industrial Research, established in 1926. The Organization was restructured by amendments to the Act in 1978.

Briefly, the functions of CSIRO are:

- conduct of scientific research and application of the results;
- research training and funding;
- maintenance of measurement standards;
- publication and dissemination of scientific information.

When the Organization was first set up, its research centred on solving the problems then facing agriculture and industry. Today, its research extends not only to those areas but into others affecting every Australian—the environment, human nutrition, conservation, urban planning.

CSIRO is governed by an Executive comprising three full-time members, including the Chairman, and five part-time Members. An Advisory Council together with committees in each State and the Northern Territory, with members appointed to represent the range of interests in the Australian community, provide independent advice to the Executive.

The CSIRO's research is carried out in some forty-one divisions and seven smaller units. The divisions and units are grouped into the following five Institutes:

Institute of Animal and Food Sciences: Divisions of Animal Health, Animal Production, Fisheries Research, Food Research, Human Nutrition, Tropical Animal Science Project for Animal Research and Development, Molecular and Cellular Biology Unit, Wheat Research Unit.

Institute of Biological Resources: Divisions of Entomology, Forest Research, Horticultural Research, Centre for Irrigation Research, Water and Land Resources, Plant Industry, Soils, Tropical Crops and Pastures, Wildlife Research, Rangelands Research Unit.

Institute of Energy and Earth Resources: Divisions of Applied Geomechanics, Energy Chemistry, Energy Technology, Fossil Fuels, Ground Water Research, Mineral Chemistry, Mineral Engineering, Mineral Physics, Mineralogy, Physical Technology Unit.

Institute of Industrial Technology: Divisions of Applied Organic Chemistry, Building Research, Chemical Technology, Manufacturing Technology, Protein Chemistry, Textile Industry, Textile Physics.

Institute of Physical Sciences: Divisions of Applied Physics, Atmospheric Physics, Chemical Physics, Cloud Physics, Computing Research, Environmental Mechanics, Materials Science, Mathematics and Statistics, Oceanography, Radiophysics, Australian Numerical Meteorology Research Centre.

A Bureau of Scientific Services is responsible for facilitating and promoting the transfer and utilization of technology and scientific and technical information for the benefit of Australian science, industry and the community at large, and undertaking development assistance projects with other nations.

The main role of CSIRO is to plan and execute a comprehensive program of general scientific research on behalf of the Commonwealth, except in the areas of defence, nuclear energy and clinical medicine. With these main exceptions, however, the research work of CSIRO includes all fields of the physical and biological sciences, and their applications.

The types of research undertaken range from fundamental studies through to experimental development, with the main concentration being on strategic research undertaken in the national interest.

Areas of research designated as having high priority for expansion in the 1980s are:

- Biotechnology;
- Water and soils;
- Oceanography;
- Energy;
- Plant pathology;
- Manufacturing industry.

The CSIRO budget for 1982-83 is an estimated \$359 million, most of which is provided directly by the Commonwealth Government. Of this, \$56 million is appropriated to Commonwealth departments (e.g. Transport and Construction) on behalf of CSIRO for capital expenditure. Some \$31 million is contributed by trust funds concerned with the wool, meat, wheat, dairying, fishing and dried fruit industries, by individual companies, by Australian and overseas government instrumentalities, and by private foundations. The trust funds constitute about half of these contributory funds and are derived mainly from industry levies but there is also a Commonwealth Government component.

The Australian Atomic Energy Commission (AAEC)

For information on AAEC see Chapter 18, Energy.

Antarctic Division, Department of Science and Technology

Australia has been active in research and exploration in the Antarctic region since early in the present century, but the overall effort has expanded appreciably since the 1940s when the Government established the Australian National Antarctic Research Expeditions (ANARE) operated by the Antarctic Division.

The Antarctic Division of the Department of Science and Technology administers, organises and provides logistic support for Australian activities in Antarctica, including the maintenance of three Antarctic stations (Mawson, Casey and Davis) and one sub-Antarctic station on Macquarie Island.

The Australian Antarctic scientific program encompasses research in the fields of marine and terrestrial biology, oceanography, earth sciences, glaciology, cosmic ray and upper atmosphere physics,

meteorology, bathymetry, medical research, surveying and mapping. Each year, the Antarctic Division, universities and private and public research organisations are invited to submit research proposals to the Antarctic Research Policy Advisory Committee.

Australia is a signatory to the Antarctic Treaty, and many of its scientific activities in Antarctica are undertaken in collaboration with other signatory countries.

Productivity Development Division, Department of Science and Technology

The Productivity Development Division of the Department of Science and Technology administers a range of programs which:

- encourage the development of a national technological capability and the commercial exploitation thereof;
- promote the application of technology in industry to enhance industrial capability, competitiveness and productivity;
- ensure the transfer of existing local and overseas technological knowledge to industry and the community;
- facilitate community awareness of technology developments of critical importance.

In April 1982 the Government accepted the recommendation of the Committee to Review Productivity and Innovation Programs which set down criteria and guidelines for future involvement in industry matters. Consequently a number of programs, undertaken by the Department, are to be transferred or terminated, with a redirection of effort in others.

The National Materials Handling Bureau (which is a part of the Division) provides research and development assistance on materials handling, physical distribution and packaging. The transfer of the Bureau's functions to the private sector is under negotiation.

Australian Institute of Marine Science (AIMS)

The AIMS has been established on a 190 hectare site within a national park at Cape Ferguson, 50 kilometres south of Townsville in North Queensland. Comprehensive headquarters facilities were opened in September 1977 and include laboratories, lecture theatre, library, computer centre, administrative and other support services. A harbour for the Institute's vessels was completed in April 1976. A 24.4 metre ocean-going research vessel constructed specifically for the Institute was delivered during October 1978.

The Institute's main function is to undertake research; in this regard its activities focus on contributing to an understanding of the tropical marine environment and its associated living communities. Attention is currently concentrated on coral reef and mangrove ecosystems. A multidisciplinary approach is taken to investigate the character of these systems and the manner in which their productivity, diversity, stability and other essential attributes are affected by environment and by the adaptation and interactions of component elements of the biota. A significant proportion of the Institute's investigations is undertaken by external collaboration, with an active visiting investigator program an important means of achieving that objective. The interests of the research staff are necessarily diverse and include physical oceanography, marine chemistry and various aspects of biology, from biochemistry to trophodynamic ecology.

Defence Science and Technology Organisation

The Defence Science and Technology Organisation, Department of Defence Support, conducts a significant amount of research and development, mainly in engineering and the physical sciences. Current expenditure is about \$140 million per year.

Further details on the work of the organisation, and its ten research and testing establishments are found in Chapter 4, Defence.

Engineering Division, Department of Transport and Construction

To support its operations as the major design and construction authority for the Commonwealth, the Department of Transport and Construction carries out applied research and laboratory testing and provides a comprehensive range of technical services. In many cases, these services directly or indirectly benefit the needs of private industry and the public generally.

Research and special testing is conducted mainly by the Engineering Division at establishments such as the Experimental Building Station in Sydney, which specialises in building and building components, and the Central Investigation and Research Laboratory in Melbourne, which specialises in engineering materials and products.

Telecom Australia Research Laboratories

Telecom Australia maintains significant facilities and a staff of approximately 500 for the performance of research and development in telecommunications science and technology.

The primary objective of Telecom's research and development is to evaluate world advances in telecommunications services and systems so that it can select those best suited to the Australian environment. It also applies its research and development facilities to the solution of technical problems arising in the operation of the Australian telecommunications network. It also co-ordinates its research and development with that of industry and academia in telecommunications and supports their efforts with research and development contracts and grants made through the Australian Computer Research Board and the Radio Research Board.

Research by business enterprises

Expenditure on research and experimental development carried out by business enterprises in 1978-79 was estimated to be \$246 million at current prices. This represents a 21 per cent increase in expenditure compared with 1976-77.

The Government provides funding to encourage industrial research and development (IR and D) under the provisions of the *Industrial Research and Development Incentives Act 1976*. Two types of grants are payable under the Act: commencement grants to encourage companies to develop a basic R & D capability; and grants designed to give on-going support for companies with established IR and D facilities to undertake specific IR and D projects showing technical and commercial promise. Commencement grants are paid at the rate of 50 per cent of eligible expenditure up to a ceiling of \$40,000, and project grants at 50 per cent of eligible expenditure up to a ceiling of \$750,000. In addition the Minister for Science and Technology is empowered under the Act to approve full funding of projects considered to be in the 'public interest'. \$49.1 million was appropriated in the 1982-83 Budget for the Industrial Research and Development Incentives Scheme and other associated industry technology programs. The Government intends that a greater proportion of its own research will be contracted out to industry. In addition, support for new and existing research associations will be increased.

Payments and Receipts for Patent Licence Fees and other Technical Know-How

Australian enterprises have significantly supplemented their R & D efforts by either purchasing or licensing foreign technology. This activity is largely associated with trans-national firms. The ABS has estimated that Australian enterprises paid \$130 million in 1978-79 for patent licences and other technical know-how, of which \$128 million was remitted overseas.

In 1978-79 Australia enterprises received \$15 million from the sale of patent licences and other technical know-how, of which \$12 million was received from overseas.

More detailed statistics in respect of these data are shown in *Research and Experimental Development, Business Enterprises Australia, 1978-79* (8104.0), a summary of which is given in Year Book No. 66 page 683.

The adoption by industry of new technology also attracts financial support from the Commonwealth through the *Industrial Design Council of Australia* and the *Standards Association of Australia* which receive subsidies from the Commonwealth Government.

The Australian Patent Information Service (APIS)

APIS exists to encourage and assist industry to extract technological information from the major industrialised nations' patent specifications. APIS Information Officers based in Canberra, Melbourne and Sydney can assist industry by conducting technology searches, providing information on the activities in specialist fields, providing general overviews of particular technology areas, etc.

Recent initiatives have included enhancement of public-search files in Patent Sub-Offices, in particular US and UK patent files and Australian design files; and a solar-energy evaluation of patent literature conducted by the Technological Evaluation Unit.

APIS provides its information on a fee for service basis and quotations will be provided prior to the commencement of a technology search or competitor watch service.

Research in universities and colleges

Expenditure on research and experimental development carried out by Universities and Colleges of Advanced Education in 1978 was estimated to be \$326 million at current prices. This represents a 33 per cent increase in expenditure compared with 1976. For further information see Project SCORE paragraphs in this chapter.

General financial support for higher education is provided primarily by the Commonwealth Government through the Councils of the Commonwealth Tertiary Education Commission (the Universities Council; and Technical and Further Education Council; and the Advanced Education Council).

In addition, the Government funds research undertaken in the universities and elsewhere through a number of granting schemes. In some cases, Commonwealth Government funds are supplemented by State governments or by levies imposed on or by specific industries (e.g. the wool, wheat and beef industries) for that purpose.

The two principal granting schemes through which supplementary funds are made available for research in universities are the Australian Research Grants Scheme (ARGS), administered by the Queen Elizabeth II Fellowships and the Australian Research Grants Committee, and the scheme administered by the National Health and Medical Research Council (NHMRC). For both schemes the principal criterion for awards is the scientific excellence of the research project. Applications are judged by expert advisory committees composed of practising scientists, and recommendations are made to the Minister for Science and Technology and the Minister for Health for the ARGS and NHMRC awards respectively.

The Commonwealth Department of Health administers the Health Service Research and Development Grant program which provides grants to researchers in educational and health institutions and to independent researchers. The Department receives advice from the Health Services Research and Development Grants Advisory Committee.

Fellowships such as the Queen Elizabeth II Fellowships and the like, while providing some additional funds, are significant more for the prestige they carry than for their contribution to overall funding levels. They are, however, more readily available to the young scientists than are the ARGS awards.

Colleges of Advanced Education do not maintain expensive research facilities or programs akin to those of the universities; nevertheless, staff are encouraged to undertake research to the extent that this is possible. Research of an applied nature, and associated consultancy services to industry and commerce, are expected to become increasingly prominent within the colleges.

Research organisations associated with education institutions

Several of the tertiary education institutions have established independent, commercial companies to promote and manage research and consultancy services to industry, commerce, government and the community. Examples are: Unisearch Ltd, associated with the University of New South Wales; Wait-Aid Ltd, associated with the Western Australian Institute of Technology; Technisearch Ltd, associated with the Royal Melbourne Institute of Technology; SARD, associated with the Swinburne College of Technology; Techsearch Inc., associated with the South Australian Institute of Technology; and the University of Newcastle Research Association.

These organisations play an important role in promoting communication between the Higher Education and other sectors. They undertake investigational and research projects, mainly in the fields of engineering and science. However, activities in other fields such as management, marketing and the social sciences are increasing. Testing work, performed generally by full-time employees, is undertaken in some instances. Results of work are confidential to the client and are not published unless authorised by that client.

Social science and humanities research

Research in the social sciences and humanities is undertaken primarily in universities (\$89 million out of \$106 million for 1978-79). Support for this research comes both from general funds, provided to the universities and from specific granting schemes such as ARGS.

The bulk of social science and humanities research carried out within Commonwealth Government agencies is performed as part of the general activities of various departments. In addition several other Commonwealth Government agencies have an active interest in either sponsoring or undertaking such research. These include the Australian Institute of Aboriginal Studies, the Australian Institute of Criminology, the Bureau of Industry Economics, the Bureau of Agricultural Economics, the Bureau of Transport Economics and the Bureau of Labor Market Research.

Agencies of the various State governments undertake research relevant to their own activities. A number of research organisations in the transport spheres are funded from both Commonwealth and State sources. The Australian Railway Research Board and the Australian Railway Research and Development Organisation are active in social science research.

Exchange of ideas and information on the social sciences is promoted through a number of professional and learned bodies, of which the Australian and New Zealand Association for the Advancement of Science and the Academy of the Social Sciences in Australia are the most broadly based. In addition to encouraging the advancement of the social sciences, the Academy sponsors and organises research, subsidises publications and acts as a consultant and advisor on the social sciences.

Non-government bodies which undertake or promote research in specific fields of the social sciences include the Australian Institute of International Affairs, the Australian Institute of Urban Studies, and the Australian Institute of Political Science.

International activities

International Organisations

Australia participates in a range of programs and projects of United Nations and other organisations (UNEP, UNESCO, WMO, OECD and (IAEA)) and in the activities of both governmental and non-governmental scientific organisations. To facilitate scientific liaison and representation, the Commonwealth Government has scientific representation at overseas posts (Tokyo, Vienna (IAEA), Paris (OECD)). Australia also participates in regional collaborative programs organised by ESCAP, the Association for Science Co-operation in Asia, the Commonwealth Science Council and the Pacific Science Association. Technical assistance is also provided for countries in the region under both multilateral and bilateral arrangements.

Participation in international non-governmental scientific bodies is arranged through learned and professional bodies. For example, the Australian Academy of Science provides representation to the International Council of Scientific Unions (ICSU) and a number of its affiliated bodies.

Antarctic Treaty

In 1957, as part of the International Geophysical Year (IGY), twelve nations co-operated in research programs covering a broad range of scientific pursuits. The outstanding co-operation between nations in the Antarctic during the IGY gave rise to discussions which resulted in the Antarctic Treaty. On 1 December 1959 the Antarctic Treaty was signed by the nations that had been active in Antarctica during the IGY, including all of those with territorial claims. The original signatories were Argentina, Australia, Belgium, U.K., Chile, France, Japan, New Zealand, Norway, South Africa, the U.S.S.R., and U.S.A. The Treaty entered into force for Australia on 23 June 1961. The Treaty, *inter alia*, reserves the Antarctic area south of 60°S latitude for peaceful purposes, provides for international co-operation in scientific investigations and research, and preserves for the duration of the Treaty the *status quo* with regard to territorial sovereignty, rights and claims.

The Treaty makes provision for other states to accede to it. Since 1959, twelve nations have acceded: Brazil, Poland, German Democratic Republic, Czechoslovakia, Romania, Denmark, the Netherlands, the Federal Republic of Germany, Papua New Guinea, Peru, Italy and Uruguay. The Treaty also makes provision in Article IX (2) for acceding nations to become Consultative Parties " . . . during such times as the Contracting Party demonstrates its interest in Antarctica by conducting substantial research activity there, such as the establishment of a scientific station, or the despatch of a scientific expedition". In July 1977, Poland was acknowledged by the Consultative Parties to have fulfilled the requirements established in Article IX (2) of the Antarctic Treaty and, as a consequence, to have the right to appoint representatives to participate in the Consultative Meetings. Poland subsequently attended the Ninth Antarctic Treaty Consultative Meeting. Similarly, the Federal Republic of Germany was accepted as a Consultative Party at the preparatory meeting to the Eleventh Antarctic Treaty Consultative Meeting and attended the Eleventh Treaty Meeting held in Buenos Aires in June/July 1981.

Conservation of Antarctic Marine Living Resources

At a diplomatic conference in Canberra in May 1980, Treaty Partners adopted the Convention for the Conservation of Antarctic Marine Living Resources. This Convention establishes the basis of a conservation regime for the entire ecosystem of the Southern Ocean. Australia is the depository Government for the Convention. The headquarters of the International Commission, formed under the Convention, have been established in Hobart. It is the first international body to be based in Australia. Australians have been elected as the first Chairman and the first Secretary of the Commission.

Studentships and Fellowships

Australia has assisted other countries, principally in the Asian and Pacific regions, by training their nationals. Large numbers of such students, mainly seeking first qualifications at tertiary level, have been accommodated under schemes such as the Colombo Plan. There are also arrangements under which established scientists from overseas are assisted to undertake study and research in Australia.

Bilateral arrangements

Various bilateral arrangements at both government and non-government levels have contributed to the development and maintenance of co-operation in science and technology between Australian institutions and scientists and those in other countries. Formal bilateral agreements, administered by the Department of Science and Technology, solely devoted to scientific and technological co-operation have been entered into with the USA (1968), India (1975), the USSR (1975; since suspended), the Federal Republic of Germany (1976), Japan (1980), the Peoples Republic of China (1980) and

Mexico (1981). Support is provided for both individual visits and specialist seminars over the whole range of civil science. Where opportunities exist, other co-operative projects which depend on special facilities are supported.

A scientific exchange program between the Australian Academy of Science and the Academia Sinica of Peking was initiated in 1976-77. Scientific fields considered most promising are plant physiology, entomology and earth science.

Visits to Japan and China by Australian scientists can alternatively be supported by the Australia/Japan Foundation and the Australia/China Council.

Meteorology

Australia is a Member of the World Meteorological Organisation (WMO), with the Director of Meteorology being Australia's Permanent Representative on WMO.

Astronomy

In the field of optical astronomy, the Anglo-Australian Telescope Board, established under the provisions of an international agreement between Australia and the United Kingdom and drawing its funds in equal shares from each country, operates the 3.9 metre Anglo-Australian Telescope at Siding Spring Mountain near Coonabarabran in New South Wales. The Telescope, among the largest in the world, came into full scientific operation during 1975. Its technical excellence and the scientific work which it has made possible have brought it to be widely recognised as one of the world's foremost optical telescopes.

Space

An agreement was signed in 1960 and has been renewed at ten-year intervals by the Governments of Australia and the United States of America to co-operate in the establishment and operation in Australia of space vehicle tracking stations. The agencies for the Australian and American Governments are the Department of Science and Technology and the National Aeronautics and Space Administration (NASA) respectively.

As part of the world-wide network supporting NASA's space program, the stations track spacecraft in their orbits around the earth or on their journeys into space, receive telemetered data from the spacecraft, and relay radio commands controlling the spacecraft.

The Department of Science and Technology is responsible for managing, staffing and operating the tracking stations on behalf of NASA. The stations are located at Orroral Valley and Tidbinbilla in the Australian Capital Territory. A communications system links them with control centres in the United States of America.

Expenditure by NASA on its tracking station operations in Australia in 1981-82 was approximately \$12.5 million.

An agreement has been signed between the Commonwealth Government and the European Space Agency (ESA) for the establishment and operation of a space vehicle tracking facility in Australia in support of ESA programs. The facility is located at the site of the Overseas Telecommunications Commission (Aust) earth station at Carnarvon, W.A. Arrangements are being made with ESA for CSIRO's Parkes radio telescope to be used to support ESA's Giotto spacecraft which will try to intercept Halley's Comet in March 1986.

Scientific Ballooning

A service to scientists conducting experiments based on balloon-borne platforms was previously provided under a joint venture between the Department of Science and Technology and the US National Science Foundation. Arrangements have now been made for the continuation of the service through the University of Melbourne.

Seismology

A comprehensive seismic station at Alice Springs (Joint Geological and Geophysical Research Station) is operated jointly under an agreement between the Governments of Australia and the United States of America. The agencies for the Governments are, respectively, the Department of Science and Technology and the United States Air Force.

The station provides continuous seismic records to assist the United States Government in the identification of underground nuclear explosions and, through the Department of Science and Technology provides seismic records to the Bureau of Mineral Resources, Geology and Geophysics. Records are also available, through the Department of Science and Technology, to Australian scientists for research in earth physics.

Defence

In the field of defence science, Australia collaborates with other countries through a variety of arrangements at intergovernmental level. Further information including defence science technology multilateral and bilateral arrangements is given in Chapter 4, Defence.

Transport

Australia is represented at Federal and State levels on a number of transport research-orientated international organisations through a variety of arrangements at intergovernmental level. Further information is given in Chapter 20, Transport and Communication.

Other

At the non-governmental level, formal arrangements for scientific co-operation with counterpart institutions in other countries have been concluded by a number of Australian bodies. For example, an arrangement covering co-operation in astronomy exists between the University of Sydney and Cornell University (USA), while over a broader area the Australian National University has an arrangement with the University of Moscow which includes exchanges in the scientific fields.

Additional information

Additional information on topics presented in this chapter may be found in the annual reports of the organisations mentioned, particularly the Department of Science and Technology, the CSIRO and its divisions, the Australian Atomic Energy Commission and the Department of Defence Support. Statistical information for the years 1968-69, 1973-74 and 1976-77 may be found in the reports published by the Department of Science and Technology on Project SCORE. Statistical information relating to 1978-79 may be obtained from the Australian Bureau of Statistics (ABS). See Project SCORE paragraphs in this chapter for details of ABS publications.

Recent information on manufacturing industry research and development is contained in ASTEC's report on *Industrial Research and Development: Proposals for Additional Incentives*, June 1980 and the report of the Industries Assistance Commission, *Inquiry into Certain Budgetary Assistance to Industry*, March 1982. In addition information is contained in the annual reports of the Australian Industrial Research and Development Incentives Board. For reports published prior to 1980 see previous editions of the Year Book.

