

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 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 1976–77, the most recent year for which complete data are available, total expenditure on research and development (R & D) in both the natural and social sciences was estimated at \$802 million, approximately equivalent to 1.0 per cent of the Gross Domestic Product in that year.

In 1976–77, governments in Australia provided approximately 80 per cent of the funds devoted to R & D and undertook in their own agencies approximately 56 per cent (in terms of expenditure) of the overall national R & D effort.

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 (ASTEC), 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, National Energy Research, Development and Demonstration Council (NERDDC) which advises the Minister for National Development and Energy on the development and co-ordination of energy research in Australia and the disbursement of funds under the National Energy Research Development and Demonstration Program (NERD&D Program); and the Australian Manufacturing Council (AMC), which is served by some thirteen advisory councils and advises the Minister for Industry and Commerce on matters of industry policy, and the Commonwealth Council for Rural Research and Extension (CCRRE), which advises the Minister for Primary Industry across the whole spectrum of rural research and extension.

Australian Science and Technology Council (ASTEC)

Prior to the establishment of ASTEC, there had been an intensive period of discussion and review concerning arrangements for the provision to the Government of adequate advice on policies for science and technology in Australia. An outline of the discussions can be found in Chapter 28 of Year Book No. 61.

ASTEC was established as a permanent body by executive action in April 1977. At that time the Prime Minister announced in Parliament that ASTEC would become a statutory body. The ASTEC legislation passed through Parliament in the Autumn session of 1978. ASTEC was established as a statutory authority in February 1979.

ASTEC's legislation states:

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 matters:

- 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.

These functions allow ASTEC a wide purview, ranging from pure science, to the problems of improving efficiency in industry by applying the results of research and development. It considers activities and technological problems of higher education institutions and private enterprise.

To discharge its functions, the Council is provided with appropriate powers. 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 Minister to whom ASTEC reports (presently the Prime Minister).

The Council's reports to the Government are made public unless there are overwhelming reasons in the national interest for not doing so. ASTEC's Act contains detailed provisions requiring the prompt tabling in Parliament of ASTEC reports except in closely defined circumstances.

ASTEC's first major exercise since its formation has been a comprehensive review of the state of Australian science and technology, embracing description of various areas of national importance, and recommendation thereon. The first part of this report, entitled *Science and Technology in Australia 1977-78*, was made public in mid-1978, and it was published in its completed form in March 1979.

ASTEC has also provided reports to Government on the organisation of the Bureau of Mineral Resources, Geology and Geophysics, in November 1978; on arrangements for the direct funding of basic research in Australia, in March 1979; on the next generation of Australian telescopes, in May 1979; and on immediate issues in Australian marine science, in July 1979. The Council's most recent reports concern priorities for additional research and development in the marine sciences and technologies in 1980-81, and, in response to referrals from the Government, proposals for additional incentives for industrial research and development.

Following a recommendation in the abovementioned review of Australian science and technology, the Australian Marine Sciences and Technologies Advisory Committee (AMSTAC) was established in February 1979 as a standing committee of ASTEC. Its functions include assessment of present activities in marine sciences and technologies, and advising on priorities and mechanisms for achieving a balanced national program in this area.

ASTEC is also proceeding with studies which will assist in the development of its strategic role involving the matching of Australia's science and technology effort to its resources, problems and goals. These studies include development of means to measure science and technology effort, examination of the mechanisms used in other countries for establishing priorities in science and technology, and of the scientific and technological implications of Government policies.

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, Housing 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 Biological Resources Study, 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

In December 1978, the Government appointed a Committee of Inquiry into Technological Change in Australia under the chairmanship of Professor Rupert Myers. The Committee was asked to examine, report and make recommendations on the process of technological change in Australian industry in order to maximise economic, social and other benefits and to minimise any adverse consequences. The Government's response to the Committee's recommendations was tabled in Parliament on 18 September 1980.

The Report identifies technological change as one of the main sources of economic growth. The Committee concluded that Australia will be best served if industry remains abreast of world technological developments and makes the fullest possible use of Australian expertise in developing new products and processes.

The Committee commissioned the ABS to undertake a survey to obtain information on the nature and extent of technological change currently occurring in Australia; results of this survey are shown on pages 666 and 667.

Energy Research and Development

The Department of National Development and Energy through the National Energy Office provides policy and technical advice on energy research, development and demonstration (R, D & D) and administers the National Energy Research, Development and Demonstration Program (NERD & D Program).

The National Energy Research, Development and Demonstration Council (NERDDC) was established in May 1978. It advises the Minister for National Development and Energy on the development and co-ordination of a national program of energy research and the disbursement of funds under the NERD & D Program. Council consists of thirteen members drawn from government, private industry and tertiary institutions who are appointed by the Minister on the basis of established expertise in the energy field. It is supported by eight Technical Standing Committees, covering all major areas of energy technology, which provide expert technical advice. The NERD & D Program is funded from the accrued funds paid to the Coal Research Trust Account under the provision of the *Coal Research Assistance Act 1977* and from a Departmental Appropriation for energy research.

This was the second full year of operation of NERDDC. During this year, a further \$26.5 million was committed to energy research projects over a wide range of energy technologies. This brought the total committed to date under the NERD & D Program to around \$42 million. An additional Technical Standing Committee (TSC) was formed to cover Economic, Social and Environmental issues, bringing the total number of TSC's to eight. NERDDC and its TSC's also assist the Department in monitoring scientific and technical progress and performance of projects being supported.

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 sectional 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, 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 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 will advise on priorities for scientific and technological research in areas such as mineral and living resources, and on the potential environment effects of exploitation.

It will advise 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 also undertake reviews of existing programs and provide advice on new programs, taking into account current government policy in these areas.

The Committee is chaired by Professor D. E. Caro, Vice-Chancellor of the University of Tasmania.

In August 1979, the Prime Minister announced the creation of the *Marine Research Allocations Panel* to advise the Minister for Science and Technology on the allocations of funds provided for grants in marine science and technology. An amount of \$400,000 was provided for 1979–80 and the two succeeding financial years, with \$300,000 to be devoted to the Great Barrier Reef region.

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 Housing and Construction, and the Physical Working Environment Branch of the Department of Science and Technology.

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 was formally established in August 1978 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 technical referral centres is planned. For the first three years, the project will operate on a pilot scale in the metals manufacturing industry. There will be two specialist centres in the first stage of the project: the Centre of Machining Technology hosted by Swinburne College of Technology, and the Centre of Casting Technology hosted by the Division of Material Science, CSIRO, Melbourne. Four generalist centres are also planned for immediate establishment.

The Information Technology Council was established in March 1978 on the initiative of the Department of Science and Technology. It is concerned with establishing facilities for the guidance, instruction, demonstration and support to business management on the use of information technology. It also seeks to promote the importance of information technologies to business and to sponsor specific projects in the field.

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 \$450,000 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.

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 the main results were being compiled at the time of writing; however, preliminary results for the Business Enterprise sector were published by the ABS in March 1980 *Research and Experimental Development—Business Enterprises Australia—1978-79 (Preliminary)* (8105.0) and a summary of these results is given below.

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. The 1973-74, 1976-77 and 1978-79 surveys also covered R & D in the humanities, which was excluded in 1968-69.

Business enterprise sector. The preliminary estimate of expenditure on R & D carried out in Australia by business enterprises during 1978-79 was \$244 million at current prices. This represents a 20 per cent increase in expenditure compared with 1976-77. At constant (average 1974-75) prices R & D expenditure was estimated to have increased by one per cent over the same period. The corresponding estimate of manpower on R & D during 1978-79 was 8,696 man years and this represents a 7 per cent decrease in man years compared with 1976-77. Additional information is summarised in the following table:

**RESEARCH AND EXPERIMENTAL DEVELOPMENT CARRIED OUT BY BUSINESS ENTERPRISES
BROAD INDICATORS BY INDUSTRY OF ENTERPRISE**

<i>Institutional sector and industry of enterprise</i>		<i>Enterprises that carried out R & D (number)</i>		<i>R & D expenditure (at current prices) (\$m)</i>		<i>Man years of effort on R & D</i>	
<i>ASIC code (1969 edition)</i>	<i>Description</i>	<i>1976-77</i>	<i>1978-79</i>	<i>1976-77</i>	<i>1978-79</i>	<i>1976-77</i>	<i>1978-79</i>
PRIVATE ENTERPRISE							
	MINING						
11	Metallic minerals	14	11	3.6	3.3	143.1	87.5
12-15	Non-metallic minerals	8	8	0.5	1.8	14.8	34.6
11-15	Total mining (excluding services to mining)	22	19	4.1	5.1	157.9	122.1
	MANUFACTURING						
21-22	Food, beverages and tobacco products	69	77	11.6	15.5	550.9	528.0
23-24	Textiles, clothing and footwear	27	20	2.1	1.1	106.4	35.9
25	Wood, wood products and furniture	22	27	0.9	1.8	49.6	60.8
26	Paper, paper products, printing and publishing	16	13	3.3	4.1	149.2	144.8
2723	Pharmaceuticals and veterinary products	20	25	4.5	7.1	172.7	236.8
(a)	Chemicals, petroleum and coal products	93	96	19.7	26.8	1,047.0	1,133.3
28	Non-metallic mineral products	32	28	3.8	4.3	169.1	162.3
29	Basic metal products	36	35	19.0	21.3	902.9	784.6
31	Fabricated metal products	74	81	4.0	5.0	228.1	222.6
32	Transport equipment	44	46	14.6	15.4	760.9	667.9
331	Photographic, professional and scientific equipment	20	17	4.6	6.9	231.5	226.7
332	Household appliances and electrical equipment	129	123	21.1	31.2	1,209.2	1,170.8
333	Industrial machinery and equipment	141	116	8.2	9.5	425.4	416.6
33	Total other machinery and equipment	290	255	33.9	47.5	1,866.1	1,814.1
34	Leather, rubber and plastic products and manufacturing n.e.c.	57	52	3.5	5.1	184.7	177.5
C	Total manufacturing	780	756	121.0	155.0	6,187.6	5,968.6
	OTHER INDUSTRIES						
E	Construction	22	24	0.9	1.6	51.6	61.4
F	Wholesale and retail trade	88	102	9.2	11.4	375.7	385.2
63	Real estate and business services	179	170	12.8	16.5	777.2	632.2
8411	Research and scientific institutions	29	22	10.9	11.3	470.6	392.1
(b)	Other n.e.c.	19	30	1.5	3.5	78.9	89.5
16,D-I,K-L	Total other industries	337	348	35.3	44.4	1,754.0	1,560.4
	Total all industries (c)	1,139	1,123	160.4	204.5	8,099.5	7,651.1
PUBLIC SECTOR BUSINESS ENTERPRISES							
	Total all industries (c)	30	37	42.4	39.1	1,243.2	1,044.6
TOTAL BUSINESS ENTERPRISES							
	Total all industries (c)	1,169	1,160	202.8	243.6	9,342.7	8,695.7

(a) ASIC Subdivision 27 excluding ASIC class 2723. (b) ASIC codes 16, D, G-H, 61-62, K-L excluding ASIC class 8411. (c) Excludes enterprises in ASIC Division A.

Statistics of Technological Change

The Committee of Inquiry into Technological Change commissioned the ABS to undertake a survey of non-farm enterprises to obtain information on the nature and extent of technological change and its effects on personnel practices in Australia for the three years to 30 June 1979. Results of the survey are shown in the following tables.

The Survey (based on a stratified random sample of 1,200 private enterprises selected from the ABS Central Register of Economic Units) was seen as complementary to detailed case studies of individual enterprises being undertaken by other bodies on behalf of the Committee; it was intended to provide a broad background against which particular cases could be seen in perspective.

Although the results of the survey provide some perspective on where and to what extent technological changes have been occurring, it is important not to read too much into the limited information that has been collected. For example, although the survey produced an estimate of the number of enterprises retrenching or recruiting employees because of technological change, it does not provide a measure of the numbers actually retrenched or recruited; it is the incidence rather than the degree of technological change and employment effect which are represented.

From the survey, it was estimated that 19 per cent of private non-farm enterprises introduced technological change in the three years to 30 June 1979. Twenty-nine per cent of manufacturing enterprises introduced technological change. Of those enterprises with employment of more than 80 persons, 76 per cent introduced technological change in the three years to 30 June 1979.

The most common form of change was in the area of equipment (other than EDP) and/or production processes (cited by 14 per cent of enterprises on the Register). However, for those enterprises with employment of more than 80 persons, the most common change was in the area of EDP equipment (60 per cent).

Most enterprises (76 per cent) introducing technological change considered that it had had no effect on the number of persons they employed as at 30 June 1979. As a result of technological change 7 per cent of those enterprises introducing technological change retrenched employees surplus to requirements. For enterprises with employment of more than 80 persons introducing technological change, 16 per cent retrenched employees as a result of such change. Ten per cent of enterprises introducing technological change recruited to fill new positions created as a direct result of such change. Thirty-three per cent of enterprises with employment of more than 80 persons recruited as a direct result of introducing technological change.

PRIVATE NON-FARM ENTERPRISES (a) INTRODUCING TECHNOLOGICAL CHANGE IN THE THREE YEARS ENDING 30 JUNE 1979 BY NATURE OF CHANGE, INDUSTRY AND SIZE OF ENTERPRISE

Nature of change introduced	Enterprises with employment of				All enterprises(a)				
	80 persons or less		more than 80 persons		Manufacturing		Non-manufacturing		Total
	No.	% (b)	No.	% (b)	No.	% (b)	No.	% (b)	No. % (b)
EDP equipment (c)	17,036	5	2,700	60	2,730	7	17,007	5	19,737 5
Equipment (other than EDP) and/or production processes	51,874	14	2,010	45	8,837	23	45,048	13	53,885 14
Raw materials	3,930	1	642	14	2,410	6	2,161	1	4,572 1
Materials handling, storage, distribution or transportation	26,331	7	1,130	25	3,991	11	23,471	7	27,462 7
Any of the above changes (d)	68,418	19	3,418	76	11,064	29	60,772	18	71,836 19

(a) Excludes public enterprises and those enterprises classified to Agriculture, Forestry, Fishing and Hunting. (b) Percentages are the proportion of all enterprises regardless of whether introducing technological change or not. (c) Includes the use of service bureau computers or commercial data processing services. (d) Does not equal the sum of the components as enterprises may have introduced more than one change.

**EFFECT (a) ON EMPLOYMENT OF PRIVATE NON-FARM ENTERPRISES (b) INTRODUCING
TECHNOLOGICAL CHANGE IN THE THREE YEARS ENDING 30 JUNE 1979 BY INDUSTRY AND
SIZE OF ENTERPRISE**

	Enterprises with employment of				All enterprises (b)					
	80 persons or less		more than 80 persons		Manufacturing		Non- manufacturing		Total	
Considered that number of employees would otherwise have been:	No.	% (c)	No.	% (c)	No.	% (c)	No.	% (c)	No.	% (c)
Higher	6,678	10	951	28	1,337	12	6,292	10	7,629	11
Much the same	52,491	77	1,803	53	6,767	61	47,527	78	54,294	76
Lower	4,124	6	346	10	1,497	14	2,973	5	4,470	6
Unable to make reliable judgment	5,125	7	318	9	1,462	13	3,981	7	5,443	8
Total	68,418	100	3,418	100	11,064	100	60,772	100	71,836	100

(a) Enterprises introducing technological change were asked to consider whether, if they had *not* introduced technological change, their employment at 30 June 1979 would have been higher/much the same/lower compared to their actual employment. (b) Excludes public enterprises and those enterprises classified to Agriculture, Forestry, Fishing and Hunting. (c) Percentages are the proportion of those enterprises actually introducing technological change.

**SELECTED PERSONNEL PRACTICES IMPLEMENTED BY PRIVATE NON-FARM ENTERPRISES (a)
INTRODUCING TECHNOLOGICAL CHANGE IN THE THREE YEARS ENDING 30 JUNE 1979 BY
INDUSTRY AND SIZE OF ENTERPRISE**

Personnel practices implemented with technological change	Enterprises with employment of				All enterprises (a)					
	80 persons or less		more than 80 persons		Manufacturing		Non- manufacturing		Total	
	No.	% (b)	No.	% (b)	No.	% (b)	No.	% (b)	No.	% (b)
Recruitment to fill new positions created as a direct result of technological change	6,143	9	1,132	33	1,951	18	5,324	9	7,275	10
Transfer of employees to jobs of equal or higher salary	5,398	8	1,496	44	2,278	21	4,617	8	6,895	10
Transfer of employees to jobs of lower salary	n.p.	n.p.	n.p.	n.p.	138	1	39	—	177	—
Reliance on natural wastage and normal turnover to reduce or avert the retrenchment of employees	9,868	14	1,598	47	1,952	18	9,514	16	11,466	16
Retrenchment of employees who were surplus to requirements	4,682	7	532	16	474	4	4,740	8	5,214	7
Consultation with employees affected and/or representatives prior to introducing change (c)	2,623	4	1,228	36	1,826	17	2,025	3	3,851	5

(a) Excludes public enterprises and those enterprises classified to Agriculture, Forestry, Fishing and Hunting. (b) Percentages are the proportion of those enterprises actually introducing technological change. (c) Many enterprises (55% of those introducing technological change) considered this practice to be not applicable.

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 (Chapter 14), fisheries (Chapter 14), water (Chapter 15), the mineral industry (Chapter 16), transport (Chapter 20), and communications (Chapter 20).

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.

Fauna and flora resources

During the last century, as each State became established, museums and botanical gardens containing herbaria were set up. Studies of fauna and flora were carried out by these bodies and by the universities. Various divisions of CSIRO have also carried out work on fauna and flora, but an important part of total Australian research into inventorying biological resources continues to be undertaken in the museums and herbaria of the State governments.

In 1973, the Commonwealth Government set up the Australian Biological Resources Study (ABRS) under an Interim Council. Funds were made available through it to stimulate taxonomic and ecological studies of Australian fauna and flora. In 1978, following recommendations by the Interim Council and by the Australian Science and Technology Council, ABRS was established as a continuing program within the Department of Science and Technology.

Funds are made available through ABRS on the recommendation of an Advisory Committee to the Minister for Science and Technology for work designed to fill the gaps in the scientific knowledge of the Australian fauna and flora. The role of ABRS is to co-ordinate all work aimed at collecting, describing, classifying and determining the distribution of Australian animals and plants. Its responsibilities include the maintenance of a comprehensive network of national taxonomic collections and a national taxonomic data bank. Its current major projects are the writing of a concise flora of Australia, the compilation of an Australian Faunal List and the establishment of an Australian Biotaxonomic Information System.

Fauna and flora conservation

Responsibility for the conservation and management of fauna and flora resources rests, in the main, with the State Governments. However, the Commonwealth has responsibility for such resources in its own Territories.

In 1975, the Commonwealth Government established the Australian National Parks and Wildlife Service, whose functions include care and management of national parks and wildlife in Australia and its Territories, conduct of ecological studies to determine additional areas which should be reserved as national parks and nature reserves, and survey and assessment of wildlife populations with particular reference to endangered species.

In June 1980, the Whale Protection Bill received Royal Assent. The Act will be proclaimed when appropriate arrangements have been concluded with the State and Northern Territory Governments. The legislation prohibits killing, capturing, injuring or interference with a whale, dolphin or porpoise in the Australian fishing zone and by Australians domiciled in Australia and Australian vessels and aircraft and their crews beyond the 200 mile Australian fishing zone, with penalties up to \$100,000.

Environmental protection

Responsibility for most pollution control aspects of environmental protection rests with the State Governments, which have all enacted legislation to control the operations of government and private enterprises that may have a deleterious effect on the physical environment.

The Commonwealth Government is responsible for pollution control in its own Territories and in respect of the operation of its own agencies within the States. It is also concerned with the enforcement of provisions of relevant international conventions to which Australia is a signatory.

Both the Commonwealth and State Governments also have legislation or procedures for assessing the environmental impact of proposed actions that may have a significant effect on the environment. These procedures generally provide for the preparation of environmental impact statements—sometimes allowing for public review—as a prerequisite to approval of new development projects or other activities with significant environmental consequences.

The various governments collaborate in environmental and conservation matters through three Ministerial Councils: the Australian Environment Council, which provides a framework for consultation on environmental matters; the Council of Nature Conservation Ministers, which is concerned with preservation of wildlife and the establishment and management of national parks; and the Australian Water Resources Council which is concerned with the assessment, development and use of national water resources.

Special arrangements have been made for minimising the environmental impact of uranium developments in the Northern Territory. An Office of the Supervising Scientist has been established under Commonwealth legislation. The Supervising Scientist has overall responsibility for the co-ordination and supervision of measures for the protection and restoration of the environment in the Alligator Rivers Region from the effects of uranium mining. The Supervising Scientist also manages the Alligator Rivers Region Research Institute.

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 1979-80 was approximately \$40.4 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 transmissions that are influenced by or dependent on the ionosphere. The staff of the Branch make regular measurements of the ionosphere above Australia and its territories, and of the sun, and issue both short and long term predictions of the state of the ionosphere as it applies to radio communication.

Research into physical phenomena affecting the condition of the ionosphere 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 Australian National Scientific and Technological Library, the CSIRO Central Library, 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 data bases. 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.

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 is in the process of developing other similar data bases in a crystallography and mass data spectra. 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. Four recent initiatives are:

- a Directory of Technical Information Sources for Industry which has been produced by the National Library of Australia; and
- a directory of Australian research projects undertaken in the natural sciences and selected social sciences in the Higher education sector. The directory, in microfiche form, was produced by the Department of Science and Technology (in conjunction with its work on Project SCORE) and the CSIRO;
- a machine based register of Australian energy R, D & D projects providing a technical description of each project is being developed by the Department of National Development and Energy as part of a National Energy Information System (NEIS);

- a Commonwealth Regional Renewable Energy Resources Information System (CRRERIS) is being developed by the Department of National Development and Energy as an outcome of the Commonwealth Heads of Government Regional Meeting (CHOGRM) of February 1979.

Units and Standards of Physical Measurement

The National Standards Commission, originally established in 1948 and given further responsibilities under the *Weights and Measures (National Standards) Act* 1960, advises on matters relating to weights and measures such as the establishment and use of uniform units and standards of measurement of physical quantities. The Commission is also responsible for the examination, approval and certification of the design and performance of patterns of measuring instruments used for trade, Australian participation in the preparation of international standards applicable to legal metrology and their subsequent adoption, and liaison with State government on the regulation of weighing and measuring practice in trade.

Major government research agencies

Commonwealth Scientific and Industrial Research Organization (CSIRO)

The CSIRO is the largest scientific research organization in Australia. It has a total staff of some 7,000 people located in more than 100 laboratories and field stations throughout Australia. About one-third of the staff are scientists.

The CSIRO is a statutory body established by the *Science and Industry Research Act* 1949. Under the Act CSIRO replaced, but had continuity with, the former Council for Scientific and Industrial Research (CSIR) which was established in 1926. The *Science and Industry Research Act* 1949 as amended by the *Science and Industry Research Amendment Act* 1978 provides that the functions of CSIRO are:

- to carry out scientific research for any of the following purposes:
 - (i) assisting Australian industry;
 - (ii) furthering the interests of the Australian community;
 - (iii) contributing to the achievement of Australian national objectives or the performance of the national and international responsibilities of the Commonwealth;
 - (iv) any other purpose determined by the Minister;
- to encourage or facilitate the application or utilization of the results of such research;
- to act as a means of liaison between Australia and other countries in matters connected with scientific research;
- to train, and to assist in the training of, research workers in the field of science and to co-operate with tertiary-education institutions in relation to education in that field;
- to establish and award fellowships and studentships for research, and to make grants in aid of research for a purpose referred to in scientific research above;
- to recognise associations of persons engaged in industry for the purpose of carrying out industrial scientific research and to co-operate with, and make grants to, such associations;
- to establish, develop and maintain standards of measurement of physical quantities and, in relation to those standards—
 - (i) to promote their use;
 - (ii) to promote, and participate in, the development of calibration with respect to them; and
 - (iii) to take any other action with respect to them that the Executive thinks fit;
- to collect, interpret and disseminate information relating to scientific and technical matters; and
- to publish scientific and technical reports, periodicals and papers.

The Act provides for CSIRO to be governed by an Executive comprising a full-time Chairman, two other full-time Members and between three and five part-time Members. It also provides for a statutory Advisory Council and State Committees as independent sources of advice to the Executive.

The CSIRO's research is carried out in some thirty seven divisions and five 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, Food Research, Human Nutrition; Centre for Animal Research and Development; Molecular and Cellular Biology Unit; Wheat Research Unit.

Institute of Biological Resources Divisions of Entomology, Fisheries & Oceanography, Forest Research, Horticultural Research, Irrigation Research, Plant Industry, Tropical Crops & Pastures, Wildlife Research.

Institute of Earth Resources Divisions of Applied Geomechanics, Land Resources Management, Land Use Research, Mineral Chemistry, Mineral Engineering, Mineralogy, Mineral Physics, Process Technology, Soils; Fuel Geoscience Unit, Physical Technology Unit.

Institute of Industrial Technology Divisions of Applied Organic Chemistry, Building Research, Chemical Technology, Manufacturing Technology, Mechanical Engineering, 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, Radiophysics; Australian Numerical Meteorology Research Centre.

There is also a Bureau of Scientific Services comprising the Central Information, Library and Editorial Section, the Centre for International Research Co-operation and various groups concerned with information and technology transfer.

The CSIRO has an annual budget of more than \$170 million. Some 85 per cent of this money is provided directly by the Commonwealth Government. The remainder 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 approximately two-thirds of these contributory funds. They are derived principally from industry levies supported by Commonwealth Government contributions.

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 fosters increased productivity in industry and commerce by stimulating and encouraging productivity improvement at the national and industry levels. It performs a catalytic and co-ordinating role in bringing together the parties (employers, employees and government) concerned with productivity development. It is responsible for technology development programs directed towards the development and utilisation of new or improved technologies, such as the Assistance to Inventors Scheme, Patent Information Services, and the promotion of industrial research and development. It also promotes technology development by encouraging the use of modern technology by industry and the commercial development of major Australian innovations by Australian industry; it assists the development of process technologies to increase the competitiveness of sectors of Australian industry, and assists the development and exploitation of Australian inventions.

The Division is involved with a number of technology transfer programs designed to assist industry in making the most effective use of existing and developing technology. These programs include quality development, in which the Division works closely with the Standards Association of Australia, the Industrial Design Council of Australia, and the Australian Organisation of Quality Control; information technology and the active participation and support of the Information Technology Council; and a technical referral network being established in conjunction with the Technology Transfer Council.

Other activities of the Division related to technology include specific productivity programs; materials handling (National Materials Handling Bureau); administration of the Australian Government's offset policy designed to stimulate technological advancement and broaden the capabilities of Australian industries; and programs in the physical, social and organisational aspects of the working environment which help to facilitate the introduction of new technology. The Division also supports the Productivity Promotion Council of Australia.

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 is essentially concerned with research and emphasises multidisciplinary projects, many of which are focussed on tropical marine science. Research projects at the AIMS during 1979-80 fell into 3 areas: estuarine and oceanic marine food webs; reef-building organisms and the Great Barrier Reef and marine pollution. These areas were selected both for their current importance to marine science and for their relevance to many applied problems. Specific programs being undertaken by the Institute concern: inshore ecology and productivity; pelagic biology; coral taxonomy; coral calcification; reef origins and maintenance; sedimentology; and physical oceanography.

Defence Science and Technology Organisation

The Defence Science and Technology Organisation, Department of Defence, conducts a significant amount of research and development, mainly in engineering and the physical sciences. Current expenditure is about \$104 million per year.

Further details on the work of the organisation are found in Chapter 4, Defence.

Technology Division, Department of Housing and Construction

To support its operations as the major design and construction authority for the Commonwealth, the Department of Housing 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 Technology 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 research in telecommunications science and technology.

Research by business enterprises

Expenditure on research and experimental development performed by business enterprises in 1978-79 was estimated to be \$244 million at current prices. This represents a 20 per cent increase in expenditure compared with 1976-77. At constant (average 1974-75) prices R & D expenditure is estimated to have increased by one per cent over the same period.

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. In 1980-81 commencement grants will be 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'. \$58.6 million was appropriated in the 1980-81 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.

The Assistance to Inventors' Scheme, which received an allocation of \$76,000 in the 1980-81 Budget, provides financial grants to individual inventors to enable them to develop worthwhile inventions, after patent application, to the prototype or demonstration stage. Grants of up to \$10,000 can be provided for each invention, as well as technical, industrial or commercial advice on how to develop the invention. Government assistance for research and development by private industry is also available through grants from the *National Energy Research Development and Demonstration Council* (NERDDC) (see page 429 of the Energy chapter for additional information on NERDDC) and the *Australian Research Grants Committee*.

Payments Overseas for Technical Know-How

Australian R & D efforts have been significantly supplemented by overseas technology largely associated with the activities of foreign firms. Australian firms in many industries have bought or licensed foreign technology. The ABS has estimated on a preliminary basis that payments remitted overseas by private business enterprises for technological know-how (e.g. patent licences, technical data and information and scientific, technical or engineering assistance) were \$109.5 million in 1978-79 while Australia received \$11.4 million for this category of technology. 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.

Metric Conversion

The conversion to the metric (SI) system of weights and measures is now well advanced in Australia. The conversion program has been developed and implemented under the guidance of a Metric Conversion Board established by the Commonwealth Government. The Board considers that the conversion was effectively achieved by 1980 as originally envisaged, although it has always been recognised that some residual use of imperial units will continue for a time thereafter, e.g. in association with equipment of long life. The implementation of the program has depended in large measure on general community co-operation. The Board sought and gained assistance from advisory groups representative of all sectors of the community.

The Australian Patent Information Service

The Australian Patent Information Service has recently been formed with the major purpose of making Australian industry aware of the wealth of technological information contained in the world collection of patent specifications held by the Patents Office. The Service is available to assist industry to gain access to this information by providing copies of patent specifications (Australian and foreign), covering the relevant area(s) of technology in which an inquirer is interested.

Industry organisations

A number of organisations aiming, wholly or in part, to support and encourage R & D have been established within industry. By far the majority support sectional interests. Examples of such organisations are the Bread Research Institute and the Australian Mineral Industries Research Association.

Research in universities and colleges

General financial support for Higher education is provided primarily by the Commonwealth Government through the Councils of the 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 those administered by the Australian Research Grants Committee (ARGC), and the National Health and Medical Research Council (NHMRC). For both schemes the principal criteria for awards are the scientific excellence of the applicant and 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 ARGC 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 the Second 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 ARGC 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 TUNRA, 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 research

Research in the social sciences is undertaken primarily in universities and agencies of the Australian and State governments. Financial support for research in non-government bodies, especially universities, is provided by government. This support comes both from general funds, provided to the universities and also from specific granting bodies such as the ARGC and the Australian Advisory Committee on Research and Development in Education.

The bulk of social science research carried out within Commonwealth Government agencies is performed as part of the general activities of various departments. However, several agencies have been established specifically to undertake research. Agencies which have been established to undertake research in particular areas include the Australian Institute of Aboriginal Studies, the Australian Institute of Criminology, the Bureau of Agricultural Economics and the Bureau of Transport Economics.

Agencies of the various State governments undertake research relevant to their own activities and programs especially related to health, youth and community services. 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 IEA) 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, London, Washington, Vienna (IEA), Paris (OECD)). Australia also participates in regional collaborative programs organised by ESCAP, the Association for Science Cooperation 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.

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 solely devoted to scientific and technological co-operation have been entered into with the USA (1968), India (1975) and the Federal Republic of Germany (1976) and are administered by the Department of Science and Technology. Similar agreements with the USSR (1975 activities suspended) and the People's Republic of China (1980) are administered by the Department of Foreign Affairs. Support is provided for both individual visits and specialist seminars over the whole range of civil science. Where opportunities exist, other cooperative 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. A similar exchange program between the Australian Academy of Science and the Japan Society for the Promotion of Science was also initiated during 1977.

Visits to Japan and China by Australian scientists can 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 the world's foremost optical telescope.

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 telemetred 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, Honeysuckle Creek 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 1979-80 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.

Scientific Ballooning

The Department of Science and Technology operates a Balloon Launching Station at Mildura, Vic. to provide a service to scientists conducting experiments based on balloon borne platforms. Since 1975 the Station has operated as a joint venture with the US National Science Foundation. The annual agreement between the two agencies was not renewed in 1980 and the Department of Science and Technology will withdraw from the Station during 1981. Alternative means of providing a scientific ballooning service in Australia are currently being investigated.

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 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. 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 on R & D performed by Private enterprises for 1976-77 may be obtained from the Australian Bureau of Statistics publication *Research and Experimental Development—Private Enterprises, 1976-77* (8104.0). The ABS has published, for the 1978-79 biennial surveys of Project SCORE, details on R & D performed in the Business enterprise, General Government, Higher education and Private non-profit sectors.

Also relevant are reports published by the former Office of Secondary Industry of the Department of Trade and Industry (*Survey of Industry Research and Development in Australia* (1968-69) and by the former Department of Manufacturing Industry (Bulletin No. 11, November 1974 *R & D in Manufacturing Industry* 1971-72).

Information on manufacturing industry research and development is contained in Chapter 6, Vol. 1A of ASTEC's report on *Science and Technology in Australia* 1977-78 (June 1978) Chapter 7, Vol. 1 of the Report of the Study Group on Structural Adjustment (March 1979) and the Report of the Senate Standing Committee on Science and the Environment on *Industrial Research and Development in Australia* (May 1979).