

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 1973–74, the most recent year for which data are available, total expenditure on research and development (R and D) in both the natural and social sciences was estimated at \$651 million, approximately equivalent to 1.3 per cent of the Gross Domestic Product (\$50,557 million) in that year. The data are summarised in the table on page 989 of Year Book No. 61.

In 1973–74, governments in Australia provided approximately 60 per cent of the funds devoted to R and D and undertook in their own agencies approximately 42 per cent (in terms of expenditure) of the overall national R and D effort.

Whilst these data serve to illustrate the dominant position occupied by governments in Australian scientific and technological R and 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

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, three national advisory bodies have been established: the Australian Science and Technology Council (ASTEC), which is responsible to the Prime Minister; the National Energy Advisory Committee (NEAC), which advises the Minister for National Development on matters relating to national energy policy; and the Australian Manufacturing Council (AMC), which is served by some eleven advisory councils and advises the Minister for Industry and Commerce on matters of industry policy. In 1978, the Government decided to establish a Commonwealth Council for Rural Research and Extension, which will advise the Minister for Primary Industry.

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 Yearbook 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, and has received Royal Assent. The legislation has not yet been proclaimed (November 1978).

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 the activities and technological problems of higher education institutions and private enterprise.

The Government intends ASTEC to play an important part in ensuring that there is a worthwhile interchange of ideas and information, and level of co-operation, between Government, industry and academic science and scientists.

The Council's advice to the Government on priorities and balance of effort influences the allocation of resources by the Government, and facilitates long-term forward planning by both Government and industry.

To discharge its functions, the Council is provided with appropriate powers. The Council is able to 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.

The Council is able to consult widely, with Commonwealth and State bodies, and with scientific, commercial, industrial and other organisations. Commonwealth bodies provide the Council with such assistance in the performance of its functions as is reasonably practicable. The Council has powers to engage consultants to conduct studies for it, and to arrange with Commonwealth authorities for officers of those authorities to be available to assist the Council. The Council also forms committees of Council members and others, to conduct investigations on behalf of the Council, and to report their findings and recommendations to the Council.

Membership of these committees is not restricted to ASTEC members. Hence the Council is able to draw on such expert advice and assistance as is necessary.

These powers assist the Council to meet its responsibilities adequately, from the conduct of basic investigations and information-gathering to reporting its advice and recommendations to the Government.

ASTEC's major exercise since its formation has been a comprehensive review of the state of Australian science and technology, embracing descriptions of various areas of national importance, and recommendations thereon. The first part of this report was made public in mid-1978.

National Energy Advisory Committee (NEAC)

The National Energy Advisory Committee was established on an interim basis in February 1977 to advise the Government on energy matters and to assist in the development of a national energy policy. At the time, the then Minister for National Resources indicated that the operations and membership of the Committee would be reviewed at the end of 1977.

In February 1978, the Minister for National Development established the permanent Committee. Mr G. J. Lynch was appointed Chairman.

The functions of the Committee include the provision of advice on Australia's energy reserves and on factors likely to influence the pattern of energy supply and demand, and future costs, in Australia; the assessment and development of our energy resources; and economy in the use of energy. The Committee is also required to offer advice on the balance of resources for research relating

to the development of energy sources in Australia, and on developments both here and overseas in respect of methods and technology associated with the production and distribution of energy.

The Committee consists of 21 members who have been selected with a view to covering a wide spectrum of expertise in the energy area, and appointed on the basis of the personal contribution which they can make to the work of the Committee, as distinct from any representational role they might otherwise perform.

Five of the Committee's reports have been published:

- An Australian Conservation of Energy Program (September 1977);
- Australia's Energy Resources: An Assessment (December 1977);
- A Research and Development Program for Energy (December 1977);
- Motor Spirit—Octane Ratings and Lead Additives (February 1978); and
- Electric Vehicles (June 1978).

Department of Science and the Environment

Successive Governments have seen the Department of Science, and now the Department of Science and the Environment, as having a complementary role in relation to an advisory council on science and technology. As a government department it has ready access to information available to government concerning civil science and technology, and is able to provide a scientific and technological perspective at the interdepartmental level. The Department's role 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, and the Antarctic Division) help to ensure that its policy advice is tempered with an awareness of practical problems in science and technology.

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 effected 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 Federal 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; and the Tertiary Education Commission and its Councils.

In May 1978 the Minister for National Development announced the establishment of a further advisory body, the National Energy Research, Development and Demonstration Council (NERDDC). This Council will advise him on the development and co-ordination of a national program of energy research, development and demonstration in Australia. The Council is supported by a secretariat within the National Energy Office of the Department of National Development. The particular areas where NERDDC, under its terms of reference, is required to provide advice to the Minister are:

- co-ordination of the Government's overall effort in energy RD and D;
- the support to be given to individual projects submitted for consideration by the Council;
- the support to be given for international co-operation in energy RD and D; and
- in consultation with NEAC, provide advice on energy RD and D priorities.

Expenditure and manpower

Project SCORE

As mentioned above, comprehensive data on the resources devoted to scientific and technological activities in Australia are not available. Therefore, though some details of Australian expenditure on research and development activities are given below, it should be noted that the data do not include many important scientifically- or technologically-based programs. Programs not covered by Project SCORE (Survey and Comparisons of Research Expenditures), some of which involve large expenditures, are R and D components of the non-scientific or technological services.

The first comprehensive survey of expenditure on R and D was carried out for the 1968-69 financial year. This survey covered R and D expenditure and manpower in the natural and social sciences in all sectors of the Australian economy. In addition to a summary report dealing with the overall national situation, separate Project SCORE reports cover the following sectors: Commonwealth Government, Business 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. 995-1,005.

Two subsequent SCORE surveys cover the financial years 1973-74 and 1976-77, although expenditure in the Higher Education sector is for the calendar years 1974 and 1976. A summary of the results of the second survey is given in Year Book No. 61, pp. 989-998. The data from the third survey had not been collated at time of writing.

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), the rural industry (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 ASTEC, ABRS was established as a continuing program within the Department of Science and the Environment.

Funds are made available through ABRS on the recommendation of an Advisory Committee to the Minister for Science and the Environment 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. A report of the first five years of the Study was published by AGPS in November 1978.

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 a National Parks and Wildlife Commission and 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.

Environmental protection

Responsibility for most aspects of environmental protection rests with the State governments, and all of these have enacted legislation to regulate those operations of governmental and private enterprises that may have a deleterious effect on the physical environment.

The Commonwealth Government has responsibility for environmental protection in its own Territories, in respect of the operations of its own agencies within the States, and in relation to projects or activities carried out by other authorities with the aid of Commonwealth funds. It is also concerned with the enforcement of provisions of relevant international conventions to which Australia is a signatory.

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.

Each government has designated ministers who are concerned with the administration of broad policies for environmental protection. In some cases, governments have implemented policies requiring the provision for public scrutiny of environmental impact statements as a prerequisite to approval of new development projects or activities with significant environmental consequences.

Meteorology

The Bureau of Meteorology, which is a Division of the Department of Science and the Environment, 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 the Environment and CSIRO.

Total expenditure by the Bureau in 1977-78 was approximately \$37.5 million.

Ionospheric Prediction Service

The Ionospheric Prediction Service (IPS) Branch of the Department of Science and the Environment 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.

Scientific and Technological Information Services

Scientific literature for scientists and technologists is provided through national and State libraries, libraries operated by scientific and technological agencies of the Commonwealth and State Governments, tertiary education institutions and industrial organisations. Two important scientific libraries within the Commonwealth Government sector are the CSIRO Central Library and the Australian National Scientific and Technological Library (ANSTEL).

Several Commonwealth Agencies including the Australian Atomic Energy Commission (AAEC), the CSIRO, the Department of Productivity and the National Library of Australia are now offering Australian subscribers access to overseas bibliographic and numerical data bases. The Overseas Telecommunications Commission is developing an international data transmission service to be known as MIDAS (Multi-mode International Data Acquisition Service) which should improve 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. CSIRO is currently operating Thermodata, a metallurgical thermodynamic data base, and is in the process of developing other similar data bases.

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. Two 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 currently being undertaken in the natural sciences and selected social sciences in the Higher Education Sector compiled jointly by the Department of Science and the Environment (in conjunction with its work on Project SCORE) and the CSIRO.

Major government research agencies

The Commonwealth Scientific and Industrial Research Organization (CSIRO)

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.

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 cooperate 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 recognize associations of persons engaged in industry for the purpose of carrying out industrial scientific research and to cooperate 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.

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 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.

Institute of Industrial Technology Divisions of Applied Organic Chemistry, Building Research, Chemical 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 Cooperation and various groups concerned with information and technology transfer.

CSIRO has an annual budget of more than \$150 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)

The AAEC was established by the Australian Parliament under the Atomic Energy Act 1953 as a statutory body whose main functions are to facilitate the development of Australia's uranium resources and the utilisation of various forms of nuclear energy within the Australian economy.

Moving in its earliest days towards the planning and construction of a nuclear research establishment at Lucas Heights near Sydney, the Commission arranged for a nucleus of scientists and engineers to obtain training and experience through overseas attachments, mainly in the United Kingdom. By the late 1950s an R and D program had been initiated at its research establishment.

The AAEC's activities are controlled by a Commission which is responsible to the Minister for National Development. The Atomic Energy Act provides for the Commission to consist of five Commissioners including a Chairman.

The Commission's current program places emphasis on the following areas: nuclear power; safety and the environment; uranium and nuclear fuels; radioisotopes and radiation; and international relations.

Current expenditure by the AAEC is of the order of \$20 million a year. Staff totals some 1,250 professional, technical, trade, administration and support personnel.

The AAEC participates in the activities of the Australian Institute of Nuclear Science and Engineering. The Institute, which has a corporate membership comprising the Commission and the Australian universities, is concerned with the awarding of studentships, fellowships and research grants,

with the organising of conferences and with arranging the use of AAEC facilities by research workers within the universities and colleges of advanced education. The Australian School of Nuclear Technology, located at Lucas Heights, is a joint enterprise of the AAEC and the University of New South Wales. Courses are provided regularly on such subjects as Radionuclides in Medicine, and Radiation Protection and Nuclear Technology. Participants have been drawn from Australia, New Zealand, Asia, Africa, Papua New Guinea and the Pacific region.

The Antarctic Division, Department of Science and the Environment

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) and the Antarctic Division.

At any given time the total staff complement of the Division varies between 170 and 220 persons, about half of whom are engaged on a short-term basis to man annual expeditions and provide general support. Expenditure by the Division in 1977-78 was approximately \$8.1 million.

Services provided by the Antarctic Division in relation to research expeditions include:

- the supply and maintenance of three permanent stations in the Australian Antarctic Territory on the Antarctic continent and one on sub-Antarctic Macquarie Island;
- the mounting of annual and shorter-term research expeditions;
- the co-ordination of activities of agencies involved with ANARE (which include the Antarctic Division itself, the Bureau of Meteorology and the Ionospheric Prediction Service of the Department of Science and the Environment); the Bureau of Mineral Resources, Geology and Geophysics, and the Division of National Mapping of the Department of National Development; certain sections of the Army; various university departments; and the CSIRO.

In addition to its general support function, the Division directly undertakes research in such fields as cosmic ray and upper atmosphere physics, glaciology, Antarctic biology and medical science matters relevant to Antarctic conditions. In 1977 the Government approved an extension of the Division's scientific program into the marine areas around Antarctica. Personnel at research stations include meteorologists, physicists, glaciologists, biologists and logistic staff.

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

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 1977-78 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

The Commonwealth Government performs a significant amount of research and development in this category. More detail may be found in Chapter 4.

Research in private industry

Expenditure on research and development carried out by private industry in 1973-74 was about \$190 million of which about \$171 million came from industry's own funds. In addition, industry contributed about \$28 million towards the cost of R and D carried out overseas and in the Higher Education, Private Non-Profit and Government sectors. Australia has not been collecting data on its private industry R and D expenditure for sufficient time to establish any trends. There are indications, however, that expenditure on R and D by private industry has fallen in actual and real terms since the 1973-74 survey. This seems particularly true of the larger companies where staff numbers employed on R and D are estimated to have fallen by about 40 per cent in the last 5 years.

The Government provides funding to encourage industrial research and development 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 and 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 1978-79 commencement grants will be paid at the rate of 50 per cent of eligible expenditure up to a ceiling of \$25,000, and project grants at 50 per cent of eligible expenditure up to a ceiling of \$500,000. In addition the Minister for Productivity is empowered under the Act to approve full funding of projects considered to be in the 'public interest'. \$24 million was appropriated in the 1978-79 Budget for the Industrial Research and Development Incentives Program.

The Assistance to Inventors' Scheme 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.

Australian R and 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. No figure is available on total Australian payments for overseas technology. However, in 1977-78 payments remitted overseas for royalties and copyrights were \$75 million while Australia received payments of \$10 million for these categories of technology.

Other fields of activity which to some extent involve the adoption by industry of new technology, and which attract financial support from the Commonwealth, include industrial design and product standardisation. The Industrial Design Council of Australia and the Standards Association of Australia 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 will be 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 (APIS) 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 and 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 (UC); the Technical and Further Education Council (TAFEC); and the Advanced Education Council (AEC)). 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 the Environment 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 scientist 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 University of New South Wales; Wait-Aid Ltd, associated with the Western Australia 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.

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 (ANZAAS) 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 the activities of both governmental and non-governmental international scientific organisations. To facilitate scientific liaison and representation, some Government agencies have scientific and technological representation at overseas posts (e.g. Japan, United Kingdom, United States of America, USSR, the International Atomic Energy Association (IAEA) and the OECD). Australia also plays an active role in regional bodies such as ESCAP (formerly ECAFE), the Pacific Science Congress, and the Association for Science Cooperation in Asia (ASCA), and has provided technical assistance to countries in the region under both multilateral and bilateral arrangements.

Australia participates in the programs of the Committee for Scientific and Technological Policy of the OECD.

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 cooperation in science and technology between Australian institutions and scientists and those in other countries. Formal bilateral agreements solely devoted to scientific and technological cooperation 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 the Environment. A fourth such agreement, with the USSR (1975), is 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 Academy 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 by Australian scientists can be supported by the Australia/Japan Foundation, established by the Australian Government in 1976.

Meteorology

Australia is a Member of the World Meteorological Organization (WMO) and operates one of the three World Meteorological Centres in WMO's principal program, the World Weather Watch.

Australia also participates in the joint WMO/ICSU Global Atmospheric Research Program. The Program's Global Weather Experiment, to run twelve months from December 1978, is of particular relevance to Australian meteorology because of the opportunity to use special systems to observe conditions over the southern oceans where data are normally scarce.

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 has been signed by the Governments of Australia and the United States of America to cooperate in the establishment and operation in Australia of space vehicle tracking stations. The agencies for the Australian and the American Governments are the Department of Science and the Environment 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 the Environment 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. An extensive communications system links them with control centres in the United States of America.

Expenditure by NASA on its tracking station operations in Australia in 1976-77 was approximately \$10 million.

High Altitude

The Australian Balloon Launching Station (ABLS) at Mildura, Victoria is operated by the Department of Science and the Environment under a joint-sponsorship arrangement with the US National Science Foundation. The station provides a service for scientific research, requiring the use of high altitude balloons, to research workers from the USA, Australia and other countries.

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 the Environment 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, provides seismic records to the Bureau of Mineral Resources, Geology and Geophysics. Records are also available, through the Department of Science and the Environment, 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.

Other

At the non-governmental level, formal arrangements for scientific cooperation with counterpart institutions in other countries have been concluded by a number of Australian bodies. For example, an arrangement covering cooperation 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 the Environment, the CSIRO and its divisions, the Australian Atomic Energy Commission, and the Department of Defence. Statistical information for the years 1968-69 and 1973-74 may be found in the reports published by the then Department of Science on Project SCORE.

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 and D in Manufacturing Industry 1971-72*).