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## SCIENCE AND TECHNOLOGY

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Science and technology directly influence the strength and competitiveness of industry by providing a basis for technological change and thereby encouraging economic growth and development. They can be seen as making major contributions to the achievement of many of Australia's social, economic and industrial goals.

There are many organisations in Australia concerned in some way with the development of science and technology in Australia.

The Commonwealth Government's conviction of the importance of science and technology is reflected in the functions of the Department of Industry, Technology and Commerce. Apart from having general responsibility for science and technology, the Department is concerned with the development and maintenance of Australia's scientific and technological capability.

A number of other Commonwealth Government organisations either support or carry out scientific and technological activities. State governments are also involved in science and technology via State government departments, science and technology councils and other organisations. Non-government organisations participating in scientific and technological activities include higher education institutions, professional and learned bodies, private organisations and industry groups.

Information on scientific and technological activities presented in this chapter includes:

- Australian Bureau of Statistics data on resources devoted to research and experimental development (R&D) and other innovative activities. The R&D surveys cover organisations in the business enterprise, general government, private non-profit and higher education sectors.
- Department of Industry, Technology and Commerce statistics on expenditure on R&D and other scientific and technological activities carried out or funded by Commonwealth Government organisations.
- Australian Bureau of Statistics information on manufacturing industry technology operations and trade categorised into high technology, medium technology and low technology (industries or commodities).

### **The Department of Industry, Technology and Commerce—DITAC**

Following the Administrative Arrangements Order of 24 July 1987, the Industry, Technology and Commerce portfolio has primary responsibility for advising the government and implementing policy in relation to Australian science and technology; manufacturing and service industries; export services and customs and excise.

Within the portfolio, DITAC is the central point of contact for industry, unions, other Commonwealth departments, and State and local governments on matters relating to manufacturing, and service industries. DITAC incorporates parts of the former Departments

of Science, Trade, and Housing and Construction. The major scientific and technological aspects of the portfolio include the following bodies and activities.

### **The Commonwealth Scientific and Industrial Research Organization—CSIRO**

CSIRO was established as an independent statutory authority by the *Science and Industry Research Act 1949*. The Act has been amended on a number of occasions since then, but the most significant amendments were made in 1978, following the government-instigated 'Birch Committee of Inquiry'. More recently, in November 1986, it was amended to reflect the decisions on the recommendations of the 'Review of Public Investment in Research and Development in Australia', specifically including CSIRO, carried out by the Australian Science and Technology Council (ASTEC).

The decisions announced by the Government in 1986, and reflected in the 1986 amendments to the Act, confirm that CSIRO's primary role is to continue as an applications-oriented research organisation in support of major industry sectors and selected areas of community interest, but with a stronger commitment to the effective transfer of its results to users. The most recent amendments have also included changes to the top management structure and the Organisation's advisory mechanisms.

Briefly, CSIRO's primary statutory functions are to:

- carry out scientific research for the benefit of Australian industry, the community, national objectives, national or international responsibilities, or for any other purpose determined by the Minister;
- encourage or facilitate the application or utilisation of the results of such research.

Other functions include dissemination and publication of scientific information, international liaison in scientific matters, and provision of services and facilities.

The research work of the Organisation is carried out in Institutes, each headed by a Director and each specifically established to undertake work in support of industry or community interest sectors of the Australian economy. Institutes are composed of Divisions, which are individually responsible for broad programs of research in support of the objectives of the Institute.

*Institute of Information and Communications Technologies:* Divisions of Information Technology; Radiophysics; Mathematics and Statistics; CSIRO Office of Space Science and Applications.

*Institute of Industrial Technologies:* Divisions of Manufacturing Technology; Materials Science and Technology; Applied Physics; Chemicals and Polymers; Biotechnology.

*Institute of Minerals, Energy and Construction:* Divisions of Building, Construction and Energy (now incorporates National Building Technology Centre); Geoscience; Exploration; Mineral and Process Engineering; Mineral Products; Coal Technology; Fuel Technology; Geomechanics.

*Institute of Animal Production and Processing:* Divisions of Animal Health; Laboratory Animal Production; Wool Technology; Tropical Animal Production; Food Processing; Human Nutrition; Australian Animal Health.

*Institute of Plant Production and Processing:* Divisions of Plant Industry; Tropical Crops and Pastures; Horticulture; Entomology; Soils; Forestry and Forest Products.

*Institute of Natural Resources and Environment:* Divisions of Water Resources; Fisheries; Oceanography; Atmospheric Research; Wildlife and Ecology; Centre for Environmental Mechanics.

CSIRO has a total staff of more than 7,200 in more than 100 locations throughout Australia. About one-third of the staff are professional scientists, with the others providing technical, administrative or other support. CSIRO's budget for 1987-88 was \$452 million.

**Commercial activities**

The main aim of CSIRO's commercial activities has been to achieve the greatest possible economic and social benefit to Australia by contributing to commercially viable innovation. During recent years, there has been a greater emphasis on research that can be exploited by Australian industry, or that will bring more substantial benefits to Australia. The selection of commercial partners with the capability of developing, applying and marketing innovations has become even more important in the planning and evaluation of research in CSIRO. A second but also important aim of CSIRO's commercial policy is to continue to maximise CSIRO's revenue from its commercial transactions.

**Sirotech Limited**

In the first few years of its operation, Sirotech has come to the forefront in technology transfer in Australia. Sirotech was established by CSIRO in 1985 to help transfer research results with sound commercial potential to the Australian industry most suited to making use of those results. Sirotech has been able to help identify and evaluate commercial opportunities, package and market them to industry and negotiate terms and finalise agreements. As a company set up to 'act commercially', it has continued to develop its capabilities in patent and intellectual property management, technology evaluation, market assessment and advice, and successful negotiation of commercial agreements.

**The Australian Nuclear Science and Technology Organisation—ANSTO**

ANSTO was established on 27 April 1987 as a statutory authority by the Commonwealth Parliament under the *Australian Nuclear Science and Technology Organisation Act Number 3 of 1987*. ANSTO replaces the Australian Atomic Energy Commission, which had been in existence since 1953.

ANSTO has its headquarters and most of its staff at the Lucas Heights Research Laboratories, 30 kilometres south-west of Sydney. Of its staff of 915, about 250 are qualified scientists and engineers. Its mission is to benefit the Australian community by the development and peaceful application of nuclear science and technology in industry, medicine, agriculture, science and other fields. In this mission, ANSTO maintains a high regional and international standing in nuclear matters and both provides advice to and carries out tasks as required by the Commonwealth Government.

The five major research program areas of ANSTO are:

- the application of radioisotopes and radiation;
- the application of nuclear physics;
- biomedicine and health;
- environmental science;
- advanced materials.

ANSTO is broadening its commercial ethos with research being directed to achieve the Organisation's social and corporate goals. Because its multidisciplinary body of expertise is located at one centre, together with its two nuclear research reactors and other specialised laboratory equipment, ANSTO can provide a range of unique and essential techniques and services to the Australian community. Established under the ANSTO legislation is the independent Nuclear Safety Bureau which is responsible for monitoring and reviewing the safety of nuclear reactor plant operated by ANSTO. The Bureau reports to the Minister responsible for administration of the ANSTO Act. ANSTO's annual expenditure is in the order of \$53 million with sales revenue of approximately \$4.3 million.

**The 150 per cent Tax Concession for Research and Development Incentive**

The 150 per cent research and development (R&D) tax incentive is the Government's major initiative to make industry more innovative and internationally competitive through

increased R&D. It was designed to redress the very low investment by Australian industry in R&D.

The incentive is available to companies incorporated in Australia and applies to expenditure on R&D up until 30 June 1991. It allows a deduction of up to 150 per cent of eligible expenditure against assessable income. With the current corporate tax rate of 39 per cent, this reduces the after tax cost of R&D expenditure to as low as 41.5 cents in the dollar.

Over 2,000 companies of all descriptions have successfully been using the incentive in its first three years to build their product range for the 1990s. It is expected that the next three years will see a further increase in the number of R&D performers and in their investment in R&D.

### **The Grants for Industry Research and Development Scheme**

The scheme provides grants to support approved R&D projects in three areas, being: discretionary grants of up to 50 per cent of agreed costs, generally for companies unable to benefit from the tax concession; generic technology grants, providing up to 90 per cent of agreed costs, designed to support new technologies with particular significance for industry development; and national interest agreements, providing up to 100 per cent of costs for R&D projects with significant benefits for Australia. The scheme applied from 1 July 1986 and replaced the Australian Industrial Research and Development Incentives Scheme.

### **National Procurement Development Program—NPDP**

Acting on the recommendations of the Inglis Committee of Review of Government High Technology Purchasing Arrangements, the Commonwealth agreed to establish the Program to fund research, development, trials and demonstration projects to encourage government departments and agencies to seek new Australian solutions for their forward procurement needs.

The NPDP differs from other Board schemes by providing assistance for industry to undertake trials and demonstrations, as well as research and development.

### **Patent, Trade Marks and Designs Offices**

The Offices, through their Central Office in Canberra and Sub-offices in each State capital, administer Australia's industrial property systems for the protection of patents, designs and trade marks. These systems encourage investment in, and innovations based on, new technology and industrial designs, and promote orderly marketing through registered trade marks.

The Offices maintain an information data base on inventions and industrial designs to facilitate the transfer and diffusion of technology. A data base of registered trade marks is also maintained. This information is available to the public through the Offices' Sub-offices.

### **The National Industry Extension Service—NIES**

The NIES is a joint Commonwealth and State Government initiative established in July 1986 to upgrade and coordinate the wide range of advisory and assistance services available to industry. NIES is helping Australian firms achieve international competitiveness by encouraging the adoption of improved technologies, management and business practices. Through a single contact point in each State and Territory, firms can be provided with information, or referred to appropriate specialist sources of advice, on issues that include strategic planning, product innovation, design, quality, the application of new technologies, marketing, the contribution of labour, and issues of particular concern to small business. Financial assistance may be provided towards the cost of business planning services.

Funds are provided through DITAC's Budget allocation to the States and Territories to assist them in delivering NIES services to industry. In addition, funding is provided for the national NIES program, which includes the development of new elements of the

program and contracting the non-profit providers of extension services—the Technology Transfer Council, and the Australian Design Council—to conduct national interest programs.

### **The Management and Investment Companies Program**

In 1984, the Government established the Management and Investment Companies Licensing Board to encourage the development of a venture capital market in Australia. The main objective of the program is to attract management and financial support for the start-up and early growth of those Australian based enterprises which have the potential to grow rapidly into substantial businesses, are export oriented and use innovative technology.

### **The Bureau of Industry Economics**

Primary responsibility for the Department's Industry Research Program lies with the Bureau of Industry Economics, which was established in 1977 as a centre for research into the Australian manufacturing and commerce sectors of the economy. The Bureau is assisted in devising its research program by a Council of Advice, comprising business and union leaders and prominent academics.

The Bureau's research program is concerned with a broad range of industry policy issues, including:

- individual industry studies as well as the investigations of general issues affecting a broad range of manufacturing and service industries;
- forward-looking studies on the likely future development of Australian industry, as well as detailed investigations of the factors responsible for the performance of industry in the recent past;
- aspects of industrial technology and production as well as pricing and marketing issues.

Evaluation of the effectiveness of existing government policies and programs is an important part of the Bureau's research. The Bureau also contributes to policy reviews, including Industries Assistance Commission and other public inquiries, and assesses the economic aspects of papers put to it by industry and trade unions.

### **The Snowy Mountains Engineering Corporation—SMEC**

An Australian Government owned business enterprise, the Corporation utilises the professional engineering and technical expertise developed during design and construction of the Snowy Mountains Hydro-Electric Scheme.

Since the establishment of the organisation in 1970, the range of SMEC's expertise has been expanded by the addition to its staff of specialists in a number of disciplines and SMEC has now grown into a multidisciplined consulting organisation of international standing in civil, electrical and mechanical engineering. SMEC has completed some 1,350 projects in 48 countries, including Australia. These projects have a capital value of \$A3,650 million and involved fees of \$A270 million.

A full range of expert engineering consulting services are provided by SMEC for pre-feasibility investigations, feasibility studies, field investigations and laboratory studies, design and preparation of contract documents, contract management and construction supervision, operation and maintenance, training and project management.

Projects are in the fields of hydro-electric and multipurpose water resources development, river basin studies, dams and power stations, power transmission and distribution, irrigation and flood control, roads and bridges, tunnels, shafts and underground works and pipelines.

SMEC, as well as working on projects in all States of Australia, has provided consulting services for projects throughout Asia and the Pacific islands, in Africa, the Middle East, and in North and South America.

SMEC is registered as an Engineering Consultant with United Nations agencies, the World Bank, Asian Development Bank, Commonwealth Fund for technical cooperation, Kuwait Fund for Arab Economic Development, and the Arab Bank for Economic Development in

Africa. Projects have been successfully carried out in many countries, using finance from these donor and lending institutions.

The Corporation was a recipient of two Australian Government Export Awards in 1977 and 1982, and the Governor-General's Award for Export Excellence in 1984.

SMEC has a staff of over 200 professionals, technical and administrative support staff. Its headquarters are in Cooma, NSW. Branch offices are located in Sydney, Brisbane, Jakarta and Kuala Lumpur, with project offices in many other locations.

### **The Australian Institute of Marine Science—AIMS**

AIMS was established as an independent statutory authority by the *Australian Institute of Marine Science Act 1972*. The responsibilities of the Institute are to conduct research and to arrange and cooperate with other institutions or individuals, in conducting marine science research as well as to collect and disseminate information relating to marine science. Its objectives are to advance the development of national knowledge of the marine environment; to communicate this knowledge so that it can be applied to the development, conservation and management of the marine resources; to create opportunities for technological and commercial development and to foster cooperation between researchers with similar interests.

The Institute's core research is organised into four closely integrated programs—coastal processes and resources, reef studies, environmental studies and marine systems analysis. These core research programs have been augmented by funding from other agencies which allows for continuing major research on the crown-of-thorns starfish phenomenon, accelerated research on weather records in corals and mangrove forests and assistance to ASEAN countries to develop technologies for assessing their coastal marine resources, especially mangroves and coral reefs.

The Institute's total budget in 1987–88 was \$11.4 million, of which \$1.2 million was funded from other agencies. Its core staff of 106 is supplemented by some 22 staff funded by other agencies.

### **The Commission for the Future**

The Commission's objective of raising community awareness of all aspects of the social and economic impacts of technological change is based on the premise that industrial restructuring and technological development alone are insufficient for the development of a productive Australian culture. A need exists for an information and education program directed at increasing support for, and understanding of, scientific and technological change and long-term options for Australia.

### **The Australian Space Board**

The Board was established to advise the government on space R&D priorities in accordance with the government's broader industry and technology policies. Part of the Board's functions include supervising and accounting for National Space Program activities funded through the Department. Those activities include providing financial incentives to companies for involvement in space-related technologies and R&D.

### **The Australian Space Office**

The Australian Space Office was established within the Department in 1987 to provide the driving force for development of a commercially viable export oriented Australian space industry. Expert industry, technological and scientific advice is brought to bear on this task via the Australian Space Board which comprise eminent businessmen, prominent academics and relevant government representatives.

The Office has initiated a program of activities to identify opportunities, stimulate entrepreneurial attitudes and overcome barriers in order to secure for Australia access to the lucrative international market for high technology space-related products and services:

- the Office is working directly with Australian industry in undertaking an in-depth examination of potential industrial opportunities in the areas of remote sensing and satellite communications;
- the proposal to establish a commercial spaceport at Cape York holds exciting possibilities for Australian entry into the space market and the Office is coordinating Federal interests;
- \$14 million has been allocated to date under the National Space Program in support of development projects aimed at assisting Australian industry to overcome the 'qualification hurdle' to the international space market;
- the Office is establishing close links with the Australian space science community in order to influence future research directions and priorities towards areas of identified industrial potential; and
- a program of international space industry missions has been initiated in order to facilitate Australian industry participation in the major space programs of other countries.

### **The National Standards Commission**

The National Standards Commission was established in 1948 as a statutory authority and operates under the *National Measurement Act 1960*. The Commission has responsibility for coordinating the Australian National Measurement System and specific responsibilities for legal metrology, the pattern approval of measuring instruments in use for trade, and the completion of metrication.

The Commission provides the Chairman and secretariat for joint Commonwealth, State and Territory Committees developing uniform trade measurement and packaging legislation.

Close liaison is maintained with the manufacturing industry, retailers, consumers and other users to ensure that the measurement system is meeting their needs.

Current Commission programs on measurement policy include precise time measurement, oil, gas flow measurement and the contribution that measurement makes to quality.

The Commission has regular contacts overseas, provides the Australian member accredited to the International Organisation of Legal Metrology and provides training courses for countries in the Asia-Pacific region.

### **Expenditure**

Science and technology (S&T) expenditures within the portfolio of the Minister for Industry, Technology and Commerce for 1986-87 were as follows:

Intramural (in-house) R&D expenditure \$454 million.

Extramural (grants, contracts, etc.) R&D expenditure \$60 million.

S&T (including R&D) expenditure \$688 million.

## **Other Commonwealth Government Science and Technology Activities**

Many other Commonwealth Government agencies play a significant role in the science and technology area. A number of these agencies are involved with R&D activities either as funders, performers or both; others are active in the S&T areas of information dissemination, scientific services and scientific training.

### **The Australian International Development Assistance Bureau—AIDAB**

The Bureau provides funds under a number of arrangements to provide scientific development and training in many third world countries. In 1986-87 the Bureau spent \$219 million on science and technology, \$39 million of which was provided as R&D funding.

### **The Defence Science and Technology Organisation—DSTO**

DSTO is a major R&D performer in the defence field in Australia, spending \$154 million on its own research programs in 1986–87. Other S&T activities include provision of scientific and technological advice on defence policy matters and equipment, and development and maintenance of a skill base in defence science and technology.

### **The Commonwealth Department of Employment, Education and Training**

The Department funds scientific and technical training in tertiary institutions via the Commonwealth Tertiary Education Commission. In addition, the Department has established the Australian Research Council to provide advice on national research policy priorities and on the coordination of national research effort. The Council will also coordinate and advise on specific research funds for tertiary education institutes, post-graduate research awards and research grants and fellowship schemes.

The Department's total S&T expenditure for 1986–87 was \$213 million of which \$204 million was for R&D. Of the \$204 million R&D expenditure the majority (\$19 million) was used to provide research funding.

### **The Commonwealth Department of Community Services and Health**

The Department is the major Australian provider of medical research funds through the National Health and Medical Research Council. In 1986–87, the value of grants awarded to medical researchers was \$59 million. Other S&T activities of the Department include provision of funds for the National Biological Standards Laboratory (\$13 million in 1986–87), Commonwealth Pathology Laboratories (\$17 million in 1986–87) and the Commonwealth Serum Laboratories (\$10 million in 1986–87).

### **The Australian Telecommunications Commission**

'Telecom Australia' operates and maintains the national telecommunications network. It is a major R&D and S&T performer (\$56 million and \$141 million respectively in 1986–87). Its R&D activities include planning and specification of Australian telecommunications requirements and the solution of technical problems arising during the operation of its telecommunication networks. Telecom's other S&T activities include planning and operation of new facilities and development of the network infrastructure.

### **The Australian Bureau of Statistics**

The Bureau is the Commonwealth Government's central statistical authority and is responsible for providing statistical services to government and private users. Other activities include the coordination of statistical activities of official bodies and the provision of statistical advice and assistance to official bodies. All of the Bureau's expenditure (\$165 million in 1986–87) is considered to be on science and technology (predominantly data collection in the social sciences), with a small proportion (\$10 million in 1986–87) attributable to R&D.

### **The Bureau of Meteorology**

The Bureau provides the national meteorological service and performs the R&D needed to maintain the service. The Bureau's total S&T expenditure for 1986–87 was \$65 million, of which \$3 million was for R&D.

### **The Antarctic Division of the Department of the Arts, Sport, the Environment, Tourism and Territories**

The Division manages Australia's Antarctic program. It organises expeditions and maintains research stations, as well as funding, coordinating and conducting research. The Division's S&T spending for 1986–87 was \$42 million and its R&D expenditure was \$27 million.

### **The Rural Industry Research Schemes**

The Schemes, administered by the Department of Primary Industries and Energy, provide funds for rural research and dissemination of agricultural information relating to production improvement within the industry. Funding for most of the Schemes comes equally from the Commonwealth and industry (via a levy on produce). In 1986–87, the Schemes contributed \$29 million to rural research.



## **The Bureau of Mineral Resources—BMR**

The Bureau's main functions are to understand and assess Australian geology as a basis for mineral exploration, to be the primary information source for geoscience data, and to monitor earthquake activity and underground nuclear explosions. BMR's R&D activities are in the areas of fossil fuel, minerals and ground water; spending on R&D in 1986–87 was \$31 million. Total S&T expenditure in 1986–87 was \$37 million.

## **Advice on science and technology**

Apart from DITAC, the most significant Commonwealth Government advisory body on science and technology is the Australian Science and Technology Council (ASTEC), a statutory authority advising the Prime Minister and government on science and technology matters. ASTEC's 1986–87 expenditure was \$1.4 million. For a fuller discussion of ASTEC's role and functions *see Year Book* No. 70.

## **State government science and technology activities**

State governments are major performers and supporters of scientific and technological activities. Many States have particular departments established for the purpose of encouraging and coordinating the use of technology in industry (e.g. the Victorian Department of Industry, Technology and Resources). Several States (New South Wales, Queensland, Western Australia and South Australia) have also established science and technology councils which provide advice to State governments on science and technology matters and promote the expansion of technology.

In addition to fostering science and technology, many State government departments are large performers of scientific and technological activities. Traditionally, for instance, those departments involved with agriculture (e.g. the Victorian Department of Agriculture and Rural Affairs and various State departments of agriculture) spend large sums on the R&D which they perform and also have a high profile in the general S&T activities of extension and laboratory services.

The total 1986–87 expenditure for R&D carried out by State government organisations on agricultural objectives was \$227 million, 64 per cent of total State government R&D spending for that year. Other major areas of State government R&D activity are Forestry and Fisheries (\$33 million in 1986–87) and Health (\$29 million in 1986–87).

## **Tertiary education institutions' science and technology activities**

Tertiary education institutions play a vital role in the two major S&T areas. These being R&D and scientific and technical training.

Universities receive direct funding for research purposes from a number of sources, the major one being the Commonwealth Government. Commonwealth funds include those administered by the Commonwealth Tertiary Education Commission (special research grants, research equipment grants); those grants and awards distributed through the Australian Research Council; and grants awarded by the National Health and Medical Research Council and through the National Energy Research, Development and Demonstration Program. Direct Commonwealth research funding for 1986 totalled \$126 million. Direct funds for research from other organisations and individuals totalled \$58 million in 1986.

Indirect research funding for universities includes both the proportion of general funds from the States Grants (Tertiary Education Assistance) Act allocated by universities to research (\$104.0 million in 1986) and the amount attributable to research but coming from general teaching-and-research funds (e.g. the estimated research portion of the salaries of teaching-and-research staff). The latest available figures for total university research expenditure (direct plus indirect sources) came from the ABS R&D survey for 1986 which gives an estimated expenditure of \$845 million.

CAEs and institutes of TAFE receive very little research funding from the Commonwealth. The Australian Bureau of Statistics measures R&D effort for CAEs (\$37 million in 1986) but does not survey institutes of TAFE.

Data on university, advanced education and TAFE enrolments are presented in Chapter 10, Education. That chapter also gives a more detailed picture of higher education facilities in Australia.

## **Other Organisations' Science and Technology Activities**

There are many other non-government organisations playing an important part in Australia's scientific and technological development. They include various learned and professional bodies such as the Australian Academy of Science, the Australian Academy of Technological Science, the Academy of Social Sciences in Australia and the Australian and New Zealand Association for the Advancement of Science. Their activities include provision of advice in the relevant scientific fields, dissemination of scientific information and enhancement of communication on scientific matters.

A number of private organisations from time to time provide advice to government on specific matters relating to science and technology. Examples from the business sector are the Australian Chamber of Manufacturers, the Business Council of Australia and the Confederation of Australian Industry. Other organisations with an interest in scientific and technological issues include trade unions, industry groups with an interest in specific technologies and individual private organisations.

As performers of research and experimental development, private organisations in Australia are making an increasingly important contribution to Australia's R&D effort. Private business enterprises, for instance, spent an estimated \$1,069 million on R&D in 1986-87, a figure which, whilst still relatively low compared with the spending of comparable OECD countries, represents an increase of 66 per cent over 1984-85 expenditure. Private non-profit organisations in 1986-87 spent \$49 million on R&D, the majority of it on health related research.

## **Statistics on Science and Technology**

### **Expenditure and human resources devoted to research and experimental development**

The Australian Bureau of Statistics' Surveys of Research and Experimental Development provide comprehensive data on research and experimental development activities in Australia by organisations in the business enterprise, general government, higher education and private non-profit sectors. They also provide some data on other innovative activities, such as technical know-how payments and receipts and patenting activity. Activities not covered by the survey include scientific or technological services, extension services, education and training, etc.

The first comprehensive survey on R&D was carried out for the financial year 1968-69. There have been six major surveys since then, the latest for which comprehensive results are available being in respect of 1986-87 (1986 calendar year for the Higher Education Sector). Less detailed data in respect of 1985-86 are available from the smaller 'inter year' R&D survey conducted by the Bureau.

The estimate of gross expenditure on R&D (GERD) carried out in Australia, as derived from the results of the 1986-87 survey, is \$3,256 million. This represents a 35 per cent increase compared with the 1984-85 survey. At constant (1984-85) prices, GERD increased by 18 per cent over the same period. The total estimate of human resources devoted to R&D during 1986-87 in Australia was 58,521 person years; this represented a 15 per cent increase compared with the 1984-85 survey.

See *Year Book* No. 70 for a detailed description of survey methods and concepts.

### **Definitions**

The survey's definitions follow guidelines described by the OECD for national R&D surveys. The OECD defines R&D as comprising 'creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications'. The Bureau provides sector specific definitions which clarify the OECD definitions for respondents and users (see ABS catalogue 8112.0).

**Survey results**

A summary of results for 1968–69 is given in *Year Book* No. 60. Results for the second survey, 1973–74; the third survey, 1976–77; and the fourth survey, 1978–79, are given in *Year Books* No. 61, 64, and 67 respectively.

A summary of results from the 1981–82, 1984–85 and 1986–87 surveys is presented below.

**HUMAN RESOURCES OF EFFORT DEVOTED TO RESEARCH AND EXPERIMENTAL  
DEVELOPMENT, AUSTRALIA  
(person years)**

<i>Sector</i>	<i>1981–82</i>	<i>1984–85</i>	<i>1986–87</i>
Business Enterprises—			
Private Sector	7,478	11,022	14,998
Public Sector	1,010	1,238	1,370
General Government—			
Commonwealth	11,412	11,119	11,429
State	6,382	6,018	6,551
Higher Education—			
Universities	17,699	19,814	21,713
CAEs	542	1,030	1,529
Private non-profit	688	712	931
<b>Total</b>	<b>45,211</b>	<b>50,953</b>	<b>58,521</b>

**GROSS EXPENDITURE ON RESEARCH AND EXPERIMENTAL DEVELOPMENT (GERD)  
CARRIED OUT IN AUSTRALIA  
GERD AT CURRENT AND AVERAGE 1984–85 PRICES  
(\$ million)**

<i>Sector</i>	<i>1981–82</i>	<i>1984–85</i>	<i>1986–87</i>
<b>AT CURRENT PRICES</b>			
Business Enterprises—			
Private Sector	318.9	645.7	1,068.6
Public Sector	54.8	77.3	120.7
General Government—			
Commonwealth	514.8	669.4	782.3
State	199.9	285.9	353.4
Higher Education—			
Universities	443.5	663.1	845.2
CAEs	9.0	22.7	36.6
Private non-profit	20.9	43.5	49.1
<b>Total</b>	<b>1,561.8</b>	<b>2,407.5</b>	<b>3,256.0</b>
<b>AT AVERAGE 1984–85 PRICES</b>			
Business Enterprises—			
Private Sector	393.4	645.7	922.3
Public Sector	77.4	77.3	104.3
General government—			
Commonwealth	645.2	669.4	689.6
State	261.5	285.9	309.0
Higher Education—			
Universities	638.6	679.9	751.1
CAEs	11.6	23.3	32.2
Private non-profit	27.1	43.5	44.5
<b>Total</b>	<b>2,054.8</b>	<b>2,425.0</b>	<b>2,853.1</b>

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

<i>Sector</i>	<i>Total</i>	<i>Commonwealth government</i>	<i>State government</i>	<i>Business enterprises</i>	<i>Higher education</i>	<i>Private non-profit and other Australian</i>	<i>Overseas</i>
1984-85							
Business Enterprises—							
Private Sector	645,659	62,815	2,948	566,709	} 210	} 236	12,741
Public Sector	77,331	4,786	310	72,204			31
General Government—							
Commonwealth	669,425	651,608	1,131	12,352	73	1,044	3,218
State	285,896	24,143	241,724	10,082	231	9,139	576
Higher Education—							
Universities	663,054	621,030	6,512	8,174	3,977	18,274	5,086
CAEs	22,673	4,232	1,880	2,861	12,503	858	339
Private non-profit	43,488	17,578	7,906	1,936	285	11,741	4,043
<b>Total</b>	<b>2,407,524</b>	<b>1,386,190</b>	<b>262,410</b>	<b>674,318</b>	<b>17,279</b>	<b>41,293</b>	<b>26,034</b>
1986-87							
Business Enterprises—							
Private Sector	1,068,632	53,407	} 4,219	997,554	} 269	} 424	13,755
Public Sector	120,715	8,664		111,055			—
General Government—							
Commonwealth	782,298	750,756	3,833	22,881	108	347	4,374
State	353,389	30,809	290,501	17,415	413	13,450	802
Higher Education							
Universities	845,223	789,246	9,010	9,659	8,943	22,120	6,245
CAEs	36,639	6,305	2,975	8,805	17,207	1,167	180
Private non-profit	49,107	19,843	6,705	2,211	411	15,468	4,468
<b>Total</b>	<b>3,256,003</b>	<b>1,659,029</b>	<b>317,242</b>	<b>1,169,580</b>	<b>27,352</b>	<b>52,976</b>	<b>29,825</b>

### Business enterprise sector

The estimate of expenditure on R&D carried out in Australia by private and public business enterprises during 1986-87 is \$1,189 million at *current* prices. This represents a 64 per cent increase in expenditure compared with 1984-85. At average 1984-85 prices, R&D expenditure is estimated to have increased by 42 per cent over the same period.

## RESEARCH AND EXPERIMENTAL DEVELOPMENT CARRIED OUT BY BUSINESS ENTERPRISES (a), AUSTRALIA DETAILS OF RESOURCES DEVOTED TO R&amp;D BY INDUSTRY OF ENTERPRISE (b)

Industry of enterprise ASIC Code	Description	Enterprises (number)			Expenditure on R&D (\$m)					Person years of effort on R&D			
		1981-82	1984-85r	1986-87	1981-82	1984-85r	1985-86(c)r	1986-87	1981-82	1984-85r	1985-86(c)r	1986-87	1988-87
11-15	Mining (excluding services to mining)	23	31	37	22.6	29.8	n.a.	51.1	381	297	n.a.	347	
	Manufacturing—												
21	Food, beverages and tobacco	72	92	99	14.1	30.9	n.a.	55.0	390	658	n.a.	778	
23-24	Textiles, clothing and footwear	16	27	35	0.8	5.6	n.a.	12.9	24	57	n.a.	119	
25	Wood, wood products and furniture	19	29	46	1.7	3.4	n.a.	6.3	43	69	n.a.	118	
26	Paper, paper products, printing and publishing	12	22	31	5.3	6.4	n.a.	9.4	125	139	n.a.	156	
27	Chemical, petroleum and coal products	128	180	267	57.3	91.1	96.8	119.0	1,307	1,576	1,596	1,832	
28	Non-metallic mineral products	22	33	37	5.8	12.9	n.a.	14.9	126	223	n.a.	172	
29	Basic metal products	27	32	45	27.1	46.1	66.7	64.5	672	681	889	861	
31	Fabricated metal products	83	92	125	7.1	15.6	n.a.	21.5	170	309	n.a.	379	
32	Transport equipment	54	65	96	48.1	90.1	124.3	126.9	1,087	1,476	1,702	1,552	
334	Photographic, professional and scientific equipment	26	30	64	6.3	16.5	n.a.	25.3	183	283	n.a.	426	
335	Appliances and electrical equipment	159	286	580	41.4	84.4	117.0	172.4	1,029	1,611	1,982	2,790	
336	Industrial machinery and equipment	156	177	242	15.7	28.5	n.a.	41.9	443	566	n.a.	692	
34	Miscellaneous manufacturing	66	77	96	7.6	8.5	n.a.	15.9	186	178	n.a.	245	
C	Total manufacturing	840	1,142	1,763	238.3	440.1	553.4	685.9	5,784	7,824	8,824	10,120	
	Other industries—												
F	Wholesale and retail trade	106	194	286	12.5	36.5	n.a.	68.4	296	641	n.a.	1,019	
63	Property and business services	206	450	569	20.2	82.2	n.a.	170.7	499	1,311	n.a.	2,245	
8461	Research and scientific institutions	31	43	79	23.0	28.8	n.a.	44.8	485	497	n.a.	636	
(d)	Other n.e.c.	72	125	198	57.1	105.7	n.a.	168.4	1,042	1,691	n.a.	2,000	
16, D-L	Total other industries	415	812	1,132	112.9	253.1	n.a.	452.4	2,324	4,140	n.a.	5,901	
	Total all industries	1,278	1,985	2,932	373.7	723.0	922.1	1,189.3	8,489	12,260	14,128	16,368	
	Private Sector Contribution	1,212	1,938	2,873	318.9	645.7	826.4	1,068.6	7,478	11,022	12,775	14,998	
	Public Sector Contribution	66	47	59	54.8	77.3	95.7	120.7	1,010	1,238	1,353	1,370	

(a) Excludes enterprises in ASIC Division 'A'. (b) 1984-85 and 1986-87 data are classified by the 1983 edition of ASIC. 1981-82 data are classified by the 1978 version of ASIC. If the 1983 version were used to classify 1981-82 data, only minor differences would occur. (c) Represents the most detailed data available for 1985-86. Manufacturing total not equal to sum of manufacturing components. (d) ASIC codes 16,D,E,G,H,61-62,J,8141-8306,8462-8495,L.

## Payments and receipts for patent licence fees and other technical know-how

Many Australian business enterprises supplement their R&D efforts by either purchasing or licensing foreign or Australian technology. Data for 1981-82, 1984-85 and 1986-87 are presented below.

### PAYMENTS AND RECEIPTS FOR TECHNICAL KNOW-HOW BY BUSINESS ENTERPRISES(a), AUSTRALIA, PAYMENTS AND RECEIPTS BY INDUSTRY OF ENTERPRISES(b) (\$ million)

Industry of enterprise		Payments for technical know-how			Receipts for technical know-how		
ASIC Code	Description	1981-82	1984-85r	1986-87	1981-82	1984-85r	1986-87
	Manufacturing—						
21	Food, beverages and tobacco	14.9	16.8	23.9	—	1.1	3.5
23-24	Textiles, clothing and footwear	1.4	8.9	n.p.	—	n.p.	n.p.
25	Wood, wood products and furniture	2.9	0.1	0.2	—	n.p.	0.6
26	Paper, paper products, printing and publishing		4.1	4.0	—	n.p.	n.p.
27	Chemical, petroleum and coal products	34.3	39.1	53.3	3.6	6.6	6.2
28	Non-metallic mineral products	5.6	7.8	1.4	—	n.p.	n.p.
29	Basic metal products	7.6	4.7	9.8	2.0	6.1	n.p.
31	Fabricated metal products	3.3	2.3	3.9	0.7	1.1	1.2
32	Transport equipment	13.8	17.4	35.5	2.0	n.p.	1.0
334	Photographic, professional and scientific equipment	16.9	n.p.	n.p.	1.3	n.p.	n.p.
335	Appliances and electrical equipment		28.3	48.5		n.p.	3.8
336	Industrial machinery and equipment	3.2	n.p.	8.3	0.2	1.4	n.p.
34	Miscellaneous manufacturing	3.3	4.9	10.9	0.9	n.p.	n.p.
C	Total manufacturing	107.2	146.6	236.2	11.5	23.8	44.9
	Other industries—						
F	Wholesale and retail trade	28.9	4.3	11.5	5.9	0.5	6.2
63	Property and business services		8.0	7.7		6.2	43.5
8461	Research and scientific institutions		n.p.	n.p.		n.p.	3.0
(c)	Other n.e.c.		n.p.	n.p.		n.p.	8.7
11-16, D-L	Total other industries	28.9	19.9	41.2	5.9	12.3	61.5
	Total all industries	136.0	166.5	277.4	17.4	36.1	106.4

(a) Excludes enterprises in ASIC Division 'A'. (b) 1984-85 and 1986-87 data are classified by the 1983 edition of ASIC; 1981-82 data are classified by the 1978 edition of ASIC. If the 1983 version were used to classify 1981-82 data, only minor differences would occur. (c) ASIC Codes 11-16, D, E, G, H, 61-62, J, 8141-8306, 8462-8495, L.

## Expenditure by Commonwealth Government organisations on science and technology

The Commonwealth Department of Industry, Technology and Commerce conducts the annual Science and Technology Statement Collection which obtains expenditure data on R&D and broader scientific and technological activities. The collection covers Commonwealth Government organisations (including public business enterprises) and

includes expenditure on both intramural (in-house) R&D activity and extramural R&D funding (grants, contracts etc.).

Latest published results show total Commonwealth Government S&T expenditure in 1986-87 to be \$74,899 million. Of this, total R&D expenditure was \$1,178.5 million (\$729.1 million intramural, \$448.7 million extramural).

The table below gives an overview of 1986-87 R&D expenditure by the Commonwealth, classified by socio-economic objective.

**TOTAL COMMONWEALTH GOVERNMENT EXPENDITURE (a) ON R&D BY  
SOCIO-ECONOMIC OBJECTIVE, 1986-87**  
(\$ million)

(Source: Department of Industry, Technology and Commerce)

<i>Socio-economic objective</i>	<i>R&amp;D expenditure (b)</i>
<i>National security (defence)</i>	<i>153.6</i>
<i>Economic development—</i>	
Agriculture	166.6
Forestry and fisheries	28.4
Mining	25.8
Manufacturing	136.3
Construction	14.3
Energy	55.7
Transport	6.5
Communications	63.5
Economic services n.e.c.	17.8
<i>Total economic development</i>	<i>515.0</i>
<i>Community welfare—</i>	
Urban and regional planning	1.5
Environment	21.6
Health	100.3
Education	2.6
Welfare	4.8
Community services n.e.c.	57.3
<i>Total community welfare</i>	<i>188.9</i>
<i>Advancement of knowledge—</i>	
Earth, ocean and atmosphere n.e.c.	95.4
General advancement of knowledge	225.0
<i>Total advancement of knowledge</i>	<i>320.4</i>
<b>Total</b>	<b>1,178.5</b>

(a) Excludes expenditure by Commonwealth Government organisations funded from recoveries and external sources such as industry and State Government. Also excludes recurrent funding for Higher Education Institutions and the costs to the Commonwealth of tax incentives. (b) Sum of intramural plus extramural expenditures.

### General government sector

The estimate of expenditure on R&D carried out in Australia by organisations in the general government sector during 1986-87 was \$1,136 million at *current* prices. This represents a 19 per cent increase in expenditure compared with 1984-85. At average 1984-85 prices, R&D expenditure is estimated to have increased by 5 per cent over the same period.

**RESEARCH AND EXPERIMENTAL DEVELOPMENT CARRIED OUT BY GENERAL  
GOVERNMENT ORGANISATIONS, AUSTRALIA  
DETAILS OF RESOURCES DEVOTED TO R&D BY SOCIO-ECONOMIC OBJECTIVE**

<i>Socio-economic objective</i>	<i>Expenditure on R&amp;D (\$m)</i>			<i>Person years of effort on R&amp;D</i>		
	<i>1981-82</i>	<i>1984-85r</i>	<i>1986-87</i>	<i>1981-82</i>	<i>1984-85r</i>	<i>1986-87</i>
<i>National security (Defence)</i>	113.2	151.0	175.1	3,625	3,232	3,146
<i>Economic development—</i>						
Agriculture	236.0	321.0	386.8	5,681	5,850	6,467
Forestry and fisheries	44.2	48.1	63.1	1,140	924	1,049
Mining (prospecting)						
Energy sources	12.0	12.8	15.5	244	202	197
Other	9.1	23.2	28.4	236	344	392
Mining (extraction)						
Energy sources	5.0	7.9	2.8	124	120	42
Other	8.7	8.4	7.6	228	138	127
Manufacturing	73.6	103.8	119.1	1,658	1,725	1,696
Construction	7.1	13.3	14.2	207	265	261
Energy	42.7	51.8	45.7	731	644	541
Transport	6.2	16.9	16.6	134	220	281
Communications	0.6	0.3	1.3	26	6	10
Economic services n.e.c.	22.6	20.2	14.5	558	404	324
<i>Total economic development</i>	467.8	627.5	715.5	10,966	10,840	11,387
<i>Community welfare—</i>						
Urban and regional planning	2.8	0.4	1.7	81	12	40
Environment	43.6	36.0	42.6	1,034	692	639
Health	24.8	42.8	56.9	890	1,067	1,185
Education	2.7	5.9	6.7	99	145	150
Welfare	1.7	3.7	7.1	64	86	118
Community services n.e.c.	3.6	9.1	19.1	85	175	227
<i>Total community welfare</i>	79.2	97.9	134.2	2,253	2,177	2,358
<i>Advancement of knowledge—</i>						
Earth, ocean and atmosphere n.e.c.	34.3	72.7	102.5	542	778	914
General advancement of knowledge	20.1	6.2	8.4	408	109	176
<i>Total advancement of knowledge</i>	54.4	78.9	110.9	950	887	1,090
<b>Total</b>	<b>714.6</b>	<b>955.3</b>	<b>1,135.7</b>	<b>17,795</b>	<b>17,136</b>	<b>17,981</b>



### Higher education sector

The estimate of expenditure on R&D carried out in Australia by higher education organisations during 1986 is \$882 million at *current* prices. This represents a 29 per cent increase in expenditure compared with 1984. At average 1984–85 prices, R&D expenditure is estimated to have increased by 11 per cent over the same period.

#### RESEARCH AND EXPERIMENTAL DEVELOPMENT CARRIED OUT BY HIGHER EDUCATION ORGANISATIONS, AUSTRALIA R&D EXPENDITURE BY SOCIO-ECONOMIC OBJECTIVE

<i>Socio-economic objective</i>	<i>Expenditure on R&amp;D (\$m)</i>						
	<i>1984r</i>				<i>1986</i>		
	<i>1981</i>	<i>Total</i>	<i>Universities</i>	<i>CAEs</i>	<i>Total</i>	<i>Universities</i>	<i>CAEs</i>
<i>National security (Defence)</i>	0.7	1.2	1.2	—	1.9	1.7	0.2
<b>Economic development—</b>							
Agriculture	35.5	58.9	57.3	1.5	74.2	72.2	2.0
Forestry and fisheries	4.3	8.2	8.0	0.2	9.0	8.6	0.4
Mining (prospecting)							
Energy sources	1.8	1.8	1.7	0.1	4.0	3.7	0.3
Other	1.8	3.4	3.2	0.1	7.2	7.0	0.2
Mining (extraction)							
Energy sources	1.0	1.0	1.0	0.1	0.8	0.8	—
Other	2.4	3.6	3.3	0.3	6.9	5.8	1.1
Manufacturing	13.0	18.6	16.1	2.4	29.5	24.9	4.6
Construction	2.7	7.2	6.9	0.3	8.9	8.0	0.8
Energy	21.7	25.4	23.7	1.7	27.6	25.6	1.9
Transport	2.6	3.7	3.2	0.5	4.2	3.6	0.6
Communications	3.2	6.0	5.5	0.4	9.4	8.4	1.0
Economic services n.e.c.	21.0	18.6	17.5	1.1	34.0	31.2	2.7
<i>Total economic development</i>	110.9	156.4	147.6	8.8	215.7	200.0	15.7
<b>Community welfare—</b>							
Urban and regional planning	4.0	4.3	4.1	0.2	6.0	5.6	0.3
Environment	5.7	12.6	11.5	1.0	17.2	15.6	1.6
Health	87.3	139.8	134.8	5.0	186.4	179.4	7.0
Education	18.1	26.6	23.6	3.0	35.5	31.6	4.0
Welfare	5.7	8.3	8.0	0.3	10.0	9.1	0.9
Community services n.e.c.	11.3	13.3	12.5	0.8	19.2	17.6	1.6
<i>Total community welfare</i>	132.1	204.8	194.5	10.4	274.3	258.9	15.4
<b>Advancement of knowledge—</b>							
Earth, ocean and atmosphere n.e.c.	26.3	42.3	41.8	0.6	49.2	48.6	0.6
General advancement of knowledge	182.4	281.0	278.1	2.9	340.8	336.0	4.8
<i>Total advancement of knowledge</i>	208.7	323.3	319.9	3.5	390.0	384.6	5.4
<b>Total</b>	<b>452.5</b>	<b>685.7</b>	<b>663.1</b>	<b>22.7</b>	<b>881.9</b>	<b>845.2</b>	<b>36.6</b>

**RESEARCH AND EXPERIMENTAL DEVELOPMENT CARRIED OUT BY HIGHER  
EDUCATION ORGANISATIONS, AUSTRALIA  
HUMAN RESOURCES DEVOTED TO R&D BY SOCIO-ECONOMIC OBJECTIVE**

<i>Socio-economic objective</i>	<i>Person years of effort on R&amp;D</i>						
	<i>1984r</i>				<i>1986</i>		
	<i>1981</i>	<i>Total</i>	<i>Universities</i>	<i>CAEs</i>	<i>Total</i>	<i>Universities</i>	<i>CAEs</i>
<i>National security (Defence)</i>	19	29	28	1	52	39	12
<i>Economic development—</i>							
Agriculture	1,554	1,922	1,863	59	2,031	1,969	62
Forestry and fisheries	167	282	265	17	256	237	19
Mining (prospecting)							
Energy sources	64	71	56	15	110	93	17
Other	67	108	96	12	206	194	12
Mining (extraction)							
Energy sources	44	34	33	1	23	21	2
Other	104	128	110	18	202	165	37
Manufacturing	583	625	522	103	922	710	212
Construction	107	225	210	15	240	214	26
Energy	764	769	706	64	729	653	76
Transport	98	129	108	22	118	89	29
Communications	143	196	175	21	306	249	58
Economic services n.e.c.	677	443	399	45	736	630	106
<i>Total economic development</i>	4,372	4,933	4,542	391	5,879	5,222	657
<i>Community welfare—</i>							
Urban and regional planning	161	116	107	9	149	134	16
Environment	256	422	377	45	490	424	66
Health	3,345	4,140	3,902	238	4,778	4,492	285
Education	923	891	767	124	947	805	141
Welfare	202	245	232	13	269	229	41
Community services n.e.c.	427	337	304	33	472	398	75
<i>Total community welfare</i>	5,314	6,151	5,688	462	7,106	6,482	624
<i>Advancement of knowledge—</i>							
Earth, ocean and atmosphere n.e.c.	1,019	1,135	1,097	38	1,163	1,136	26
General advancement of knowledge	7,516	8,597	8,458	139	9,043	8,834	209
<i>Total advancement of knowledge</i>	8,535	9,732	9,556	176	10,205	9,970	235
<b>Total</b>	<b>18,241</b>	<b>20,844</b>	<b>19,814</b>	<b>1,030</b>	<b>23,242</b>	<b>21,713</b>	<b>1,529</b>

### Private non-profit sector

The estimate of expenditure on R&D carried out by private non-profit organisations during 1986-87 was \$49.1 million at *current* prices. This represents a 13 per cent increase in expenditure compared with 1984-85. At average 1984-85 prices, R&D expenditure is estimated to have increased by 2 per cent over the same period.

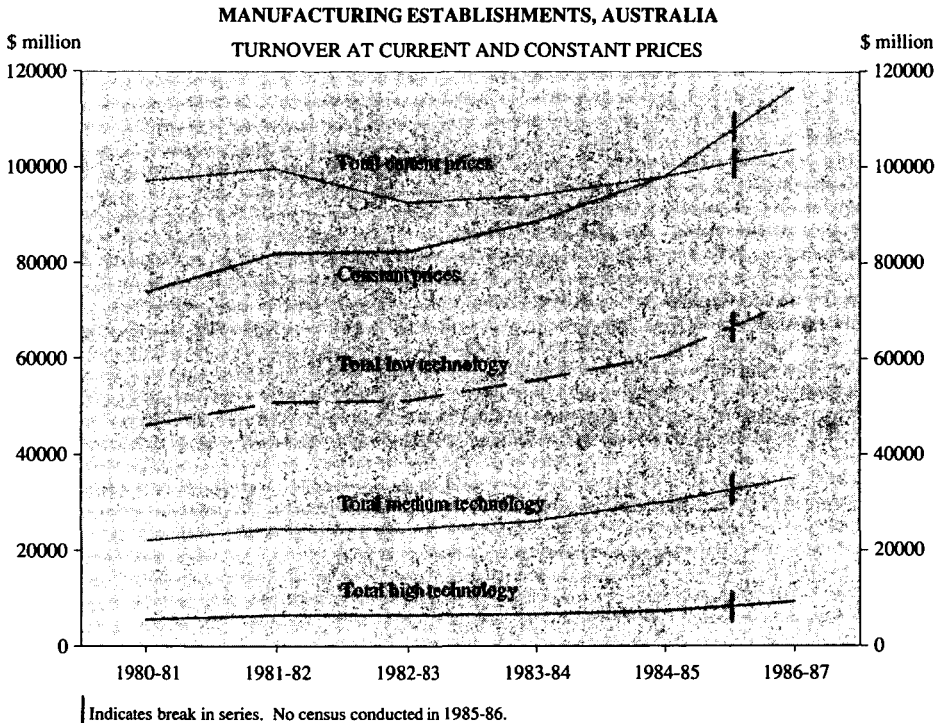
#### RESEARCH AND EXPERIMENTAL DEVELOPMENT CARRIED OUT BY PRIVATE NON-PROFIT ORGANISATIONS, AUSTRALIA DETAILS OF RESOURCES DEVOTED TO R&D BY SOCIO-ECONOMIC OBJECTIVE

<i>Socio-economic objective</i>	<i>Expenditure (\$'000)</i>			<i>Person years of effort on R&amp;D</i>		
	<i>1981-82</i>	<i>1984-85r</i>	<i>1986-87</i>	<i>1981-82</i>	<i>1984-85r</i>	<i>1986-87</i>
<i>National security (Defence)</i>	—	—	—	—	—	—
<i>Economic development—</i>						
Agriculture	36	55	69	3	2	3
Forestry and fisheries	—	—	35	—	—	1
Mining (prospecting)						
Energy sources	—	—	—	—	—	—
Other	—	n.p.	—	—	n.p.	—
Mining (extraction)						
Energy sources	—	—	—	—	—	—
Other	—	—	—	—	—	—
Manufacturing	—	—	267	—	—	3
Construction	—	n.p.	—	—	n.p.	—
Energy	3	535	303	1	8	4
Transport	196	n.p.	52	12	n.p.	1
Communications	—	3	—	—	1	—
Economic services n.e.c.	512	780	1,363	18	18	28
<i>Total economic development</i>	<i>747</i>	<i>2,116</i>	<i>2,089</i>	<i>34</i>	<i>41</i>	<i>40</i>
<i>Community welfare—</i>						
Urban and regional planning	—	397	358	—	6	4
Environment	—	4	564	—	—	16
Health	17,758	38,801	43,496	563	615	818
Education	1,739	1,228	1,200	63	24	20
Welfare	420	558	882	22	16	23
Community services n.e.c.	35	88	10	1	2	—
<i>Total community welfare</i>	<i>19,952</i>	<i>41,075</i>	<i>46,511</i>	<i>649</i>	<i>662</i>	<i>881</i>
<i>Advancement of knowledge—</i>						
Earth, ocean and atmosphere n.e.c.	—	45	48	—	1	2
General advancement of knowledge	210	251	459	6	8	8
<i>Total advancement of knowledge</i>	<i>210</i>	<i>296</i>	<i>507</i>	<i>6</i>	<i>9</i>	<i>10</i>
<b>Total</b>	<b>20,909</b>	<b>43,488</b>	<b>49,107</b>	<b>688</b>	<b>712</b>	<b>931</b>

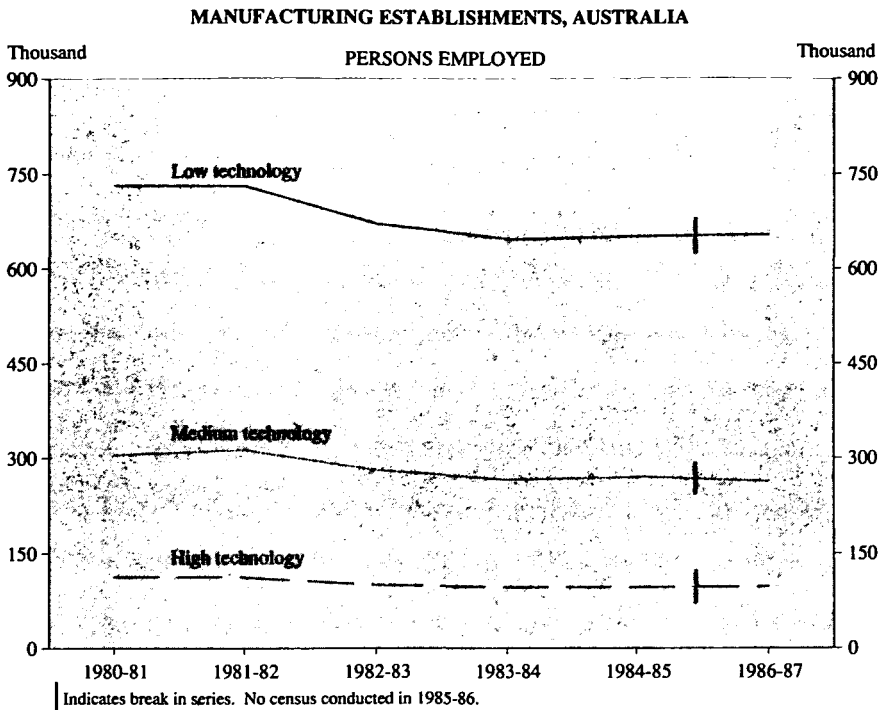
### Statistics on manufacturing industry technology

The level of technological development in manufacturing industry can be viewed by classifying industries to high, medium and low technology according to the intensity of their R&D effort. Using the OECD classification by this method, high technology industries are defined as those manufacturing establishments classified to aircraft (Australian Standard Industrial Classification (ASIC) Class 3244). Communications and other electronic equipment (ASIC Classes 3351 and 3352); electrical appliances and machinery (ASIC Classes 3353–3357); pharmaceutical and veterinary products (ASIC Class 2763); and photographic, professional and scientific equipment (ASIC Group 334). Medium technology covers chemicals (apart from ASIC Class 2763); petroleum and coal products; non-ferrous metals and basic products; motor vehicles and parts, railway equipment and other transport equipment (ASIC Class 3245); industrial machinery; rubber and plastic products; and, other manufacturing (ASIC Group 348). Low technology covers food, beverages and tobacco; textiles, clothing and footwear; wood and wood products; paper and paper products, etc.; petroleum refining; non-metallic mineral products, basic iron and steel products; fabricated metal products; ships and boats; and, leather products.

The figure below shows that high technology industries as a group showed current price growth in turnover in the six year period from 1980–81 to 1986–87 (65 per cent). Low and medium technology groups have performed comparably with growths of 57 per cent and 60 per cent respectively. In constant prices terms, total manufacturing industry turnover has shown little growth (1 per cent over the period).



The following figure shows a downturn in manufacturing industry employment levels (net drops of 13 per cent, 14 per cent and 11 per cent for high, medium and low technology industries respectively). Data for the latest year available show modest rises between 1984-85 and 1986-87 for high and low technology industries (1.2 per cent and 0.5 per cent respectively) while medium technology industries recorded a drop of less than 1 per cent.



## Trade statistics

Another way of viewing Australian manufacturing industry's level of technological development is to look at trade of high technology products. Products are classified initially according to commodity (Australian Import and Export Commodity Codes) but converted to an ASIC basis. Definitions of high, medium and low technology groups according to ASIC are the same as above.

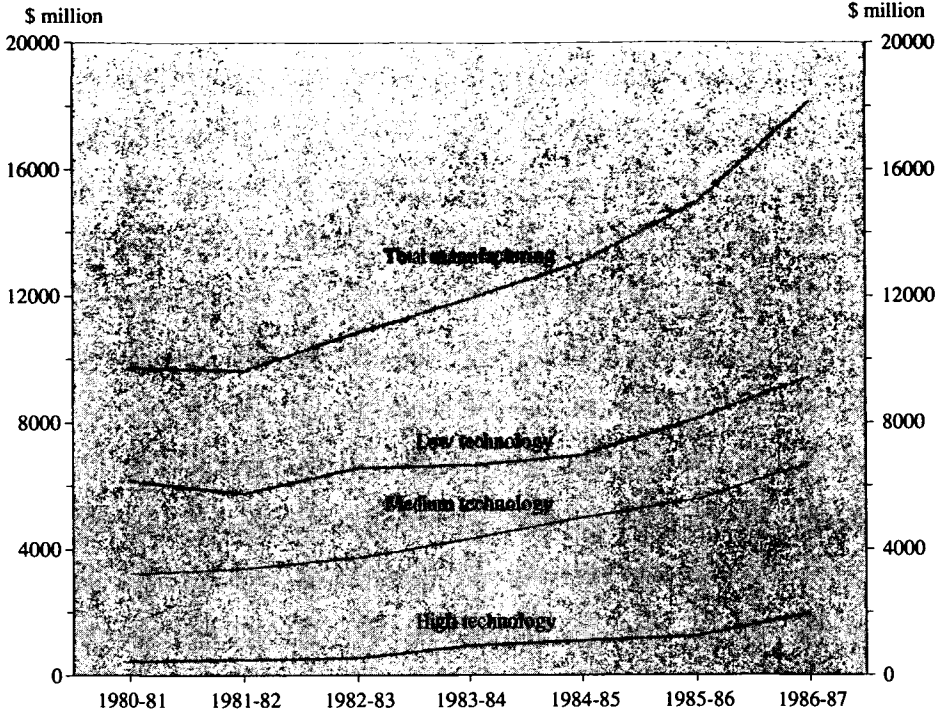
The current price value of imports of Australian manufactures is increasing for all groups but most of all for high technology products (19 per cent increase between 1985-86 and 1986-87 compared to 8 per cent and 4 per cent for low and medium technology products respectively).

Current price export growth over the four year period 1983-84 to 1986-87 is also highest for the high technology group (110 per cent compared with 56 per cent for medium and 42 per cent for low technology).

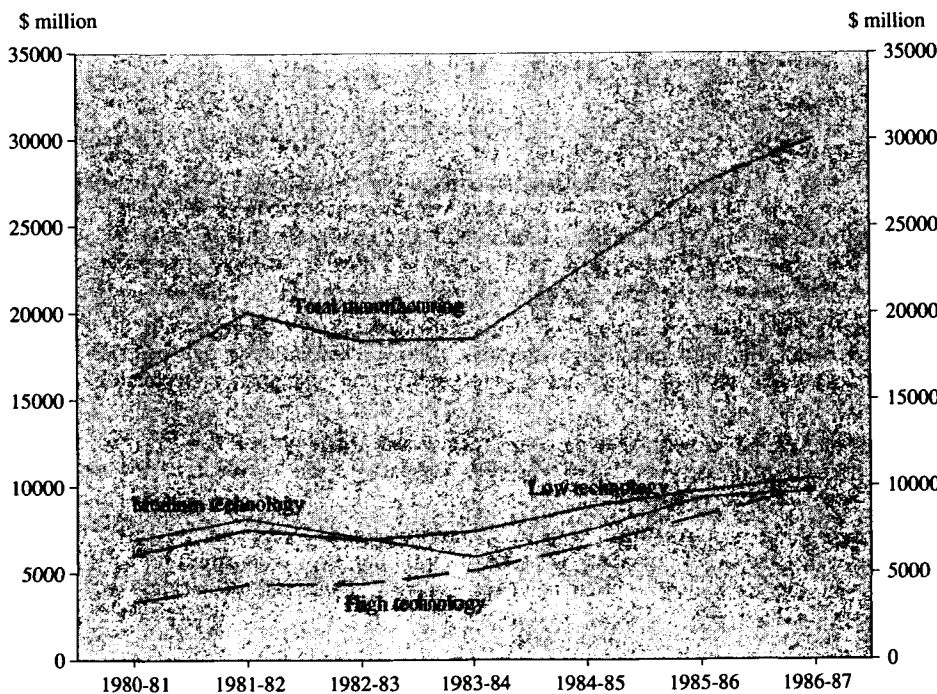
The current price value of total exports of manufactured goods has increased more than imports over the period 1985-86 to 1986-87 (21 per cent compared to a 10 per cent increase for the total current price value of imports). The highest increase was for high technology products (59 per cent compared with 21 per cent and 16 per cent for medium and low technology products respectively).

Over the four year period 1983-84 to 1986-87 the value of imports of high technology goods has increased the most (92 per cent compared to 63 per cent and 41 per cent for medium and low technology goods respectively).

EXPORTS OF MANUFACTURES, AUSTRALIA



IMPORTS OF MANUFACTURES, AUSTRALIA



## Other Activities

For information on other activities related to science and technology, see *Year Book* No. 70. That edition contains information on scientific and technological information services (page 640), social science and humanities research (page 652) and international activities (page 653).

## 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 Industry, Technology and Commerce, the CSIRO, the Australian Nuclear Science and Technology Organisation, the Department of Defence, and in the annual *Science and Technology Statements*. Statistical information on R&D for the years 1968–69, 1973–74 and 1976–77 may be found in the reports on Project SCORE published by the (then) Department of Science. Statistical information on R&D relating to 1978–79, 1981–82, 1984–85, 1985–86 and 1986–87 may be obtained from the Australian Bureau of Statistics (ABS). Further statistical information on higher education is obtainable from the Commonwealth Tertiary Education Commission. Trade and industry operations data are available from the ABS.

The Department of Industry, Technology and Commerce's *Australian Science and Technology Indicators Report*, published in 1988, uses S&T indicators to give a good overview and analysis of science and technology information in Australia. It presents information on R&D effort and expenditure, science and technology workforce, S&T information resources, scientific equipment and facilities, literature-based S&T measures, patent activity, technology training, financial support for technological development, industry operations and trade by level of technology, and transfer of technical knowledge.

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