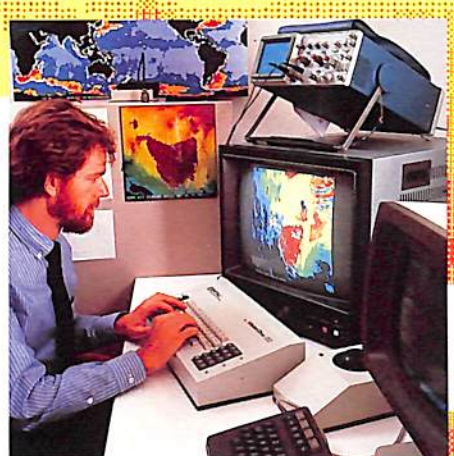
AUSTRALIA

CSIRO

Annual Report 1985/86



CSIRO
Annual Report
1985/86

Commonwealth Scientific and Industrial Research Organization, Australia

The Role, Organisation and Functions of CSIRO

Role

CSIRO is Australia's main research institution. It carries out scientific research in support of all major areas of Australian economic and community interest excluding defence, nuclear science and clinical medicine. It works principally in the physical and biological sciences and technologies but includes some research in the social sciences where this is necessary to make other work effective.

The object of approximately 80% of its work is to increase economic efficiency in industry, thereby improving competitiveness, promoting employment and generating wealth in the community. Promoting human health and conserving the natural environment account for approximately 15% of its work and the remainder is aimed at increasing scientific knowledge relevant generally to Australia.

CSIRO's research output includes:

- developing manufacturing technologies that lead to new and improved products and processes;
- finding better ways of producing and processing Australia's agricultural and mineral products;
- improving communications and instrumentation;
- developing new industrial materials and chemicals;
- conserving and finding new sources of non-renewable energy;
- improving water quality and availability;
- improving the built environment and conserving the natural environment; and
- identifying ways to better health.

The results of this work are transferred to users through publications, collaboration with State agencies and industrial partners, licensing, seminars and open days.

Organisation

CSIRO is an independent statutory authority created by the Commonwealth of Australia. It is governed by an eight-member Executive drawn from industry, special community interests and scientific research. Three members are full-time, one being the Chairman and Chief Executive. Following a recent review, the Executive will be replaced by a Board.

The Organization comprises 43 Divisions and research Units grouped into five Institutes. Some 2500 professional scientists operate in more than 100 laboratories and field stations throughout Australia.

CSIRO is responsible for conducting research and for deciding, in consultation with community representatives, what research it should undertake. The Executive is advised by an independently appointed statutory Advisory Council, which is in turn supported by State and Territory Committees. These bodies also will be replaced under the new Board arrangements. Consultative links exist with Federal Government departments having strong interests in science and technology.

Functions

The formal functions of CSIRO are set out in the *Science and Industry Research Act* 1949. They were last updated in 1978. In summary they are:

- to carry out scientific research relevant to Australian industry, the community, national objectives, national or international responsibilities, or for any other purpose determined by the Minister;
- to encourage and facilitate the application and utilisation of research results;
- to liaise with other countries in matters of scientific research;
- to train research workers;
- to make grants and award fellowships and studentships relevant to the Organization's research;
- to recognise, cooperate with and make grants to industrial research associations;
- to establish, and promote the use of, standards of measurement of physical quantities;
- to collect, interpret and disseminate scientific and technical information; and
- to publish scientific and technical reports, periodicals and papers.

ISSN 0069–7311

Commonwealth Scientific and Industrial

Research Organization, Australia

The Honourable Barry O. Jones, M.P.,
Minister for Science,
Parliament House,
CANBERRA, A.C.T. 2600.

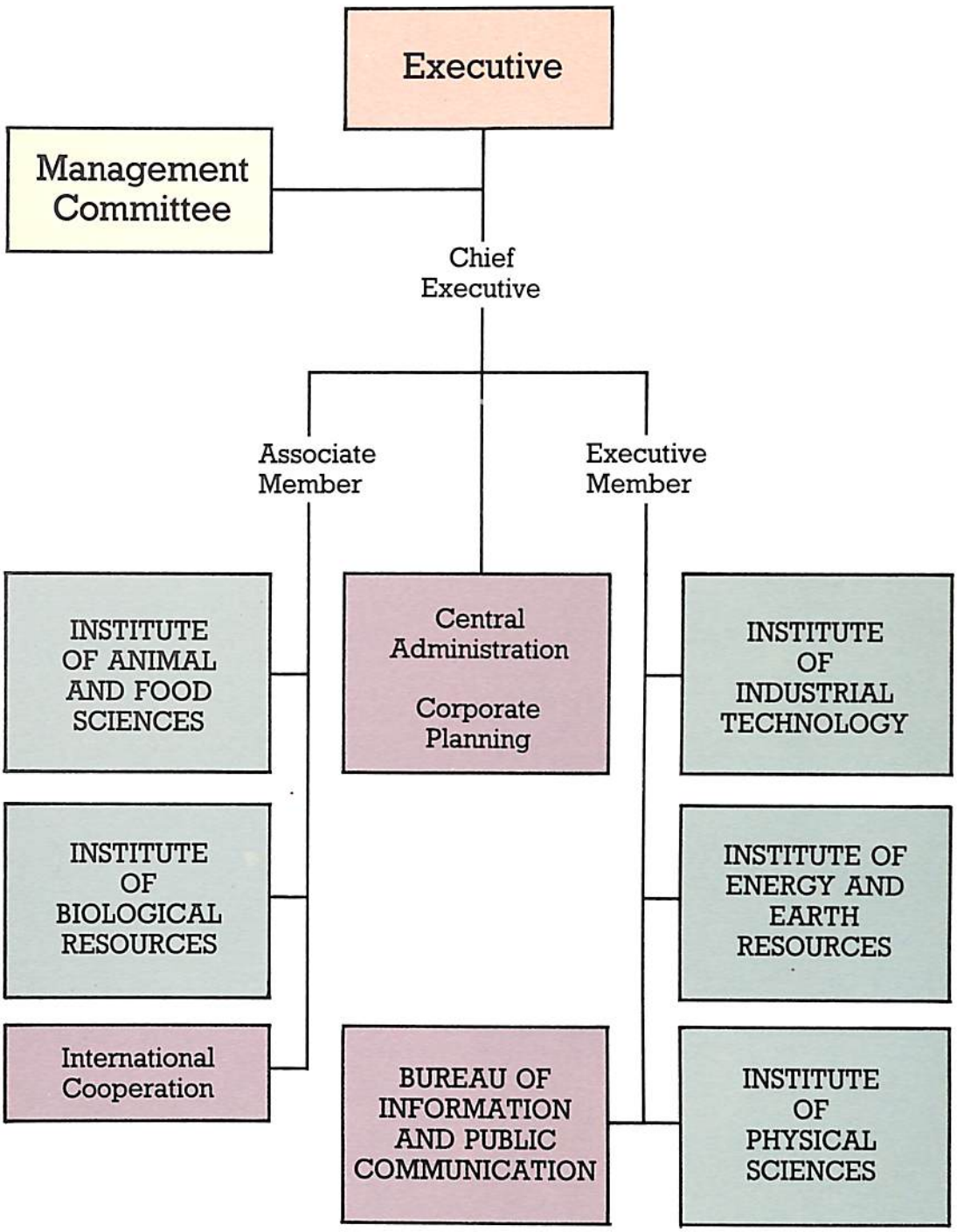
The Executive of CSIRO has pleasure in submitting to you, for presentation to Parliament, its thirty-eighth annual report, which covers the period 1 July 1985 to 30 June 1986. The report is submitted in accordance with section 57 of the Science and Industry Research Act 1949.

N.K. Boardman (Chairman)
A.E. Clarke
K.J. Foley
M.D. Kirby
G.G. Spurling
G.H. Taylor
P.D.A. Wright

August 1986

Organization Chart

The chart shows the structure of CSIRO as at 1 July 1986.



Executive

Chairman and Chief Executive
Dr N.K. Boardman

Full-time Member
Dr G.H. Taylor

Part-time Members
Prof. A.E. Clarke
Dr K.J. Foley
Hon. Justice M.D. Kirby
Mr G.G. Spurling
Mr P.D.A. Wright

Associate Member
Dr M.G. Pitman

Management Committee
Chief Executive
Full-time Member
Associate Member
Directors
Corporate Secretary
General Managers

INSTITUTE OF ANIMAL AND FOOD SCIENCES
Director
Dr A.D. Donald (*Acting*)

Divisions and Chiefs
Animal Health
Dr J.K. Dineen (*Acting*)
Animal Production
Dr T.W. Scott
Australian Animal Health Laboratory
Mr W.A. Snowdon
Fisheries Research
Dr F.R. Harden Jones
Food Research
Dr J.H.B. Christian
Human Nutrition
Dr P.J. Nestel
Molecular Biology
Dr G.W. Grigg
Tropical Animal Science
Dr D.F. Mahoney
Unit and Officer-in-Charge
Wheat Research
Dr C.W. Wrigley

INSTITUTE OF BIOLOGICAL RESOURCES
Director
Dr J.J. Landsberg (*Acting*)

Divisions and Chiefs
Entomology
Dr M.J. Whitten
Forest Research
Mr A.G.J. Brown (*Acting*)
Horticultural Research
Dr J.V. Possingham
Plant Industry
Dr W.J. Peacock
Soils
Dr D.E. Smiles
Tropical Crops and Pastures
Dr E.F. Henzell
Water and Land Resources
Dr R.J. Millington
Wildlife and Rangelands Research
Dr B.H. Walker
Unit and Officer-in-Charge
Centre for Irrigation Research
Dr D.S. Mitchell

INSTITUTE OF INDUSTRIAL TECHNOLOGY
Director
Dr W.I. Whitton

Divisions and Chiefs
Applied Organic Chemistry
Dr D.H. Solomon
Building Research
Dr F.A. Blakey
Chemical and Wood Technology
Dr W. Hewertson
Manufacturing Technology
Dr R.H. Brown
Protein Chemistry
Dr R.D.B. Fraser
Textile Industry
Dr D.S. Taylor
Textile Physics
Dr K.J. Whiteley

INSTITUTE OF ENERGY AND EARTH RESOURCES
Director
Dr A.F. Reid

Divisions and Chiefs
Energy Chemistry
Dr P.G. Alfredson
Energy Technology
Dr D.C. Gibson
Fossil Fuels
Mr I.W. Smith (*Acting*)
Geomechanics
Dr B.H.G. Brady
Groundwater Research
Mr R.A. Perry
Mineral Chemistry
Dr T. Biegler (*Acting*)
Mineral Engineering
Dr R.J. Batterham
Mineral Physics and Mineralogy
Dr B.J.J. Embleton
Minerals and Geochemistry
Dr D.F.A. Koch

INSTITUTE OF PHYSICAL SCIENCES
Director
Dr N.H. Fletcher

Divisions and Chiefs
Applied Physics
Dr J.J. Lowke
Atmospheric Research
Dr G.B. Tucker
Chemical Physics
Dr L.T. Chadderton
Environmental Mechanics
Dr J.R. Philip
Information Technology
Dr G.E. Thomas
Materials Science
Dr J.R. Anderson
Mathematics and Statistics
Dr T.P. Speed
Oceanography
Dr A.D. McEwan
Radiophysics
Dr R.H. Frater

Central Administration
Office of the Chairman
Corporate Secretary
Dr N.J. Sullivan (*Acting*)
Finance and Administration
General Manager
Mr H.C. Crozier
Personnel
General Manager
Mr K.J. Thrift

Corporate Planning Unit

Centre for International Research Cooperation (CIRC)
Officer-in-Charge
Dr B.K. Filshie

Bureau of Information and Public Communication
Director
Mr P.J. Dunstan

CSIRO Office of Space Science and Applications (COSSA)
Director
Dr K.G. McCracken

CSIRONET
Executive Chairman
Mr D. McCullough
Chief General Manager
Mr D.S. Glavonjic (*Acting*)

SIROTECH Ltd
Chairman
Mr L.L. Cuming
Chief Executive
Mr J.J. Doyle

CONTENTS

Chairman's Review

Australia's decline as a trading nation has prompted a great deal of discussion in the past year on the need to make Australian industries, particularly the manufacturing and service industries, more competitive and export-oriented. One interesting feature of the debate has been the increasing recognition of the importance of research and innovation in achieving this objective.

The world has become much more industrially competitive over the past decade or so, with the established industrial nations facing growing pressure from the newly industrialised countries, many of them in Australia's neighbourhood. The most intense competition is in advanced technologies, the area in which world trade is expanding most rapidly.

Many countries are striving to gear their scientific research and development (R&D) more closely to industrial uses. This drive transcends differences in political ideology; the same trend is apparent in the Soviet Union, the United States and Japan.

Australia has long had an international reputation for its science. In science, as in sport, our performance belied our small population. This talent has been put to good use in our agricultural and mining industries, less so in the other industrial sectors, although even in these areas we have demonstrated time and again we can come up with world-beating products and processes.

However, with the policy developments and initiatives of the last few years, and especially the past year, I believe Australia is now better placed than ever before to reap economic benefits from its research capability.

This year, we have seen the introduction of the Federal Government's 150% tax incentive for R&D and a new offsets policy that will encourage foreign contractors to undertake more R&D and technical training in Australia — arguably the two most significant initiatives in technology policy by Government in recent times. The introduction of the National Industry Extension Service, and the Grants for Industry Research and Development to replace the Australian Industrial Research and Development Incentives Scheme are other examples of Federal Government action during the year.

State Governments, too, have taken steps to encourage the establishment of technology-intensive industries, while universities, through the Australian Vice-Chancellors' Committee, announced recently several proposals for strengthening and expanding links with industry.

CSIRO, which celebrates this year its 60th anniversary, is itself undergoing a profound transformation.

The Government's decisions, announced in June, on the Australian Science and Technology Council's (ASTEC) review of CSIRO represent strong support for CSIRO and give the Organization an even greater national role than it has had traditionally. Announcing the decisions, the Minister for Science, Mr Barry Jones, said: 'While CSIRO will place more emphasis on the application of its research, it is important that its ability to contribute to future industrial development is not inhibited by excessive attention to the short-term needs of existing industries. CSIRO must maintain a balance in its activities, with a major emphasis on strategic research, while ensuring that its science remains at the forefront of world developments.'

The present Executive will be replaced by a governing Board comprising a part-time non-executive Chairman, a full-time Chief Executive and six to eight part-time members. This restructuring of CSIRO should give a clear separation of policy-making, by the Board, and the management of CSIRO, and strengthen the injection of outside views in policy formulation.

ASTEC also recommended that the Organization be allowed to retain outside earnings without this leading to a cut in budget funds. The Government's endorsement of this will be a major incentive to working more closely with industry.

In August, the Executive adopted a strategy for 1985 to 1990, aimed at improving the focus, evaluation, management and use of CSIRO's research. Its implementation is under way.

Almost all of the Organization's 41 research Divisions now have advisory committees, which include representatives from industry, government, tertiary bodies and relevant community groups, and this year the Organization set up sectoral committees covering industry sectors and areas of community activity to which its work is directed.

CSIRO's new commercial company, SIROTECH Ltd, has been in operation for close to two years, and has already demonstrated its capability for bringing CSIRO research closer to industry. In the last financial year it negotiated the setting up of two joint venture companies, with ICI Australia Ltd and Du Pont (Australia) Ltd, and agreements for the commercialisation of many CSIRO developments, including a new reconstituted timber product, Scrimber. Scrimber is to be manufactured by the South Australian Timber Corporation and has generated great interest in Japan and North America.

The CSIRO Manufacturing Industry Collaborative Research Program, launched in late 1985 and managed by SIROTECH, has been well received by industry. More than 10 collaborative research projects have commenced. SIROTECH has, under the program, also completed major market research projects to assess prospects for R&D collaboration in the automotive components and chemicals and plastics industries.

The pulsed-arc welding system developed by CSIRO was one of the world-beating technologies that contributed to Australia's victory in the 1984 America's Cup challenge. The process is being used on the hulls of all the contending Australian yachts in the 1987 Cup trials.

CSIRO has been conducting space research for several decades, but this activity has substantially increased with the setting up in 1985 of COSSA, the CSIRO Office of Space Science and Applications. COSSA is now coordinating CSIRO's involvement in over 20 space-related projects. CSIRO resources devoted to space R&D increased from $1.5 million in 1984/85 to $3.55 million in 1985/86.

These initiatives and the Government's response to ASTEC do not represent a change in CSIRO's primary role, but rather a change in emphasis — a move to make the Organization more effective in its role.

This was the rationale behind the Executive's decision in March to merge the Divisions of Chemical Physics and Materials Science to form a new Division of Materials Science and Technology. The merger will, I believe, strengthen the work of the two Divisions. The research of the new Division will cover advanced ceramics, surface coatings and improved alloys and composites. New materials have enormous potential for making Australia's future industries more competitive and better able to exploit new and expanding international markets.

Despite all the recent initiatives by Government, CSIRO and others, I remain concerned about Australia's capacity to make the most of its scientific capability. In celebrating successes such as CSIRO's super-tough ceramic PSZ, the aircraft landing system Interscan, a revolutionary welding machine and an exciting new robot vision system, it is easy to overlook a crucial point: Australia's research effort is minuscule compared with that of the technological giants of the world such as Japan and the United States. Australia's total R&D budget is only about half that of the biggest private R&D spenders in the U.S., General Motors and IBM.

Furthermore, most industrial countries have targeted the same broad areas of research for greatest effort — areas such as space, information technology, biotechnology and new materials.

Australian industries, particularly manufacturing, must work collectively and cooperatively, and with research groups, to identify their longer-term problems and needs, strengths and opportunities. CSIRO and other research institutions can then focus their research on those areas that will produce the greatest benefit for Australian industry and the Australian community.

The agricultural and mining sectors do work collectively in this way. But it has become clear in the debate and discussions of the past year that Australia cannot continue to rely as heavily as it has on its traditional exports of raw materials to pay for the comfortable standard of living we enjoy, and take for granted.

Our agricultural and mineral exports must be diversified and increased in value through local processing. Our exports in manufactured goods and services must improve.

Many factors affect our ability to expand our export base, but technological innovation, and hence R&D, is one factor that cannot be neglected. Unless all sectors of industry make a strong commitment to research, and to the rapid adoption of research findings, we cannot hope to become more competitive, to improve our performance as a trading nation.

The debate about CSIRO that has been a feature of the past few years may now subside. But the outcome of that debate is not 'business as usual'. The staff of CSIRO now face a greater challenge than at any time in the Organization's 60-year history. The challenge is not only to maintain excellence in scientific research. It is now also one of striving to ensure that the nation receives the maximum benefit, economically and socially, from that research.

The staff of the Organization is its most valuable resource and I take the opportunity to express the appreciation of the Executive for their achievements over a year of considerable change, and some uncertainty due to the review.

Paul Wild retired as Chairman on 24 September 1985. His unswerving faith in the Organization and its creative staff was an inspiration and a strength, particularly in the more difficult periods of the past few years. On behalf of the Executive and staff I thank him for his fine and courageous leadership, and for his outstanding contributions to the research of the Organization over many years.

Highlights

Dr J.P. Wild

Dr J. Paul Wild, AC, CBE, ScD, FTS, FAA, FRS, retired as Chairman of CSIRO on 24 September 1985 after seven years' service in the position. He joined the Organization in 1947 and served as an associate member of the Executive from March 1977 until his appointment as a full-time member in 1978.

Dr Wild graduated BA from the University of Cambridge in 1943, MA in 1950, and ScD from the same university in 1962. He joined the Division of Radiophysics in 1947 and became Chief of the Division in 1971. During his time with the Division he made significant contributions and discoveries in the field of radioastronomy, and originated the concept of the microwave aircraft landing system, Interscan, now being developed commercially.

As Chairman, Dr Wild was responsible for implementing changes arising from government decisions on the Independent Inquiry into CSIRO (the Birch inquiry) and the 1978 amendments to the *Science and Industry Research Act* 1949. He oversaw the introduction of an Institute structure and corporate planning, the upgrading of CSIRO's work in support of manufacturing industry, and improvements in CSIRO's communication with industry and government.

Dr N.K. Boardman

Dr N. Keith Boardman, ScD, FAA, FRS, became Chairman on 25 September 1985, succeeding Dr Wild. In view of the review of CSIRO being conducted by ASTEC at the time, the Government made short-term appointments to all positions on the Executive, including the Chairmanship. Dr Boardman was appointed initially for nine months and this term was subsequently extended to 31 December 1986 to allow further time for government consideration of the ASTEC report and amendments to the *Science and Industry Research Act* 1949.

Dr Boardman graduated BSc and MSc from the University of Melbourne, and was awarded a PhD in Biochemistry by the University of Cambridge. He was a Research Scientist with the CSIRO Wool Research Section from 1949 to 1951, and in 1956 joined the CSIRO Division of Plant Industry, rising to the position of Chief Research Scientist in 1968.

Dr Boardman was a Member of the Australian Research Grants Committee from 1971 to 1975, President of the Australian Biochemical Society from 1976 to 1978, and Treasurer of the Australian Academy of Science from 1978 to 1981. He is a Member of the Council of the Australian National University, the CRA Scientific Advisory Board, the Board of Management of the Australian Centre for International Agricultural Research, and a Member of that Centre's Policy Advisory Council. He is also a Member of the National Biotechnology Program Research Grants Advisory Committee.

Research

New Chemical Company

CSIRO has formed a joint enterprise company, Dunlena Pty Ltd, with Du Pont Australia Pty Ltd to exploit on the international market new crop-protection chemicals resulting from the biological organic chemistry program of the Division of Applied Organic Chemistry.

Dark Fibre Detection

The Division of Textile Physics has developed an instrument that provides optimum illumination for visually detecting dark fibres in the early stages of wool processing. The procedures have been accepted as a draft standard by the International Wool Textile Organization.

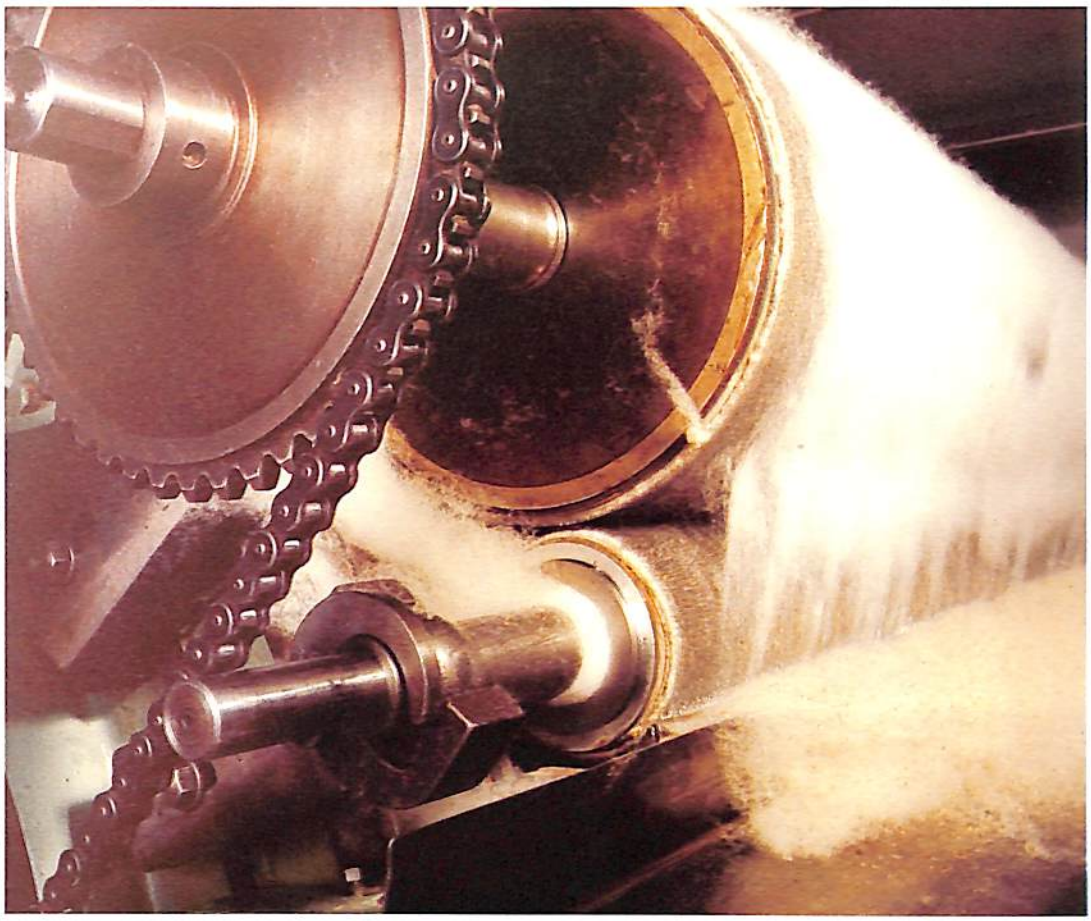
Water-based Pigment Printing

A water-based pigment printing process, produced jointly by the Division of Protein Chemistry and Albright and Wilson (Aust.) Ltd, has been released to the textile industry for printing cotton, polyester and other fabrics.

Hard, Wear-resistant Coatings

A pilot plant has been constructed, in collaboration with Sutton Tools Pty Ltd, for depositing titanium nitride, a hard, wear-resistant coating, on cutting and forming tools to increase substantially their useful life.

Research at the Division of Textile Industry has resulted in improved productivity of worsted card machines that now offer wool topmakers dramatically improved production rates for their worsted cards.



Sewage Treatment Process

The Division of Chemical and Wood Technology, in collaboration with the University of Melbourne, has evolved a new sewage treatment process — the Alternating Aerobic/Anaerobic Completely Mixed Activated Sludge System — to reduce the content of nitrogenous substances in sewage effluent.

ATLAS

ATLAS — the Automatic Tester for Length and Strength — a computer that tests the length and strength of wool staples, was developed by the Division of Textile Physics and manufactured by Kel Engineering Laboratories. The Minister for Primary Industry, the Hon. John Kerin, opened the ATLAS installation in Sydney in December.

Micro-BRIAN

The microcomputer version of CSIRO's Barrier Reef Image Analysis System (BRIAN) is now available commercially under a SIROTECH, CSIRO and MPA Pty Ltd agreement. Micro-BRIAN can be used for basic image processing, and the mapping and monitoring of shallow water and reefs, erosion, and crops, forests and other vegetation and is predicted to win a significant share of the computerised image-analysis market.

Influenza Research

A new Australian company — Biota Holdings Ltd — involving CSIRO, the Australian National University in Canberra, and the Victorian College of Pharmacy has been set up to find an influenza cure. Its aim is to produce a drug for treating influenza and a synthetic influenza vaccine.

Beta-carotene

Research on biomembranes at the Division of Chemical and Wood Technology has led to the setting up by Betatene Ltd of a plant to extract beta-carotene from the marine alga *Dunaliella salina*.

Fatty Acids Protection

The Division of Human Nutrition has identified specific unsaturated fatty acids as affording protection against abnormal heart rhythm, a major cause of sudden death in humans.

Cost Estimation Program

The Housing Industry Association has purchased exclusive rights for two years to the Division of Building Research's centralised data base for cost estimation for small builders because it has the right balance between accuracy and simplicity of operation.

Insect Control by Nematodes

CSIRO, in collaboration with Biotechnology Australia Pty Ltd, has developed techniques for the mass rearing of nematodes — microscopic parasitic worms for controlling such insect pests as currant borer moth and black vine weevil — and their formulation into a spray for field use.

Better Trace Metal Analysis

A Division of Minerals and Geochemistry inventor has set up a company, Chemtronics, to market an instrument for analysing minute quantities of trace elements in solutions. The simple and cheap instrument can be used in mineral exploration, environmental monitoring and industrial processing.

Diagnostic Test for FMD

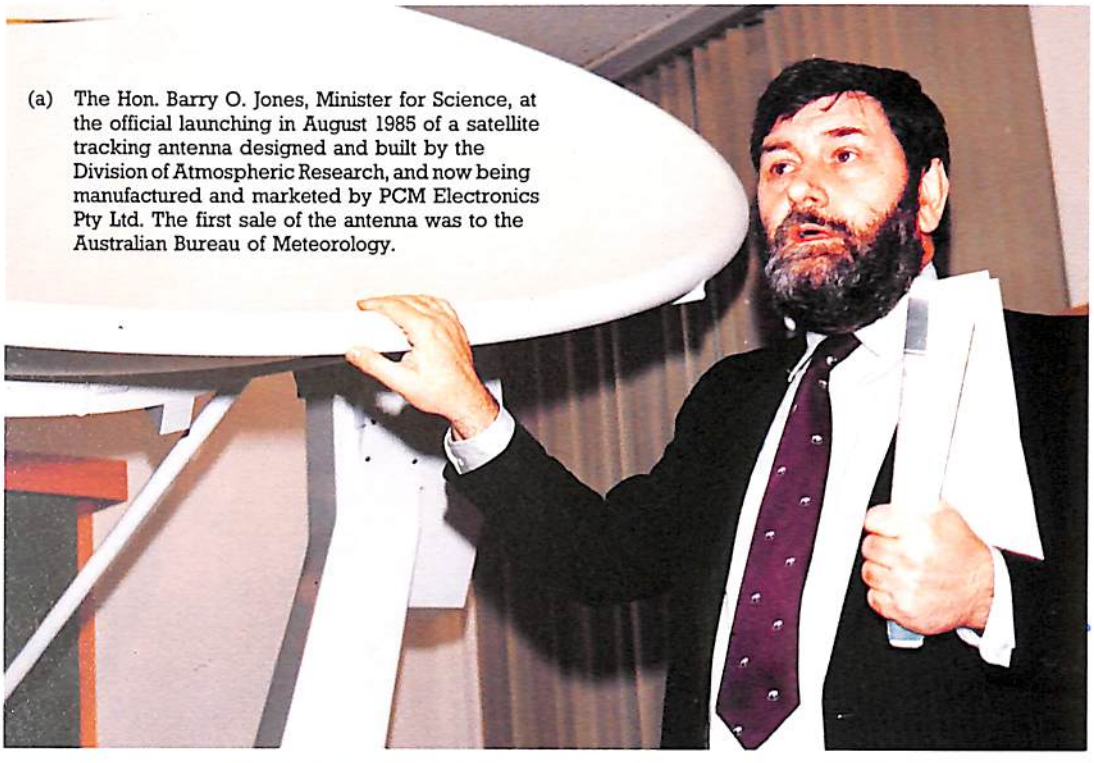
The Australian Animal Health Laboratory has set up an improved diagnostic test for foot-and-mouth disease that does not require the use of live virus.

Image Processing

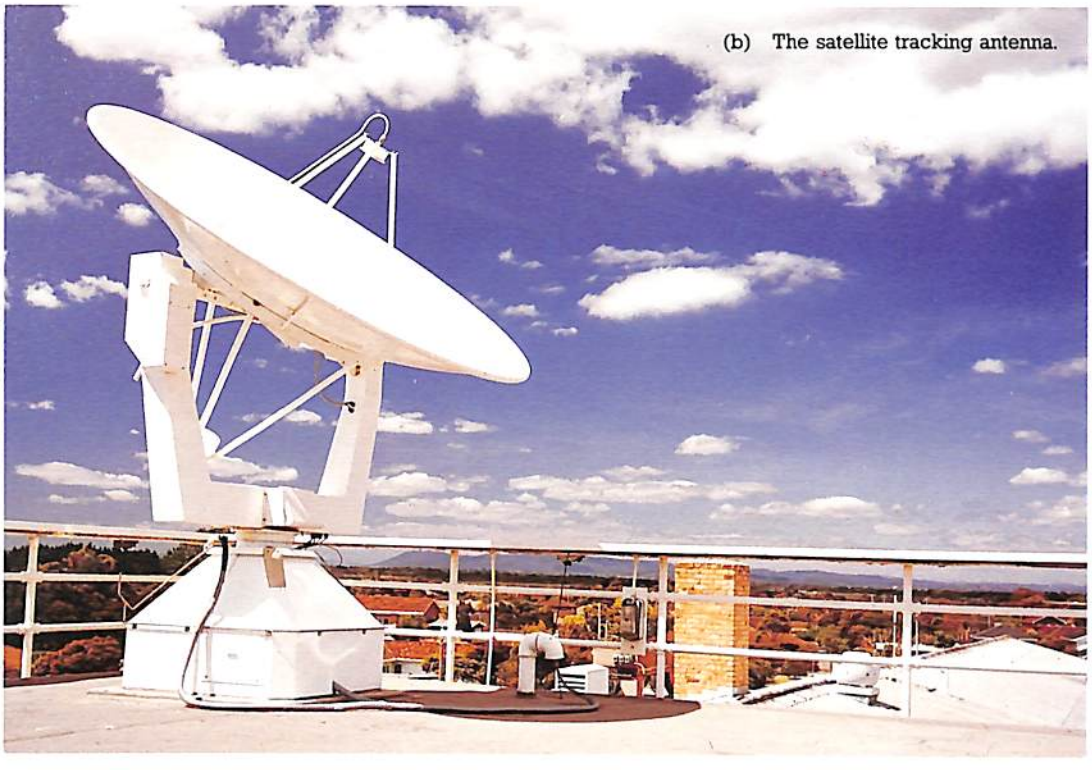
A new Australian satellite receiving and image processing system, developed by the Division of Atmospheric Research in collaboration with industry, will enable users to produce pictures from environmental satellites to obtain data on fisheries and mineral resources, weather and agriculture for a relatively low initial purchase price.

Weight Loss Reduction

The Division of Tropical Animal Science has shown that it is feasible to counter the usual weight loss in cattle during the tropical dry season by using drugs that reduce metabolic rate.



(a) The Hon. Barry O. Jones, Minister for Science, at the official launching in August 1985 of a satellite tracking antenna designed and built by the Division of Atmospheric Research, and now being manufactured and marketed by PCM Electronics Pty Ltd. The first sale of the antenna was to the Australian Bureau of Meteorology.



(b) The satellite tracking antenna.

Sheep Worm Control

A new cost-effective worm control program, Drenchplan, is now being marketed to sheep producers in New South Wales following field research by the Division of Animal Health, the N.S.W. Department of Agriculture and local Pastures Protection Boards.

Search and Rescue

A satellite-based search and rescue system was tested for the first time in Australia during the Sydney-Hobart Yacht Race by the Division of Oceanography in Hobart in collaboration with Amalgamated Wireless (Australasia) Ltd and the Cruising Yacht Club of Australia.

Fire Bombing Study

Recommendations of a CSIRO study on fire bombing as a cost-effective means of fighting bush fires were released publicly in February. The National Bushfire Research Unit incorporated results from Project Aquarius, which evaluated the use of air tankers in fire fighting.

Events

Antennas Contract

The Minister for Science, the Hon. Barry O. Jones, and the Minister for Industry, Technology and Commerce, Senator the Hon. John Button, announced in July the letting of a $15 million CSIRO contract to Evans Deakin Pty Ltd for constructing seven 22-m-diameter antennas for the Australia Telescope.

Communication Director Appointed

Mr Peter Dunstan was appointed to the new position of Director of Information and Public Communication and took up his duties in November 1985. Mr Dunstan was formerly the General Manager of Corporate Affairs for Unilever Australia.

Paul Wild Observatory

The Minister for Science, the Hon. Barry O. Jones, announced in October that the principal site for the Australia Telescope, at Culgoora, N.S.W., would be known as The Paul Wild Observatory, after the former Chairman of CSIRO, who retired in September 1985.

CSIRO Medals

Three scientists received the inaugural CSIRO Medals in October. They were: Dr Peter Coleman (Division of Protein Chemistry) for work towards the understanding of molecular mechanisms involved in viral infection and immunity; Dr Raymond Jones (Division of Tropical Crops and Pastures) for his findings on the cause and cure of *Leucaena* toxicity in cattle; and Dr Graeme Ogilvie (Division of Manufacturing Technology) for his unique system for controlling the transfer of weld metal droplets in electric arc welding.

Women in Science

A national program began in October to encourage more girls to take up science as a career. Under the CSIRO Women-in-Science Project, female CSIRO scientists and technical staff will visit schools to discuss science careers with Year-10 girls.

Sir Ian McLennan Award

Dr Brian Sowerby, of the Division of Mineral Engineering, received in December CSIRO Advisory Council's inaugural Sir Ian McLennan Achievement for Industry Award for his work on an innovative coal analysis system, COALSCAN.

New Science Club

Double Helix — a self-funding science club for students between 10 and 18 years — was formed in January. Activities will be arranged at CSIRO Science Education Centres in capital cities and at other locations.

Australia-U.S.S.R. Agreement

The recent normalisation of relations between Australia and the U.S.S.R. has reactivated the science and technology agreement. Earth sciences and astrophysics were identified as priority areas and there have been exchange visits by Russian and CSIRO scientists.

UNESCO Prize

The Division of Entomology's salvinia eradication project team working in Papua New Guinea received international recognition through the award of the 1985 UNESCO Science Prize.

Analytical Facility Funded

CSIRO, the Western Australian Government, and Western Australian mining companies have funded jointly an advanced electron microprobe facility at the Division of Minerals and Geochemistry. The sponsors will use the instrument in mineral exploration and processing, corrosion and failure analysis, forensic science, and environmental and occupational health studies.

Corporate Policies

Future Directions for CSIRO — the ASTEC Review

CSIRO welcomed Government decisions on the ASTEC review. They included the retention of CSIRO as a single entity funded through a single Ministry, and a confirmation of its main role as being longer-term research in support of industry and selected community interests with effective transfer of research results to users.

Other Government decisions were the clearer separation of policy and management decision-making, an associated vesting in the Chief Executive of executive powers that have hitherto resided with the full Executive, and equal status with other Board members for the Chief Executive by being appointed by the Government rather than the Board.

Further decisions dealt with strategy and planning activities and advisory mechanisms. Some matters addressed in the review, particularly those concerned with staffing policies, have been left by the Government for either implementation or further examination by the incoming Board and report to the Minister for Science.

Distribution of Research Effort

Executive growth areas for 1986/87 are:

- Generic manufacturing technologies
- Space science and technology
- Information technology
- Water resources research
- Raw materials processing
- Human nutrition.

Significant expansion of biotechnology research has taken place since 1979/80 and, while the area remains of high importance, adequate resources are now being devoted to this area. Advanced materials as a growth area has been deferred pending developments resulting from the review of materials science and technology and the decision by the Executive to form a new Division of Materials Science and Technology. The Executive has declared that growth will continue in the water area. However, soil conservation research has been 'protected' until a review of soil conservation is completed.

An analysis of changes in the sectoral balance of CSIRO's research effort over the past five years is summarised in chapter 2, with a commentary on the major features of the changes.

A Strategy for CSIRO

Implementation of the strategy for CSIRO announced in 1985 is discussed in chapter 3. The main elements of the strategy are:

- Balance of research effort
- Concentration of effort
- Evaluation of research benefits
- Interaction with industry and the community
- Human resource development and management.

Information and Public Communication

A statement of policy on external communication was endorsed and a new Bureau of Information and Public Communication was established. Policies are being implemented to encourage greater staff participation in communication. A Divisional communication grants scheme, CSIRO participation in major public exhibitions and the organising of functions to enable community leaders to discuss CSIRO's role and work are among other initiatives adopted.

Reviews

Reviews were completed of the Division of Food Research; materials science and technology and a related review of the Division of Chemical Physics; and CSIRO's external communication activities. Review committee reports were received and considered by the Management Committee for the Divisions of Applied Physics, Mineral Chemistry, Groundwater Research, Water and Land Resources, and Environmental Mechanics.

Sectoral Reports

Manufacturing Industries

Substantial progress has been made towards implementing CSIRO's policies for Australia's manufacturing industries outlined in the 1983/84 Annual Report. Initiatives undertaken towards achieving policy goals include research involving: the redirection of measurement science into new instruments for export; the development of rare-earth magnets; wool processing techniques; wood utilisation; water purification and technology; aerospace products, automobiles and plastics — all leading wherever possible to the strengthening of local industry.

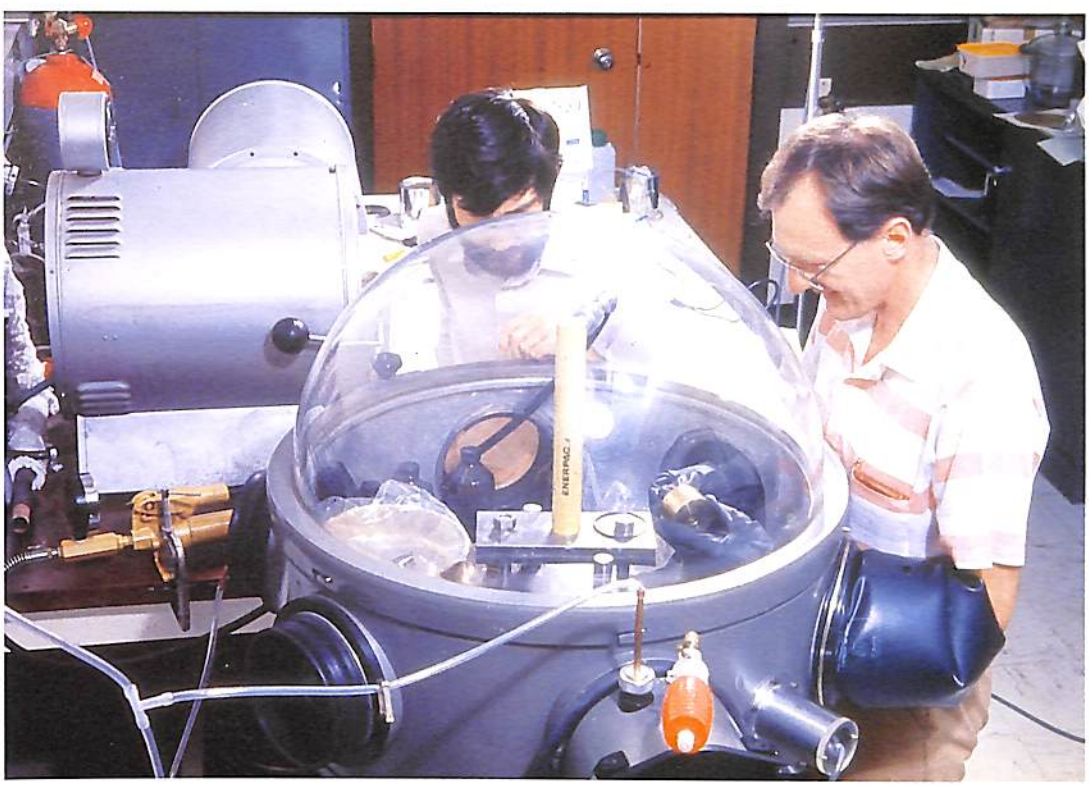
Ways of encouraging industry awareness of technology and improving manufacturing skills are explored through collaboration with industrial partners, and staff exchanges between Divisions and the companies with which they are working. The formation of the Manufacturing Industry Sector Policy Committee, with the primary task of setting long-term policies and priorities for the sector, was designed to assist the alignment of CSIRO research with the needs of Australian manufacturing industries.

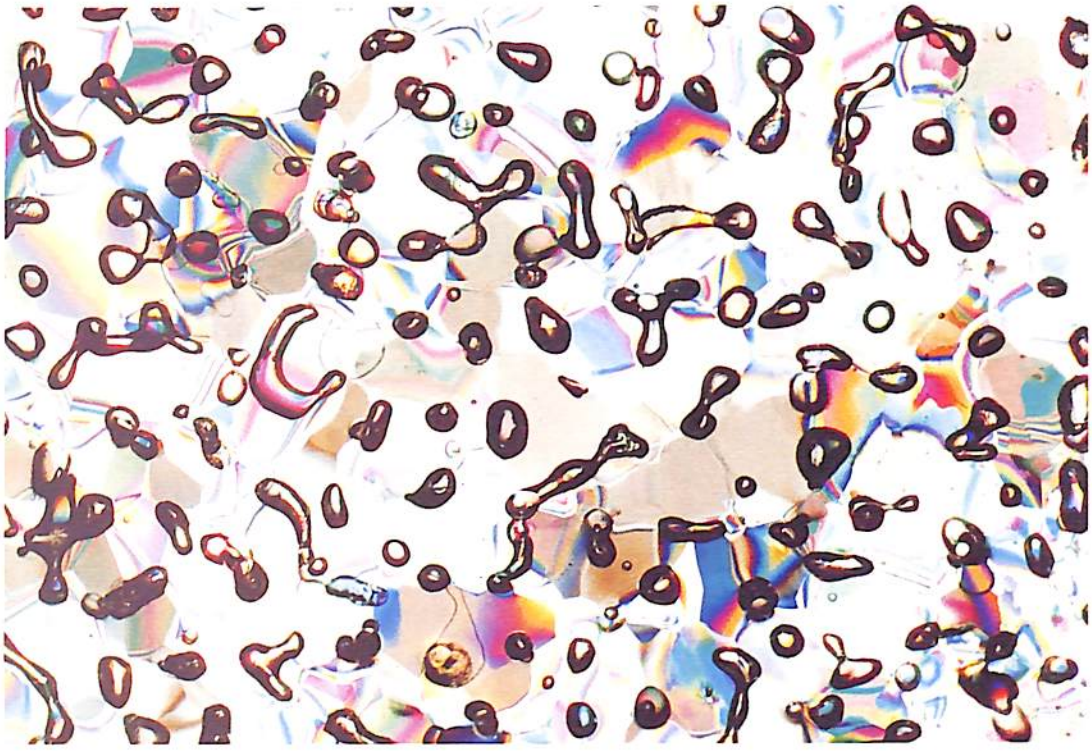
The Division of Applied Physics has developed the technology to manufacture rare-earth supermagnets that are 10 to 100 times stronger than conventional magnets. The materials are very reactive and oxygen must be excluded during manufacturing operations such as milling, pressing in a magnetic field and sintering.

Rural Industries

A number of research programs underwent some change in emphasis during the year. They included: development of options for increasing the productivity of cattle already adapted to the tropics; a novel vaccine approach to controlling sheep blowfly; feasibility studies on water recycling on the farm; and investigations into the performance of myxomatosis in the arid zone.

The Institute of Biological Resources identified four priority areas for research, due for commencement and aimed at maintaining agricultural and forest productivity. These were: heavy clay soils; heliothis; tropical grazing systems; and tropical rainforest research. The Institute of Animal and Food Sciences nominated the nutritive value of pastures and mineral supplementation as research priorities.





The Division of Atmospheric Research, in collaboration with the Antarctic Division of the Commonwealth Department of Science, has analysed air bubbles trapped in the antarctic ice over hundreds, even thousands, of years to establish past levels of trace gases in the atmosphere. This slice of ice from Antarctica provides a detailed record.

Notable events included the birth of the world's first 'transgenic' sheep; the transfer of a gene for pea-seed protein into tobacco plants; immunisation of sheep and cattle against mastitis; and completion of a study of the use of aircraft for the aerial bombing of bushfires.

Mineral, Energy and Water Resources

CSIRO and ICI Australia Ltd have successfully developed a process to make high-purity zirconia from local resources and have established Z-TECH Pty Ltd to penetrate major overseas markets for zirconia products.

The COALSCAN gauge to monitor the ash content of coal being treated for export is now being manufactured under licence to CSIRO. Both the instrument and its inventor received awards during the year.

Recent theoretical and experimental advances in measuring and predicting unsaturated water flow through soils and plants will assist water resource managers to monitor groundwater quality and quantity.

Conservation and the Natural Environment

Research topics examined during the year concerned:

- Soils and land use. Pasture management for soil conservation; a new technique for soil-water research.
- Ecology and environment. The conservation of native grasslands; a study of water taints and odours; ecology research for management.
- Flora and fauna. The use of dragonfly larvae as indicators of the effect of sewage effluent on stream biology; the biological control of pests and weeds; increasing eucalypt productivity.
- Oceans. The Research Vessel *Franklin's* first full year of operation; variability of ocean temperatures off northern Australia.
- Atmosphere. Investigating antarctic air bubbles for trace gases; drought research and the El Niño phenomenon.
- Environmental protection. Detecting trace elements; industrial waste; determining the physiological effects of fluoride on trees.

Service Industries

Urban and Civil Engineering

Research in this area concentrated on the building and construction industry, on aspects of urbanisation in Australia, and on civil engineering and transport systems.

In building research much of the current work is aimed at studying the substantial deterioration of urban infrastructure. A National Infrastructure Committee and a Parliamentary Inquiry into Australian Infrastructure were set up. Other research concentrates on corrosion studies, new railway sleeper technology, concrete deterioration, wind loading, and water penetration of buildings.

Human Health

Human nutrition's designation as a growth area resulted in the strengthening of existing programs and the creation of new activities, including clinical nutrition in cooperation with Flinders University.

Standards for Manufacturing and Service Industries

The Division of Applied Physics (National Measurement Laboratory) has statutory responsibility for maintaining standards of measurement of physical quantities. A representative Standards Advisory Committee has recently been established to advise on present and future needs for standards and associated calibration services. Expertise developed in meeting the statutory obligations has been applied to work related to digital electronic instruments for electrical measurements; time coordination within Australia; optical-fibre technology; and fast digitisers for recording high-voltage impulses.

Dr Bill Blevin, Chief Standards Scientist and Assistant Chief of the Division of Applied Physics, and Dr Ernest Ambler, Director of the U.S. National Bureau of Standards, exchange formal documents acknowledging the equivalence of six primary Australian and American physical standards.

Multi-sectoral Technologies

Biotechnology

Research programs range from developing animal disease vaccines and diagnostic probes for plant and human diseases to gene transfers in plants and animals to improve productivity. Current research projects include: a recombinant DNA vaccine against footrot in sheep; insect control by nematodes; sewage treatment; testing for gluten in processed foods; wheat research; high-quality-protein lucerne; genetic manipulation to create twin calves; and biomaterials for medical engineering.

Information Technology

The Division of Information Technology, in its first full year of operation, has concentrated on the

NASA's C-130 and CSIRO's F27 research aircraft fly together near Townsville, Qld, during the U.S.A./Australia Joint Scanner Project in October.

following Executive-designated priority areas: software engineering and related hardware; man-machine interface; computer networking; information management; and devices and systems hardware technology. In addition, the development of information technology is being supported throughout CSIRO and elsewhere in collaboration with the tertiary education sector and industry.

Space Technology

The CSIRO Office of Space Science and Applications (COSSA), which coordinates the Organization's space technology activities, has developed a space research and development program involving 15 Divisions and providing a core technology for a modern industrial state. The research work includes: remote sensing; communication satellite facilities and equipment; and meteorology spacecraft systems.

International Aid

Relevance to existing research has been a major criterion for CSIRO participation in aid programs. Appropriate expertise, staff and resources, and cost recovery have been other factors. Although there has been an increase in the number of non-agricultural activities, agricultural research continues to be the main focus of the Organization's involvement in development assistance, and the number of requests for help in this area is growing. CSIRO currently has responsibility for 34 projects funded by the Australian Centre for International Agricultural Research (ACIAR), and is involved in both bilateral and multilateral programs.

Administration

Management

CSIRO's top structure will be changed following the ASTEC review, and will comprise a Board including a Chief Executive and a part-time Chairman, with six to eight part-time external members. The Board will replace the present Executive, of which the Chairman is also Chief Executive.

Administrative Review

A review of the central personnel functions was considered by the Executive in May 1986. Matters covered included devolution of operations to Divisions, career planning, training and development, corporate succession analysis and performance counselling.

SIROTECH

The CSIRO Manufacturing Industry Collaborative Research Program, managed by SIROTECH Ltd, was launched in late 1985. Surveys of two manufacturing sectors — automobiles, and chemicals and plastics — have been conducted to identify projects that might be jointly funded by CSIRO and industry.

SIROMATH

A substantial increase in work load arose from surveys and other major projects. Turnover increased by 20% during 1985/86.

Personnel

Examination of the ASTEC review and report and CSIRO's submission in relation to personnel and the training of research workers were important issues during the year. Industrial relations and current trends in union amalgamation are reported on. Two initiatives of note were: expansion of the scheme for vacation scholarships and the introduction of volunteer fellowships for qualified people wishing to gain research experience. Progress was also made in implementing full equal employment opportunity principles.

Consultative Council

Topics considered by the Council included equal employment opportunity; industrial democracy; and the ASTEC review.

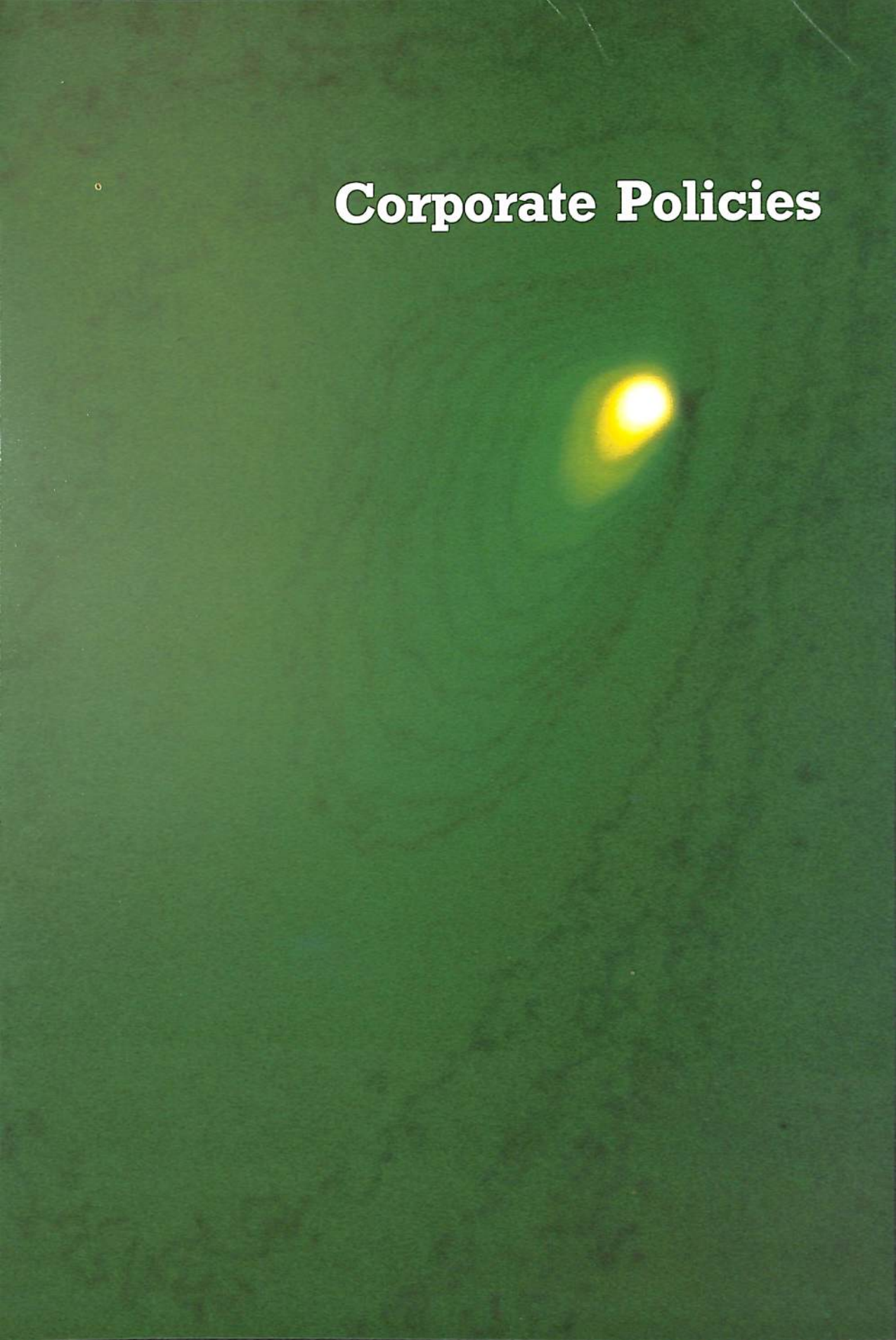
Finance and Works

Major developments and activities included: the rationalisation of the CSIRO property portfolio; further contracts for work on the Australia Telescope; relocation of the Division of Manufacturing Technology; setting up of the corporate telecommunications network; the energy management program; accrual accounting; and implementation of revised administrative arrangements.

Advisory Council and State and Territory Committees

Topics considered by the Advisory Council at its three meetings during the year, and by the five Standing Committees, included: CSIRO's five-year strategy plan; its external communication activities; future research growth areas; the ASTEC review; Divisional and sector reviews; and the selection of a candidate and presentation to him of the inaugural Sir Ian McLennan Achievement for Industry Award.

Corporate Policies



The images introducing the major sections of this report came from the Max-Planck-Institut für Aeronomie, Lindau/Harz, West Germany. They are the first imaging results from the Halley Multicolour Camera (HMC) on board the spacecraft Giotto during its fly-by of comet Halley and were received on Earth by the CSIRO radio telescope at Parkes, N.S.W. The images are centred on the brightest part of the inner coma and show the silhouette of a large, solid and irregularly shaped cometary nucleus and jet-like dust activity visible in reflected light. The nucleus is at least 15 km long and 10 km wide.

The images show, in order of their appearance in this report:

1. The inner dust coma of comet Halley with jets and the nucleus just resolved, seen at a distance of 124 050 km.
2. The innermost coma with dust jets and nucleus seen from 25 650 km away.
3. The nucleus of comet Halley from 18 270 km. Two bright jets appearing near the northern tip are directed towards the Sun.
4. The source of the bright dust jet on the northern tip of the nucleus from 4910 km. Morphological features with dimensions of a few hundred metres are apparent. The scalloped areas in the source region appear to be the sources of smaller jets that combine to form the large jet.
5. Details of a jet source in high resolution, as seen from 2220 km. This is one of the last images taken by the HMC.

1. Future Directions for CSIRO — the ASTEC Review

On 25 June 1986, the Minister for Science, the Hon. Barry O. Jones, announced the Government's decisions on the recommendations of a review of CSIRO undertaken by the Australian Science and Technology Council (ASTEC). The review was initiated in May 1985 at the request of the Government. ASTEC submitted its report to Government in November 1985.

Background

ASTEC's review of public investment in research and development (R&D), with initial emphasis on future directions for CSIRO, took place against a background of changing economic conditions in Australia, of differing public and political expectations of CSIRO, and of rapid change and policy development and implementation in CSIRO itself.

Indicative of the extent of change in the external environment in which CSIRO operated was the replacement of the 'mineral resources boom' philosophy of the late 1970s and early '80s by the recognition that Australia needed to rely more heavily on its 'people resources', with emphasis on a revitalised and more internationally competitive manufacturing sector.

Although little time had elapsed since Government decisions in 1978 on the recommendations of an Independent Inquiry into CSIRO conducted in 1976/77, the changing economic and industrial situation had prompted a number of commentators to question the relevance of some of those decisions to the Australia of a later decade. The questions raised included: What should be the appropriate sectoral balance of CSIRO's research activities? What is the Organization's role, particularly in support of the manufacturing sector? Why should CSIRO be maintained as a unified organisation with a charter to cover all industry sectors and selected areas of community interest?

Sectoral Balance of CSIRO Activities

CSIRO recognises that its contributions to the agricultural and minerals industries have been regarded generally as being more effective than its contribution to the manufacturing sector. The export orientation of the former industries, and their consequent recognition of the need to adopt modern technologies to remain internationally competitive, has been a significant factor in the effectiveness of CSIRO's work on their behalf. The effectiveness of the Organization's efforts in support of the manufacturing sector has been, by comparison, less consistent. However, over the years many of the resource-based manufacturing industries, for example the mineral processing, food processing and wood pulp and paper industries, have been major beneficiaries of CSIRO research.

The technology-based industries in the manufacturing sector are the most research intensive. They have also demonstrated in recent years the greatest international growth in volume and value of output and in trade. In its submission to the Independent Inquiry into CSIRO, the Organization pointed to the strong foreign domination of the technology-based industries in Australia. The strong reliance by firms in these industries on their parent companies' R&D, and the consequent low level of indigenous R&D, acted as a significant barrier to an effective CSIRO contribution.

Nevertheless, from the late 1970s onwards the Organization determined that it should build up its research in support of these industries, find means for interacting more effectively with them, and contribute to policies elsewhere that would make customers more aware of and receptive to research developments.

In the early 1980s — particularly by 1983 with the advent of a new Government — there was a more general awareness of the need for a strong manufacturing sector. CSIRO welcomed this consensus and the strong advocacy by its Minister of support for new manufacturing and information industries. It saw the recognition of the changing patterns in the value of world trade as justifying the steps it had taken, and was taking, to build up its effort in support of technology-based manufacturing activities. Since 1981, CSIRO has increased its level of support for the manufacturing sector by 15%, incorporating a greater than 70% increase in support for the more technology-based industries in this sector (see chapter 2).

The Organization has also recognised the need for a continued commitment to those industry sectors — agriculture and minerals — that continue to be receptive customers for its research. These sectors have a continuing and increasing requirement to remain internationally competitive and can exploit opportunities arising from advances in science and technology. Moreover, advances in biotechnology, for example, may be particularly important for agriculture, but may also provide significant opportunities for emerging new manufacturing enterprises such as veterinary vaccine production — not only for the domestic, but also for the world market.

While the ASTEC report did not address directly the sectoral balance of CSIRO's research activities, in making decisions on the review the Government did confirm that the Organization should regularly prepare broad strategic plans for its activities. The first broad strategy published by the Organization in 1985 gave particular emphasis to the question of the extent of CSIRO's support for the various industries and community interests it serves.

Nature of CSIRO's Major Role

The 1977 Independent Inquiry into CSIRO proposed a distinct role for CSIRO in support of the manufacturing and other sectors: to provide a strong scientific and technological base on which industry itself should draw for its own product and process innovation. Other government measures should be used to promote innovative activity in individual firms and enterprises. Accordingly it recommended, and the Government agreed, that CSIRO's major role should be to undertake what it described as strategic mission-oriented research in support of all industry sectors and selected community interest areas (e.g., the environment and human health). Tactical research for more specific product and process innovations should remain the responsibility primarily of industry itself, with a strong supporting role by CSIRO through making its skills available for contract and collaborative research. The demand for such contract research would, however, be largely dependent on the priority that industry itself gave to technological innovation and supportive R&D.

CSIRO consequently indicated in its 1980/81 and 1983/84 statements of research policy for the manufacturing sector that its main role with funds provided by Government should continue to be the conduct of longer-term more broadly applicable research as a base for industry's own more specific work.

To maintain the relevance of this longer-term research CSIRO needed to increase its interaction with industrial firms. The Executive decided, as a result, that each Division should establish a strong user-oriented advisory mechanism. There remains a need, however, to support those new industries, based on new technologies, that obviously cannot yet be represented in these user groups.

CSIRO also undertakes, mainly with funds provided by industry, a significant component of 'tactical' work to build up its interactions with firms, to provide a market stimulus to its more strategic research efforts, and to capitalise on spin-offs resulting from longer-term research. With its closer proximity to the market, industry itself should determine such R&D aimed at specific product and process developments. CSIRO's contribution to these activities is best achieved through collaborative and contract research arrangements, with a substantial input from the firms themselves.

With a few exceptions, all in accord with Government decisions, the Organization's research is 'applications oriented', in the main having a longer-term emphasis, but with a substantial element of more immediate application. Accordingly the CSIRO submission to the ASTEC inquiry advocated strongly (see volume 2 of the CSIRO submission) that its role should be to conduct applications-oriented research, with an emphasis on more strategic, i.e. longer-term and broadly applicable, work.

CSIRO has welcomed ASTEC's endorsement of this 'applications orientation' and 'strategic emphasis' in its report to Government, and the subsequent confirmation by Government of this role for CSIRO.

CSIRO as a Single Entity

The Independent Inquiry into CSIRO in 1977 examined the options of dividing up CSIRO into a number of single-purpose research organisations or maintaining the Organization as a single entity but with its funding appropriated in part through various Ministries. Both of these options were seen as being inappropriate for CSIRO — because of the degree of inflexibility in resource allocation that would ensue, and the need for the governing body of the Organization to be able to allocate resources according to scientific opportunities as well as industry or community interest needs — and were rejected.

The Government of 1978 endorsed the Independent Inquiry's recommendation that CSIRO should remain a single body funded through a single Ministry. Nonetheless, in the following years there emerged claims in favour of transferring specific activities from the Organization to single-purpose research institutions. Similarly, some submissions from government departments to the ASTEC inquiry raised again the matter of alternative funding arrangements for CSIRO.

CSIRO has found these continuing proposals for parts of its resources to be not only demanding of the time of senior management, but more importantly, disruptive to the conduct of research in the areas under dispute. Against this background, it hoped that decisions taken as a

result of further examination by ASTEC of the relevant issues would lead to a more settled climate and allow future efforts to be concentrated on meeting well-defined, Government-agreed objectives for the Organization.

Government Decisions

CSIRO has welcomed the Government's decisions on the ASTEC inquiry (see Box), announced at the end of the reporting year. In particular, the Organization strongly supports decisions that:

- CSIRO should continue as a single entity as the Government's principal agency for the conduct of research in support of industry development and selected community interests;
- the main role for CSIRO should continue to be the conduct of strategic applications-oriented research with funds provided by Government for this purpose, and with a build-up in more immediate tactical work with funds provided by user beneficiaries;
- the Organization should continue to contribute effectively to future industrial development, and the applications orientation of its work should not result in excessive attention being given to the short-term needs of existing industries;
- increasing attention should continue to be given to the transfer of its research results to users, with SIROTECH maintaining its strong support role in this area;
- CSIRO should — as an incentive for closer interaction with users, particularly those in manufacturing industry — retain revenue earnings from contracts and licences without a reduction in its appropriation funding by Government; and
- CSIRO proposals for an early retirement scheme — as a means of providing increased flexibility to meet changing needs and opportunities — should proceed.

While ASTEC recommended, and the Government agreed, that an Institute structure should be maintained for CSIRO, a need was seen for a clearer separation of policy and management decision-making. The major recommendation to achieve this was the reconstitution of the present Executive as a Board with an external part-time Chairman and a shift in the balance of the governing body towards even greater external representation.

CSIRO agrees with this proposed clearer separation of policy decision-making from executive actions aimed at implementing policy, with an associated vesting in the Chief Executive of executive powers that to date have resided with the full Executive. In particular, CSIRO welcomes the Government decision that the Chief Executive should have equal status with other Board members by being similarly appointed by the Government rather than by the Board. As the most senior officer of the Organization, the stature associated with Government appointment is seen as vital for the important tasks of strong leadership and liaison with industry and community leaders and Governments.

CSIRO had advocated that its Deputy Chief Executive should also be a Board member because of the necessity for a strong partnership between the Organization and its governing Board. A strong executive representation on the Board is a common and growing feature of many companies, particularly those engaged in high-technology activities. While Government did not endorse this CSIRO proposal, the Organization is committed to generating the necessary effective partnership with the Board, and is confident this can be achieved.

Other important decisions of Government dealt with strategy and planning activities and advisory mechanisms.

CSIRO introduced more formal planning procedures following the 1976/77 review by the Independent Inquiry. During 1984/85, a major review of planning was undertaken and new arrangements were introduced in 1985 shortly before the ASTEC review was initiated. Similarly during 1984/85 CSIRO developed an overall strategy for the future (see chapter 3).

The ASTEC review did not make recommendations relating to CSIRO's planning activities or strategy developments. However, in parallel with its consideration of the ASTEC report the Government was considering a more general report on statutory authorities, including their strategy and planning responsibilities. Accordingly, in making decisions on the ASTEC recommendations, the Government also decided that:

- the Minister for Science, on behalf of the Government, should issue periodic policy guidelines to the CSIRO Board;
- the Board, following consultation with the Minister for Science, should issue a strategic plan for CSIRO for a three- to five-year period in accord with any guidelines previously provided by the Minister; and

- the Chief Executive should seek Board endorsement of an annual operating plan for the Organization in accord with the Board's strategic plan.

CSIRO believes that these decisions by Government provide a sound policy framework for its recently introduced strategy activities and revised planning arrangements. In particular, the issuing by Government of clear policy guidelines to CSIRO should overcome the uncertainties that have arisen in the past and that have been referred to above.

The Government also agreed with ASTEC's recommendation that current legislative requirements for advisory bodies should be repealed, but added that the CSIRO Board should establish appropriate non-statutory advisory mechanisms. CSIRO recognises the importance of sound advice for its operations and acknowledges the vital contributions made in the past by many members of its advisory mechanisms, both the statutory bodies and the non-statutory Divisional advisory groups and review committees. In particular, it has appreciated the important role played by the State Committees in providing a link with both State Governments and with many influential industry and community representatives in individual States.

While CSIRO agrees with the ASTEC view of the current structures as being not ideal, it recognises the importance of appropriate and effective advisory mechanisms.

A number of other important matters, particularly those concerned with staffing policies, have been left by the Government for either implementation or further examination by the incoming Board and report to the Minister for Science. These will be referred to the new Board as a matter of urgency soon after it is established.

Instructions for the necessary amendments to the *Science and Industry Research Act* have been given with the intention of bringing these forward for Parliamentary consideration in the 1986/87 Budget session. It is hoped that the new Board will be in place before the end of 1986.

In the 1984/85 Annual Report the then Chairman, Dr J.P. Wild, expressed confidence that the review would result in a clear charter for CSIRO, so that it would be well equipped to deal with the opportunities and problems facing Australia in the years ahead. CSIRO believes that the Government decisions announced in June 1986 fulfil that expectation.

At present the economic problems facing Australia loom large and are the subject of intense debate. But the significant opportunities afforded by the nation's most valuable resource — the skills and capabilities of its people — should not be overshadowed by the more readily apparent immediate problems. CSIRO is well placed to contribute to the nation's future development through the generation and application of new scientific discoveries and new technologies. It is a time of exciting opportunities — for example, in biotechnology, new materials and information technology. These developments can be applied to both overcoming problems of today and exploiting opportunities in the future. CSIRO recognises that it has the capability and responsibility to contribute significantly to the achievement of these goals. The Government's decisions provide the Organization with the clear charter to make this contribution to the country's future well-being.

Government Response to Recommendations from the ASTEC Report on Future Directions for CSIRO

ASTEC Recommendation	Response	
Role of CSIRO		
That CSIRO's main role be the conduct of applications oriented research combined with a commitment to ensuring the effective transfer of its research results to end users. (ASTEC Recommendation 1)	**Accepted**	With the understanding that such a role includes the performance of strategic research in support of future industrial development. The *Science and Industry Research Act* is to be amended so that CSIRO's primary role is specified as Sections 9(a) and 9(b) in the current *Act*. Sections 9(c) to 9(j) would become subsidiary functions of the Organization.
That in undertaking its main role CSIRO concentrate primarily on research in support of existing and emerging industry sectors and measures to facilitate the adoption of the practical results of its research. (ASTEC Recommendation 2)		
That CSIRO continue to conduct research into Australia's natural resources and aspects of public health, and coordinate this work as closely as possible with other organisations active in these fields. (ASTEC Recommendation 3)		
Senior Management Structure		
That the existing CSIRO Advisory Council and State and Territory Committees be discontinued. (ASTEC Recommendation 6)	**Accepted**	The Board will be encouraged to seek external advice and to set up appropriate non-statutory advisory mechanisms.
That the present Executive of CSIRO be replaced by a Board of eight Directors consisting of a Chairman and six ordinary Members plus the Chief Executive of CSIRO. Apart from the Chief Executive, all Board members should serve part-time and be drawn from outside the Organization. (ASTEC Recommendation 14)	**The Board to be composed of a part-time Chairman, the Chief Executive of CSIRO and six to eight part-time external members.**	
That the CSIRO Board be empowered to appoint and dismiss the Chief Executive. (ASTEC Recommendation 15)	**The Chief Executive to be appointed by the Governor-General after recommendation to Cabinet by the Minister for Science following consultation with the CSIRO.**	
Single Statutory Authority		
That CSIRO be retained as a single statutory authority. (ASTEC Recommendation 5)	**Accepted**	

ASTEC Recommendation	Response	
Retention of Earnings That CSIRO be able to retain its earnings from outside sources. (ASTEC Recommendation 13 (iii)) That to promote the effective commercialisation of its research, CSIRO be permitted to retain income from inventions arising from research not covered by prior commercial agreement. (ASTEC Recommendation 13 (iv)) That the level of appropriation funding for CSIRO be maintained. (ASTEC Recommendation 12)	**Accepted** **Future levels of funding to be determined in the Annual Budget context.**	While future levels of funding for CSIRO will need determination in the Annual Budget context, the retention of earnings should not lead to a decrease in the CSIRO appropriation.
Early Separation That CSIRO introduce an early separation incentives scheme where appropriate separation terms can be offered to research staff at management's discretion. (ASTEC Recommendation 21(iii))	**Accepted**	CSIRO to implement an early separation incentives scheme for CSIRO professional staff, subject to approval of the specific scheme by the Minister for Science in consultation with the Ministers for Employment and Industrial Relations and Finance.
Link with Public Service Board That the present statutory relationship between CSIRO and the Public Service Board end. That CSIRO pursue staffing policies compatible with its own objectives which give management greater flexibility in setting terms and conditions of employment. (ASTEC Recommendation 18)	**The Minister for Science to examine the matter further following consultation with the incoming Board and relevant CSIRO staff associations.**	
Uncontentious Recommendations on the Function and Administration of CSIRO That CSIRO continue to participate widely in the coordination mechanisms provided by the Commonwealth and State ministerial council's standing committees and technical sub-committees, the Australian Manufacturing Council and industry organisations. (ASTEC Recommendation 7)	**Agree in principle**	To be implemented after examination by the incoming Board of CSIRO which will report to the Minister for Science.

ASTEC Recommendation	Response	
That the CSIRO-Universities Joint Research Scheme be expanded as funds can be made available. The Scheme should also include other suitable higher education institutions. (ASTEC Recommendation 8)	**Agree in principle**	To be implemented after examination by the incoming CSIRO Board which will report to the Minister for Science.
That to increase interaction with industry CSIRO actively seek more contract research from individual firms or groups of firms. (ASTEC Recommendation 9)		
That CSIRO actively seek opportunities to use the establishment of independent and joint venture companies as a way of making its skills and technology available commercially. (ASTEC Recommendation 10)		
That SIROTECH continue to provide an avenue for links between CSIRO and the broader industrial community. Its activities should supplement rather than supplant direct researcher-to-industry contracts. (ASTEC Recommendation 11)		
That the full costs of research and development and other services performed under contract to or in a joint venture with industry be charged under normal commercial arrangements unless a demonstrable public benefit arises. (ASTEC Recommendation 13(i))		
That CSIRO endeavour to stimulate and assist private research, development and consulting services. (ASTEC Recommendation 13(ii))		
That Institutes relate primarily to existing and emerging industry sectors rather than to scientific disciplines. (ASTEC Recommendation 16)		
That Divisions and other operational research units work to mission statements with goals expressed in terms that allow their progress to be evaluated at predetermined points. (ASTEC Recommendation 17)		

ASTEC Recommendation	Response	
That CSIRO adopt measures to encourage short term exchanges of staff with other public and private organisations. (ASTEC Recommendation 20) That the staff appraisal system in CSIRO contain adequate mechanisms for recognising achievements other than by publication. (ASTEC Recommendation 22) That CSIRO in cooperation with the universities and other degree-granting institutions increasingly make its facilities and research staff available for training research workers in areas where the Organization offers particular advantages. (ASTEC Recommendation 25(i)) That CSIRO also play a role in technical training, especially where this assists in the commercialisation of its work or providing for its own staff requirements. (ASTEC Recommendation 25(ii))	**Agree in principle**	To be implemented after examination by the incoming CSIRO Board which will report to the Minister for Science.
Remaining Recommendations That the incoming CSIRO Board of Directors give consideration to transferring elsewhere research groups conducting pure basic research which is not linked to the major objectives of CSIRO. (ASTEC Recommendation 4) That CSIRO and the Department of Finance investigate amendments to the present superannuation scheme and/or alternative schemes which would improve mobility into and out of the Organization, and that the Government then introduce the necessary changes. (ASTEC Recommendation 19) That CSIRO increase the use of fixed term appointments for professional staff. (ASTEC Recommendation 21(i))	**To be referred to the incoming CSIRO Board for examination and report to the Minister for Science.**	

ASTEC Recommendation	Response
That new research staff without proven post-doctoral or other relevant experience be appointed initially to provisional fixed term appointments so that their ability can be evaluated effectively before they are offered indefinite appointment. (ASTEC Recommendation 21(ii))	**To be referred to the incoming CSIRO Board for examination and report to the Minister for Science.**
That property rights to and income from inventions not subject to prior commercial agreement be divided between the inventors and CSIRO according to a formula to be determined by the CSIRO Board, the overriding consideration being to promote the commercial development of the technology. (ASTEC Recommendation 23)	
That the position title 'research scientist' be changed to 'research scientist/-engineer' and that research workers employed in such positions use that part of the title appropriate to their qualifications. (ASTEC Recommendation 24)	

2. Distribution of Research Effort

This chapter describes the current distribution of CSIRO's research effort within categories of the CSIRO classification scheme. The scheme contains major sectors broken down progressively into sub-sectors and research areas. The chapter also summarises recent trends in sectoral balance, and lists research topics identified by the Executive as growth areas for expansion.

Current Distribution of Research Effort

The only changes to the classification scheme introduced in 1985/86 are the proportional allocation of standards work across industrial sectors (principally manufacturing and service industries) and the reclassification of astronomy research from the conservation and the natural environment sector to the space technology sub-sector.

Table 2.1 shows the distribution of resources to research areas as at 30 June 1986 according to the classification scheme. In the table, percentage allocations are given for professional staff (based on professional staff numbers at 30 June) directly involved in research programs and for expenditure.

Table 2.2 indicates the allocation of financial and staff resources to the Divisions and independent research Units that constitute CSIRO Institutes.

Sectoral Balance — Recent Trends

The level of resources to be devoted to research directed towards different sectors of economic activity and community interest is one of the major strategy elements to be addressed by the incoming Board. To provide a sound basis for addressing this question, an analysis of changes in the sectoral balance of the Organization's activities in recent years has been undertaken.

Over periods of decades CSIRO has made substantial adjustments to its research effort in support of different sectors. Representation of the long-term trends in the 1984 document 'CSIRO 1978–83: Years of Change' clearly showed that the emphasis of the 1930s on agricultural research had, by the early '80s, been replaced by a broader thrust on behalf of a whole range of industrial sectors and selected areas of community interest. Of more immediate interest, however, are the recent changes that have occurred, the current sectoral balance of activities, and the level of support for the various sectors that should be planned for the future.

Changes in the sectoral balance of CSIRO's research effort over the past five years are presented below, with a commentary on the major features of these changes. A consistent basis for classifying research activities has been critical for reliable comparison of sectoral allocations for this period.

CSIRO Classification Scheme

The formal presentation of research activities in terms of sectors of economic activity and community interest commenced with the 1978/79 Annual Report, following government decisions in 1978 requiring an increased emphasis on policy in the Organization's reports to Parliament. Since then, the classification scheme has been progressively refined, the major changes being:

- the replacement in 1983/84 of a classification scheme based on total allocation of individual programs to a sector according to the nature of the product or process under investigation with a scheme based on proportional allocation of individual programs to a number of sectors according to the perceived beneficiaries of the work; and
- the introduction in 1984/85 of the category 'multi-sectoral technologies' to present more visibly the Organization's research in the important areas of biotechnology, information technology and space technology — all of which have significant impact on a number of industrial sectors.

In parallel with these changes CSIRO has progressively refined the research area categories in each sector to demonstrate more clearly the perceived user beneficiaries of the research. These research area category adjustments have resulted in some changes to the sectoral allocation, for which adjustments must also be made for comparable presentation of sectoral balance. (For example, with the introduction in 1984/85 of the research area 'aquatic environment' in the conservation and the natural environment sector, some work previously classified in the water resources sub-sector of the mineral, energy and water resources sector was reallocated to the new research area.)

Details of adjustments made to the data for previous years for valid comparison with the 1985/86 data are presented in the document 'CSIRO Sectoral Balance of Research Effort: 1981–1986', which is available on request. It has been necessary to make one adjustment to the data for 1985/86 presented in Table 2.1. On advice

from Divisional Chiefs, the research programs in the multi-sectoral technologies category (with the exception of astronomy) have been reallocated across the relevant sectors of economic activity or community interest. Otherwise, the lack of reliable data on these technologies prior to their introduction into the CSIRO classification scheme would have prevented an examination of trends since 1981. Table 2.3 shows how this reallocation was effected for professional staffing in 1985/86. (Comparable data for 1984/85 were similarly treated.)

Sectoral Changes 1981–1986

Adjusted data for professional staffing, as at 30 June of each reporting year, for each industrial or community interest sector are presented in Table 2.4 (total professional staff numbers) and Table 2.5 (percentage of total professional staff). Figure 1 depicts the data presented in Table 2.4 for the five major sectors of CSIRO's research effort.

The information presented in Tables 2.4 and 2.5 and Figure 1 represents CSIRO's total professional staff directly engaged on research programs, irrespective of funding source. However, individual sectors receive various levels of support from their user groups. Accordingly, in Table 2.6, the data have been divided into the categories appropriation-funded professional staff and externally funded professional staff, but only for those years for which reliable information was available, i.e. 1984 to 1986.

These data should be regarded as indicative only of the level of external support for each sector, since in some instances external funds are used to fund support staff or equipment rather than professionals, and contributions other than by direct funding (e.g., secondment of industry staff to research programs) are not included.

To summarise, this analysis demonstrates considerable evolutionary change in the sectoral balance of the Organization's research effort over the past five years.

Major features of note are:

- Total professional staff directly engaged on research programs increased by about 90 from 1981 to 1986, mainly because of the transfer of resources from the Australian Atomic Energy Commission (AAEC) Research Establishment to CSIRO in 1983, and an increase of about 65 externally funded staff since 1984. The number of appropriation-funded professionals has decreased by about 40 in the same period.
- The manufacturing sector has had the strongest growth in professional staff, the number increasing by some 90, or approximately 15%, since 1981. Of even greater significance has been the increase in support for the more technology-based industries in this sector, professional staff increasing by about 180, or some 70%, since 1981. Half of this increase was achieved by redeployment from the more resource-based manufacturing industries, and half from overall growth in the resources directed to the sector.

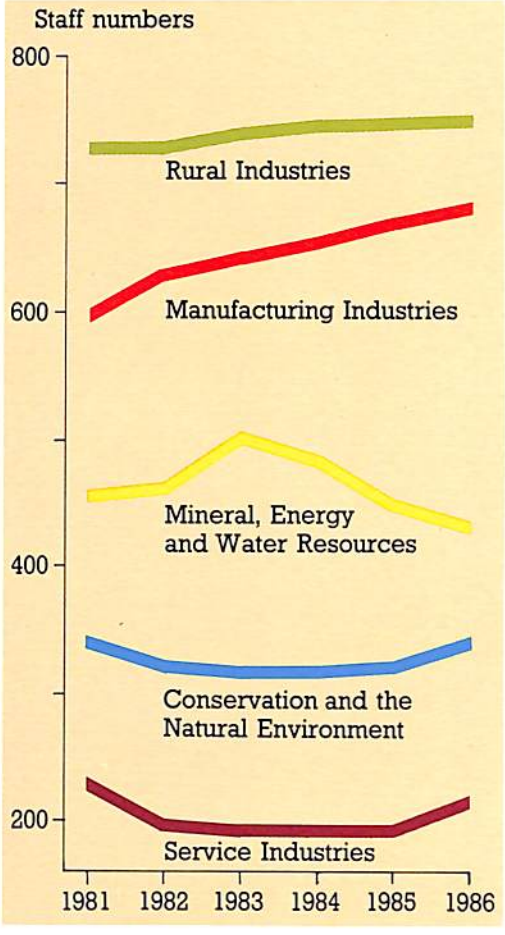


Figure 1. Professional staff numbers — major research sectors.

- Staffing for the rural sector increased marginally from 1981 to 1984, but the level of resources devoted to this sector has only been maintained in recent years by strong support from the rural industries. Since 1984, the number of externally funded professionals has increased by about 40, or 30%. The

proportion of externally funded staff in this sector is the highest, at 22% of total sector resources.

- The level of resources devoted to the mineral, energy and water resources sector has declined substantially (a decrease of some 70 professionals) from a peak in 1983 following the transfer of AAEC resources to CSIRO. Resources devoted to water research have, however, increased steadily since 1981 to the present level of 90 professionals. The large decrease since 1983 has been in resources devoted to energy research, attributable to both a decline in external support from NERDDC and a redeployment of internal resources — predominantly to the manufacturing sector — during this period.
- There was a substantial decline in work in the service industries from 1981 to 1982, due mainly to a redeployment of resources from standards to industrial physics in the Division of Applied Physics. Smaller, although still significant, decreases also occurred in construction industry and human health research in 1982. The major factor in the increase in resources in this sector in 1986 has been the build-up of effort in information technology.

Designated Growth Areas

The Executive periodically designates research areas where growth will be specifically encouraged. For 1985/86, the growth areas were:

First priority for growth

- biotechnology
- information technology
- generic (broadly applicable) manufacturing technologies
- space technology
- water and soils.

Second priority for growth

- raw materials processing
- human nutrition
- plant diseases.

Significant changes or developments within each of these areas are described in the following section. For 1986/87, the Executive revised its priorities for growth following consultation within CSIRO and comment from the CSIRO Advisory Council. Designated growth areas for 1986/87 are:

- generic manufacturing technologies
- space science and technology
- information technology
- water resources research
- raw materials processing
- human nutrition.

Substantial expansion of research in biotechnology has taken place since it was first designated for growth in 1979/80 and, while the area remains highly important, the Executive believes that adequate resources are now being devoted to it. The designation of advanced materials as a growth area has been deferred pending developments resulting from the review of materials science and technology and the decision by the Executive to form a new Division of Materials Science and Technology. Soil conservation research has been transferred from the Executive's list of designated growth areas to a 'protected' status pending a review of soil conservation and erosion research and its future role in CSIRO.

Significant Changes within 1985/86 Designated Growth Areas

Biotechnology. In Divisions of the Institute of Animal and Food Sciences, additional support was given for research on animal vaccines. In particular, work on the development of vaccines against footrot in sheep in the Division of Molecular Biology and against ephemeral fever in cattle in the Division of Tropical Animal Science was strengthened. A new program to examine the feasibility of vaccinating sheep against blowflies began in the Division of Tropical Animal Science. Resources were redirected by the Division of Animal Health to enable a new approach to be taken to improving the immune reaction of sheep to infectious and parasitic organisms. The aim is to identify genes responsible for producing immune proteins in the body and to transfer into sheep embryos, and hence into future generations, those conferring resistance to particular diseases.

In the Division of Animal Production, further support was given to similar work aimed at inserting genes — such as those from growth hormones in sheep — into sheep embryos to improve livestock productivity. The Division's research on the genetic manipulation of rumen micro-organisms for enhanced utilisation by the animals of low-quality roughage was also strengthened during the year. The Division of Molecular Biology redeployed staff and resources into studies on the organisation of cells into tissues and on the development of biomaterials. Both have relevance to biomedical technology.

In the Institute of Biological Resources, studies in biotechnology have been concerned mainly with developing a basic understanding of plant gene structure, control and action. Much activity

has centred on developing new methods of plant improvement and pest and disease control by gene transfer and cell culture. Some steps have been taken towards the use of these methods in a range of biological applications. Effort is being directed to the identification of strain variations in plant pathogens. Breeding programs based on gene transfer, for example transferring high-sulphur-protein genes into the leaves of pasture legumes, are also under way.

Horticultural virology studies on the characterisation and diagnosis of virus diseases of horticultural crops have been expanded, and the use of recombinant DNA techniques in the development of novel methods for controlling insect pests has been intensified. Microbial biotechnology is being applied in efforts to bring about the degradation of anti-nutritive substances in tropical grasses and legumes.

In the Institute of Industrial Technology, three professional officers in the Division of Protein Chemistry were redeployed from wool chemistry to biotechnology projects that impinge on the wool industry. This research has attracted considerable external funding and six professional officers funded from outside sources were appointed during the year.

Information technology. The highlight of the year was the arrival in August 1985 of Dr G.E. Thomas, Foundation Chief of the Division of Information Technology. Since he came to Australia, Dr Thomas has had widespread and frequent contact with a diverse range of people from Australian industry and tertiary educational institutions and with members of Federal and State Governments. This activity has been part of the process of establishing the new Division of Information Technology, which is an important component of the CSIRO Information Technology Program.

During the year, the Division's professional staff grew from 9 to 24 and laboratories were established in Sydney, Canberra and Melbourne. Close links have been forged, and collaborative research projects commenced, with several companies and tertiary educational institutions. Projects were initiated in computer networking; communications standards (including participation in the formation of the National Protocol Support Centre); the design of integrated circuits; software reliability; knowledge-based systems; geographic information systems; and image processing and advanced graphics.

There has been strong competition for the funds available in the other two components of the CSIRO Information Technology Program. These are:

- the support of information-technology-related projects throughout CSIRO;
- the CSIRO Collaborative Program in Information Technology, through which $400 000 were distributed during the year to Australian industry and tertiary educational institutions to support collaborative work with various CSIRO Divisions.

Elsewhere in the Institute of Physical Sciences, the Division of Radiophysics increased its emphasis on work in core areas of information technology. These included gallium arsenide devices and microwave integrated circuits, VLSI (very-large-scale integrated) chips for signal processing, and software for image reconstruction from sparse data, which can be applied in medicine, geology, non-destructive testing, and remote sensing.

In the Institute of Industrial Technology, the commitment of the Division of Building Research to information technology continued throughout the year. A major effort has been devoted to developing expert systems for use by the building industry, using as bases the knowledge available in all the Division's programs. Further progress has been made in developing computer programs for planning and management, particularly for use on microcomputers. The Division of Information Technology, local firms and academic institutes have actively collaborated. A particular market is the local government area. In addition, a program has been made available through a local industry association as part of a videotex system for home builders.

In the Institutes of Biological Resources and Energy and Earth Resources, information technology continued to receive enhanced support in such areas as management decision programs and expert systems. The Division of Mineral Physics and Mineralogy, in collaboration with the mining research association AMIRA Ltd, is continuing with the development of specialist integrated information systems based on software for the modelling and display of remote-sensing and geophysical data.

Generic (broadly applicable) manufacturing technologies. In the Institute of Industrial Technology, the staff of the Sydney Laboratory of the Division of Manufacturing Technology was increased to eight. The Officer-in-Charge, Professor H. Kaebernick, took up his position in March 1986. The Sydney Laboratory will concentrate on control systems in manufacturing and on high-power industrial lasers. The Integrated Manufacturing Group in Adelaide was

increased to four staff and will concentrate on manufacturing information systems. Three additional staff were appointed to the Integrated Manufacturing Program in the Melbourne Laboratory. All these positions came through Executive allocation. In addition, two appointments funded from external sources were made in this area. The Division of Textile Physics recently established a High Technology Systems Group to bring together existing expertise in advanced instrumentation, computer science and image processing. This group currently comprises eight professional officers. While their activities for the near future will be directed towards the raw wool measurement program, it is expected that the instrumentation and technology generated will have much wider application. Also in the Division of Textile Physics, the work on separation and filtration has been very successful and has attracted two substantial collaborative projects. To match this input from industry, the Division has redeployed an additional two professional officers into this area.

In the Institute of Energy and Earth Resources, work on augmented heat transfer in the Division of Energy Technology was strengthened. The Division also redeployed technical support to its project on engine and vehicle efficiency, which is now aimed primarily at assisting automotive component manufacturers to improve their products.

In the Institute of Physical Sciences, the Division of Applied Physics has made a significant contribution to manufacturing technologies as a result of redeploying staff over the past five years, principally from the standards area. The Division's effort is concentrated on instrumentation and measurement — building largely on the expertise in measurement science in the Division — and non-destructive evaluation. A new program in the latter area, incorporating ultrasonic testing, electronic testing and vibrational signature analysis, began during the year. In the Division of Mathematics and Statistics, a project on industrial statistics was begun, with initial work concentrating on the vital issue of quality control in manufacturing. The second Mathematics-in-Industry Study Group meeting was held during the year and several specific industrial processes were examined. These meetings, involving CSIRO and industry, now seem to be established as a mechanism for fostering the effective use of mathematics in Australian industry.

Space technology. The CSIRO Office of Space Science and Applications (COSSA) has the role of developing and coordinating the Organization's effort in this growth area. The major emphasis is in remote sensing and satellite-based communication systems. CSIRO staff have made innovative contributions to the development of reception and processing facilities, which are of special relevance to a sparsely populated, resource-rich, island continent and which have high potential for generating wealth through domestic and export sales of space and ground-sector equipment and from technology spin-offs to local industry. The CSIRO program seeks to build on existing skills in the Organization to develop technologies suitable for the space systems of the 1990s. Technology transfer to industry, by providing research and development support, is a critical component of the program. The aim is to 'space qualify' Australian industry so that it can bid for contracts for fabricating spacecraft components. A good working relationship has been established between CSIRO and industry, and CSIRO and the Commonwealth Department of Industry, Technology and Commerce.

Much of the work in space technology is carried out in the Institute of Physical Sciences, where a substantial amount of redeployment to this area occurred during the year. The Division of Radiophysics placed increased emphasis on the design and development of antenna reflectors and associated feed systems, particularly for satellite earth stations. In the Division of Atmospheric Research, work on satellite remote sensing received a substantial boost with the commercialisation of the CSIDA satellite image reception equipment, resulting in the launch of this product in August 1985. The Division of Mathematics and Statistics expanded work on analysing satellite data, while in late 1985, scientists in the Division of Chemical Physics began developing optimal optical systems configurations for airborne and spaceborne multispectral scanners for remote sensing. The ocean remote-sensing group in the Division of Oceanography participated in demonstrating a satellite-based search-and-rescue facility.

A significant proportion of space-related work is carried out in the Institute of Energy and Earth Resources in relation to mineral, energy and water resources. The Division of Mineral Physics and Mineralogy coordinated a series of remote-sensing experiments conducted in Australia in October (see chapter 11) and is currently directing a collaborative program to implement low-cost modifications to the Australian LANDSAT Station reception facility at Alice Springs. The Divisions of Geomechanics and Groundwater Research also expanded efforts in

the remote sensing of geological and water resources, respectively.

Water and soils. As outlined earlier in this chapter, water resources research, the water component of the water and soils growth area, has been designated a separate growth area for 1986/87. Significant reorganisation of this research is anticipated following recent internal and external review. The soils component will take on a 'protected' status under the heading of soil conservation research, pending the outcome of the review of soil conservation and erosion research in CSIRO. The review covers all eco-climatic regions of Australia and includes relevant biological research. It relates to soils subject to erosion by wind and water, and includes consideration of other forms of degradation in so far as they are seen as immediate precursors of erosion.

In the Institute of Biological Resources, greater emphasis has been placed on physical hydrology, erosion and sedimentation; water and solute movement in soils; and on management of irrigation and drainage waters and other problems relevant to the Murray/Darling catchment area. In the Institute of Energy and Earth Resources there has been a focus on urban supply-demand behaviour and catchment performance in relation to aquifer recharge.

In the Institute of Industrial Technology, new physico-chemical and biological processes for sewage treatment are being taken to pilot scale in the Division of Chemical and Wood Technology, and an additional professional officer has been recruited using an Executive-allocated position.

In the Institute of Physical Sciences, the Division of Environmental Mechanics began studying physical processes occurring in Australian streams, lakes and dams, with special emphasis on those processes — such as radiation climate in the water column, gas exchanges at the air-water interface, sedimentation and erosion — that influence water quality and that determine the outcome of biological processes in the water body.

Raw materials processing. In the Institute of Energy and Earth Resources, about 15 professional officers were redeployed to this area. Initial attention is being focused on high-intensity smelting processes for minerals and the production of advanced materials from indigenous minerals and hydrocarbons. In particular:

- the Division of Mineral Engineering is investigating further industrial applications for metal production by high-intensity smelting and has begun an investigation to improve understanding of the fundamentals of the process;
- the Division of Minerals and Geochemistry is continuing its efforts to improve the quality of crystalline products in the Bayer process for producing alumina from bauxite. In conjunction with the Division of Mineral Chemistry, it has started to investigate means of achieving a more economic process for extracting rare earths from Australian ores;
- the distribution of research effort into alternative liquid fuels in the Divisions of Energy Chemistry and Fossil Fuels is being changed to reduce work related to the production of oil from coal and to increase effort devoted to natural gas conversion;
- additional effort is being spent on producing high-grade products from Australian energy resources. The Division of Fossil Fuels is evaluating the requirements for fabricating carbon fibres and other carbon products from coal-derived pitches and, with the Division of Energy Chemistry, is examining very-low-ash demineralised coal for specialist fuel applications and as a possible substitute for petroleum coke used in carbon anode manufacture. The Division of Energy Chemistry has also been able to increase its effort to produce transport fuels from shale oil with funds from both industry and the National Energy Research, Development and Demonstration Program.

In the Institute of Industrial Technology, four professional officers were redeployed from the Wood Science Program of the Division of Chemical and Wood Technology to increase effort to produce useful chemicals from wood products. The Division of Textile Industry has two principal objectives in wool research — (i) to reduce the costs of wool processing, and (ii) to improve the marketability of wool end-products by developing technology that enables new or improved products to be manufactured. Both remain high-priority objectives, but it has been decided that a significant shift of resources is necessary for achieving the second objective. This policy change was initiated during the year by the redirection of six professional officers and further changes are expected. Research strategies in wool processing will emphasise processes that have promise for direct improvement of the price received by the wool grower and that are specific to the fibre, i.e. scouring and topmaking. These early processing stages offer the potential for expanding wool's manufacturing and export base in Australia.

In the Institute of Physical Sciences, the Division of Materials Science, in consultation with the Divisions of Energy Chemistry and Fossil Fuels in the Institute of Energy and Earth Resources, continued to work on converting shale oil and liquid and gaseous lower hydrocarbons into liquid fuels. Work on supported metal and alloy catalysts stopped in mid-1985 and the resources previously allocated to this project were used to initiate work on catalytic partial oxidation with the aim of converting methane to methanol or lower aliphatics.

Human nutrition. Research in this area is concentrated in the Institute of Animal and Food Sciences. The Division of Human Nutrition was allocated extra funding in 1985/86 by the Executive and the Director of the Institute. This support was applied generally towards the operating expenses of the four programs of the Division — developmental biology; control processes in growth and over-nutrition; dietary lipids and related factors in human health; and nutritional epidemiology and behaviour. Support was also earmarked for strengthening a new research program, nutritional regulation of metabolic processes relevant to cardiovascular disorders, which was largely formulated as a result of the internal redeployment of staff. In response to a rapidly increasing number of inquiries from governments, industry and the public on nutrition and dietary matters, an information officer was appointed to the Division.

The Division of Fisheries Research began a project to study the occurrence and level of nutritionally important polyunsaturated fatty acids in marine algae from Australian waters. Several of these fatty acids are unique to the marine environment and may have significant medical applications.

Plant diseases. Research is carried out in the Institute of Biological Resources. Research in the Division of Soils emphasises management systems that minimise the impact of soil-borne diseases on cereals. The Division of Plant Industry studies virus diseases in legume pastures, plant breeding approaches to the development of resistance to diseases, disease epidemiology, and basic mechanisms of disease susceptibility and resistance.

The Division of Tropical Crops and Pastures has established a joint project based at the University of Queensland to study anthracnose disease of the pasture legume stylo. The Division of Horticultural Research carries out work on virus diseases of perennial crops and the Division of Forest Research is studying diseases of both native and exotic tree species.

Redeployment

Resources to undertake expanded activity in Executive-designated growth areas come mainly through redeployment of existing resources. This is achieved in two ways: redirection by the Executive of vacancies arising from the normal process of staff turnover, and redirection by Chiefs and Directors of personnel from work of lower priority or from completed work.

In the Institute of Animal and Food Sciences, Executive and Institute Director initiatives led to 25 professional and technical positions and over $1.1 million of appropriation funds being redeployed into Executive growth and Institute priority areas. Human nutrition received the largest allocation of positions and funds but resources were also directed to biotechnology and raw materials processing. Individual Divisions of the Institute also redeployed resources to growth areas by reducing or terminating work of lower priority. Examples include: the Division of Molecular Biology, which ceased to work on new growth factors and on the biology of cell commitment, and the Division of Animal Production, which terminated research into fleece rot, and reduced research effort on the isolation and role of proteins in embryo development.

In the Institute of Biological Resources, 25 professional staff were redeployed into Executive and Institute growth areas. The major shifts were to biotechnology, water and soils, plant diseases and information technology, resulting in less emphasis on a number of 'unprotected' areas.

In the Institute of Energy and Earth Resources, 31 professional staff, representing 3.1% of the Institute's total professional complement, were redeployed either to Executive growth areas or Institute priority areas. More than $1 million of appropriation funds were also redirected into these areas to allow for the employment of new staff and the purchase of equipment, thus providing a further 2.5% redeployment of resources. The main redeployments of staff were to raw materials processing, water resources, space science and information technology. Research programs for which no additional resources were provided were those concerned with minerals exploration, coal-mining, synthetic fuels from coal, oil-shale processing, renewable energy, and land and atmospheric environmental protection.

In each of the previous two years, the Institute of Industrial Technology redeployed 9% of its professional staff to Executive-designated growth areas. These redeployments were reported in

detail in the 1983/84 and 1984/85 Annual Reports. Divisional programs then required a period of stability during which research efforts could be consolidated. Nevertheless, some redeployment into several growth areas took place during 1985/86. In addition, increased effort was made possible by Executive allocation of some extra resources. It should be noted that there was a significant increase in the number of externally funded positions in the Institute's growth area programs during the year.

In the Institute of Physical Sciences, 27 professional staff — 5% of the Institute's total number — redirected their activities to either Executive-designated growth areas or other Institute growth areas. Substantial redeployment occurred in the Division of Atmospheric Research — from studies of cloud physics to work on satellite remote sensing and from a variety of areas to studies of drought in Australia. In the Division of Radiophysics, increased emphasis was placed on solid-state micro-electronic devices, antenna systems for satellite ground stations and signal processing. Significant redeployment occurred in the Division of Applied Physics, where work on advanced materials, non-destructive testing and analogue-digital image processing was strengthened; in the Division of Mathematics and Statistics, where greater emphasis was placed on generic manufacturing technologies and information; and in the Division of Environmental Mechanics, where work was reoriented to emphasise water and soils and drought research.

Table 2.1 CSIRO Research Areas 1985/86

Manufacturing Industries	% of Total Direct Research Expenditure		% of Total Direct Professional Staff	
Technology-based manufacturing industries				
Scientific and electronic equipment and instruments	1.89		2.02	
Chemicals, polymers, and pharmaceutical and veterinary products	3.47		3.30	
Fabricated metal products and processes	0.44		0.43	
Machinery and equipment	0.13		0.14	
Not specifically allocated	1.10		1.10	
		7.0		**7.0**
Resource-based manufacturing industries				
Food and beverages	3.08		3.66	
Textiles and leather	1.92		2.02	
Wood, paper and forest products	1.25		1.32	
Industrial mineral processing and basic metal products	1.80		2.10	
		8.0		**9.1**
Manufacturing — general				
Generic manufacturing technologies	1.28		1.41	
Advanced materials	3.02		3.34	
Standards for manufacturing industries	0.89		0.86	
Not specifically allocated	0.64		0.64	
		5.8		**6.2**
Not specifically allocated		**0.3**		**0.4**
Total — Manufacturing Industries		**21.1**		**22.7**

Table 2.1 (cont.)

Rural Industries	% of Total Direct Research Expenditure		% of Total Direct Professional Staff	
Agriculture				
Cereal crops	2.04		1.89	
Oilseed and legume crops	1.06		0.83	
Horticultural crops	1.82		1.76	
Fibre and industrial crops	2.91		2.17	
Pastures	2.29		1.56	
Sheep	1.34		1.16	
Beef cattle	1.90		1.34	
Dairy cattle	0.20		0.15	
Intensive livestock	0.17		0.06	
Minor livestock species	–		–	
Agricultural systems	1.27		1.01	
Multi-commodity research	3.12		2.17	
Not specifically allocated	3.55		3.15	
		21.7		17.2
Forestry				
Plantation forests	1.59		1.68	
Natural forests	1.03		1.08	
Bushfires	0.24		0.24	
Not specifically allocated	0.21		0.22	
		3.1		3.2
Fishing				
Fisheries	2.11		1.87	
Marine biology	0.73		0.70	
		2.8		2.6
Not specifically allocated		0.5		1.0
Total — Rural Industries		28.1		24.0

Table 2.1 (cont.)

Mineral, Energy and Water Resources	% of Total Direct Research Expenditure		% of Total Direct Professional Staff	
Mineral resources				
Exploration	2.13		2.58	
Mining	0.80		0.75	
Minerals beneficiation	1.68		2.22	
Not specifically allocated	0.15		0.23	
		4.8		5.8
Energy resources				
Coal production	1.22		1.27	
Coal utilisation	1.31		1.46	
Petroleum, natural gas and oil shale	2.42		2.48	
Renewable energy, and energy storage, conservation and use	1.67		1.87	
		6.6		7.1
Water resources				
Water resource management	2.36		2.87	
Water technology	0.48		0.53	
Not specifically allocated	0.09		0.11	
		2.9		3.5
Not specifically allocated		0.1		0.2
Total — Mineral, Energy and Water Resources		14.4		16.6

Table 2.1 (cont.)

Conservation and the Natural Environment	% of Total Direct Research Expenditure		% of Total Direct Professional Staff	
Soils and land use				
Soil resources	0.38		0.38	
Land use	0.54		0.57	
Soil conservation and management	0.93		1.07	
Not specifically allocated	0.69		0.84	
		2.5		2.8
Ecology and environment				
Aquatic environment	0.94		0.82	
Terrestrial environment	1.68		1.58	
		2.6		2.4
Flora and fauna				
Flora	1.10		1.11	
Fauna	1.59		1.37	
		2.7		2.5
Oceans and atmosphere				
Oceans	0.97		0.78	
Atmosphere	1.52		1.75	
Not specifically allocated	0.05		0.05	
		2.5		2.6
Environmental protection				
Land	0.24		0.26	
Water	0.34		0.28	
Air	0.65		0.66	
Human environment	0.14		0.15	
Not specifically allocated	0.11		0.12	
		1.5		1.5
Not specifically allocated		0.6		0.9
Total — Conservation and the Natural Environment		12.4		12.7

Table 2.1 (cont.)

Service Industries	% of Total Direct Research Expenditure		% of Total Direct Professional Staff	
Urban and civil engineering				
Transport systems	0.06		0.07	
Geo-engineering	0.49		0.50	
Construction	1.21		1.47	
Urban planning	0.15		0.22	
Not specifically allocated	0.10		0.10	
		2.0		2.4
Human health				
Nutrition and food safety	1.64		1.95	
Medical technology	0.59		0.50	
Not specifically allocated	0.02		0.02	
		2.2		2.5
Standards for service industries				
Standards and calibration services	1.27		1.24	
		1.3		1.2
Total — Service Industries		5.5		6.1
Multi-sectoral Technologies				
Biotechnology		9.8		8.4
Information technology		3.5		4.4
Space technology and astronomy				
Space technology	1.34		1.44	
Astronomy	2.17		2.35	
		3.5		3.8
Total — Multi-sectoral Technologies		16.8		16.6
International Aid				
International Aid		1.7		1.3
CSIRO — Research Total		100.00		100.00

Table 2.2 1985/86

	% of Total Direct Research Expenditure		% of Total Direct Professional Staff	
Institute of Animal and Food Sciences				
Animal Health	2.8		2.1	
Animal Production	4.6		4.2	
Australian Animal Health Laboratory	2.7		0.7	
Fisheries Research	3.3		3.0	
Food Research	4.6		5.2	
Human Nutrition	1.4		1.5	
Molecular Biology	1.2		1.2	
Tropical Animal Science	2.6		1.8	
Wheat Research	0.3		0.5	
Institute Total		**23.5**		**20.2**
Institute of Biological Resources				
Entomology	4.6		4.0	
Forest Research	3.2		3.4	
Horticultural Research	1.0		1.0	
Plant Industry	6.1		5.8	
Soils	2.9		3.5	
Tropical Crops and Pastures	4.1		2.5	
Water and Land Resources	2.3		2.5	
Wildlife and Rangelands Research	2.9		2.5	
Centre for Irrigation Research	1.0		1.0	
Institute Total		**28.1**		**26.2**
Institute of Energy and Earth Resources				
Energy Chemistry	1.9		1.7	
Energy Technology	1.2		1.3	
Fossil Fuels	2.0		2.2	
Geomechanics	1.5		1.6	
Groundwater Research	1.1		1.3	
Mineral Chemistry	1.8		2.3	
Mineral Engineering	3.1		3.5	
Mineral Physics and Mineralogy	2.0		2.3	
Minerals and Geochemistry	1.1		1.4	
Institute Total		**15.7**		**17.6**

Table 2.2 (cont.)

	% of Total Direct Research Expenditure		% of Total Direct Professional Staff	
Institute of Industrial Technology				
Applied Organic Chemistry	1.7		1.8	
Building Research	2.5		3.1	
Chemical and Wood Technology	2.8		3.1	
Manufacturing Technology	1.9		2.1	
Protein Chemistry	2.1		2.3	
Textile Industry	2.6		2.0	
Textile Physics	1.7		1.6	
Institute Total		15.3		16.0
Institute of Physical Sciences				
Applied Physics	5.2		5.0	
Atmospheric Research	1.9		2.2	
Chemical Physics	1.8		2.2	
Environmental Mechanics	0.5		0.6	
Information Technology	0.6		1.0	
Materials Science	1.6		2.0	
Mathematics and Statistics	1.5		2.6	
Oceanography	1.3		1.0	
Radiophysics	3.0		3.4	
Institute Total		17.4		20.0
CSIRO — Research Total		100.0		100.0

Table 2.3 Professional Staff Numbers in the Multi-sectoral Technologies Sector 1985/86

	Biotechnology	Information technology	Space technology	Total
Manufacturing Industries	71	27	15	113
Rural Industries	129	18	–	147
Mineral, Energy and Water Resources	1	6	10	17
Conservation and the Natural Environment	–	8	11	19
Service Industries	12	52	–	64
Astronomy	–	–	59	59
International Aid	–	–	–	–
Total	**213**	**111**	**95**	**419**

Table 2.4 Total Professional Staff Numbers in CSIRO Sectors (as at 30 June)

	1981	1982	1983	1984	1985	1986
Manufacturing Industries	596	631	642	656	672	684
Rural Industries	726	730	742	748	749	750
Mineral, Energy and Water Resources	454	461	502	482	447	433
Conservation and the Natural Environment	339	319	315	317	322	339
Service Industries	229	196	193	191	192	217
Astronomy	64	61	64	72	66	59
International Aid	15	18	20	22	24	33
Total	**2423**	**2416**	**2478**	**2488**	**2472**	**2515**

Table 2.5 % of Total Professional Staff in CSIRO Sectors (as at 30 June)

	1981	1982	1983	1984	1985	1986
Manufacturing Industries	24.6	26.1	25.9	26.4	27.2	27.2
Rural Industries	30.0	30.2	29.9	30.1	30.3	29.8
Mineral, Energy and Water Resources	18.7	19.1	20.3	19.4	18.1	17.2
Conservation and the Natural Environment	14.0	13.2	12.7	12.7	13.0	13.5
Service Industries	9.5	8.1	7.8	7.7	7.8	8.6
Astronomy	2.6	2.5	2.6	2.9	2.7	2.3
International Aid	0.6	0.7	0.8	0.9	1.0	1.3

Table 2.6 Professional Staffing by Funding Source (as at 30 June)

	1984		1985		1986	
	Appropriation-funded	Externally funded	Appropriation-funded	Externally funded	Appropriation-funded	Externally funded
Manufacturing Industries	582	74	598	74	596	88
Rural Industries	621	127	610	139	585	165
Mineral, Energy and Water Resources	436	46	411	36	388	45
Conservation and the Natural Environment	289	28	299	24	309	30
Service Industries	186	5	188	4	207	10
Astronomy	72	–	65	1	56	3
International Aid	19*	3	19*	5	25*	8
Total	**2205**	**283**	**2189**	**283**	**2166**	**349**

* The allocations of appropriation-funded staff to International Aid represent small contributions from a number of programs that have other primary purposes but are judged to have some relevance to international aid activities.

3. A Strategy for CSIRO

The 1984/85 Annual Report described an overall strategy for the Organization that had been developed by a number of Executive working parties over the preceding year. Major features contained in this strategy were:

- *Balance of research effort.* Procedures were developed for addressing and deciding how the Organization's resources should be allocated across economic sectors, research areas and technologies.
- *Concentration of effort.* The need to concentrate resources to achieve results in the time-scale necessary for their effective application was specified as being of major importance for research managers.
- *Evaluation of research benefits.* More systematic procedures for evaluating the potential benefits of research were identified as being necessary to concentrate research into the most effective areas. Similarly, retrospective analysis of benefits arising from completed research was identified as being essential for CSIRO to be able to demonstrate the value of its research to the Australian economy and society.
- *Interaction with industry and the community.* More effective interaction with users and potential users in the planning of research, and in the transfer of research results, was affirmed as vital for the Organization's major task of conducting applications-oriented research. More effective communication with Government, community leaders and the general public was also recognised as being important.
- *Human resource development and management.* CSIRO's success ultimately depends on the creativity of its scientists, and the direction of their skills and expertise into areas of greatest need. To this end, requirements were identified for reward systems clearly geared to achievement, for the training of scientists in research management roles, and for flexibility of management at all levels to redeploy human resources in response to changing opportunities and needs.

Important steps have been taken to implement all these elements of CSIRO's strategy during the year, with the commencement or completion of a number of tasks. In some areas emphasis has been placed on providing, for early decision by the incoming Board, options for future action based on sound analytical information. Actions taken to implement each element of CSIRO's strategy are described below.

Balance of Research Effort

The Executive has recognised that assessment of the extent of effort to be directed to different sectors of economic activity and to community interest areas is a vital part of its role. Similarly, the Organization's research managers must identify clearly priorities within sectors. Decisions on those emerging technologies warranting increased effort also have to be made.

Action has been taken in each of these three areas. Firstly, the criteria described in the 1984/85 Annual Report were used to select growth areas for 1986/87. These criteria incorporate:

- the national economic and social benefits to be gained
- the prospects for significant scientific advances
- the availability of high-quality staff
- the funding requirements for a viable and effective research effort
- the appropriateness of the proposed research for CSIRO
- the likelihood of effective utilisation of research results through their transfer to users, and
- the external commitments to industries and governments already entered into by the Organization.

The growth areas selected are presented in chapter 2 of this Report.

While these growth areas relate to technologies or industries as a whole, it is equally important that priorities within individual sectors be established. Some topics of continuing high priority within sectors will call for the current level of research effort to be maintained; other topics will warrant increased support by reallocation of resources within a sector. In order to examine sector policies and priorities in more detail a number of sector policy committees were established in 1986. These committees comprise those Directors whose Institutes contribute significantly to the following sectors:

- manufacturing industries
- rural industries
- minerals and energy
- construction and urban and civil engineering
- water resources
- information and space industries
- natural environment, and
- public health.

Each of these committees is now preparing policies and priorities for consideration by the incoming Board.

An analysis has also been undertaken of recent trends in the sectoral balance of the

Organization's research. The analysis covers the five-year period from June 1981 to June 1986. A summary, presented in chapter 2, shows the substantial and steady increase in resources devoted to the manufacturing sector over this period — namely, an increase of some 90 professional staff, or 15%, over the base year. This sector now represents the highest level of professional staffing in CSIRO funded from appropriation sources.

While this analysis clearly portrays recent changes in sectoral allocations, of greater importance is the emphasis CSIRO should give in the future to the different sectors.

CSIRO is therefore developing projections of future sectoral balance based on the growth-area decisions made by the Executive and the determination of priorities within sectors now being undertaken by the sector policy committees. These projections, in conjunction with the criteria mentioned above, will allow the incoming Board to assess whether the proposed changes in balance represent an appropriate response to changing needs and opportunities, or whether further changes in resource allocation are necessary.

Concentration and Benefit Evaluation

In its research planning, the Organization has placed a high priority on concentrating the research effort on topics of greatest importance. This was emphasised in guidelines issued as part of the new planning procedures presented in the 1984/85 Annual Report and now being implemented.

To identify topics on which effort should be concentrated, an evaluation must be made of the benefits likely to accrue from successful application of the research results of individual programs and projects. The strategy announced in 1985 committed the Organization to developing more systematic procedures for the evaluation of these benefits by research managers. Accordingly, the Executive has established a sub-committee with the following terms of reference:

To report to the Executive on:

(i) guidelines on techniques for use by Institutes and Divisions for
  (a) prospective evaluation of benefits in relation to the planning of research programs or projects; and
  (b) methods for monitoring the progress of projects against set goals.
(ii) the incorporation of the recommended techniques in the Executive's recently endorsed procedures for research planning and reviews of research activities.
(iii) the applicability of current techniques, and developments required, for undertaking retrospective evaluation of research benefits.
(iv) education and training needs to promote effective application of recommended procedures and techniques.

The Executive sub-committee has conducted a survey of current evaluation approaches and techniques in a selected sample of CSIRO Divisions. It has also discussed with business consultants and academic groups approaches to be taken to ensure effective decisions in the planning and management of programs. Guidelines for procedures to be adopted by Divisions will be proposed by the sub-committee to the new CSIRO Board.

Interaction with Industry and the Community

Effective interaction with potential users of research results is essential to the planning of research. The on-going assessment of programs and the successful transfer of research results to customers are also recognised as being vital to the effectiveness of a government research organisation.

To achieve the above, and in accord with Executive decisions on the review of CSIRO's planning activities, each Division has established one or more user-oriented advisory committees. Increased emphasis is being placed on this working-face consultation with industry, as well as on establishing effective communication at the top management level through regular meetings with such groups as the Business Council of Australia.

SIROTECH Ltd — the Organization's technology-transfer company — is a further important element in establishing effective communication with the business community. SIROTECH has already achieved significant results, and, through management of CSIRO's manufacturing industry collaborative program, is extending its links with industry.

CSIRO has also taken significant steps to improve its more general interaction with the community. Following a review of the Organization's external communication activities, the former Bureau of Scientific Services has been reorganised as the Bureau of Information and Public Communication under a new Director (see chapter 4). Further restructuring of this Bureau is

now proceeding so that CSIRO can effectively contribute and respond to social and scientific issues within its areas of expertise.

Human Resources

CSIRO's contribution to the nation depends ultimately on the intellectual contribution of its staff. Personnel policies that provide an environment conducive to promoting creativity by individuals, and the focusing of their efforts on topics of the highest priority, are therefore vitally important. CSIRO requires policies that will enable it to attract and retain people of the highest calibre, as well as those providing flexibility to respond to changing needs and opportunities.

Particular attention has therefore been given to:

- promotion criteria and their effective application
- staff development and training, and
- staff redeployment and retirement policies.

The reward system for staff must be perceived as being based on both achievement of scientific excellence and effective contribution to economic activity and community needs. Changes to promotion criteria introduced in 1984/85 that give increased emphasis to practical achievement are now being implemented.

A new training unit has been established to help upgrade the research management skills of scientists, particularly those relating to project management techniques. Retraining in areas of emerging scientific prominence will also be essential to enable effective redeployment of existing resources to research areas judged to be of higher priority.

To allow the necessary flexibility in resource allocation, an injection of new scientific skills beyond that achievable by application of term-appointment policies and the normal pattern of retirement and replacement is sometimes necessary. The rapid advances in new areas of science, and the similarly rapidly changing demands now facing CSIRO, led the Executive to propose the introduction of an early-retirement scheme to enable a more rapid recruitment of younger scientists. The Government has endorsed the implementation of this scheme in 1986/87; negotiations on the scale of benefits are now being undertaken.

The ASTEC review recommended a number of other changes in personnel policies; the Government has referred these to the incoming Board for further examination and report. They include the respective levels of term and indefinite appointments, the financial rewards for contributions to successful commercial activities, and superannuation arrangements that will provide for greater mobility of scientists into and out of CSIRO. Options on all these matters are currently being developed for consideration by the new Board. The relationship of the Organization with the Public Service Board has been referred to the Minister for Science for further consideration.

4. Information and Public Communication

One feature which distinguishes science in the 1980s from the science of previous decades is the need to communicate it. The 1980s have seen scientists come under mounting pressure to be more accountable, relevant and useful. Effective communication is central to all these things; it is essential for the introduction of new technology.

This emphasis is being reflected in CSIRO's policies on external communication and information services. These have been substantially revised during the year to enhance the effectiveness of the Organization's contribution to Australia's economic and social needs.

CSIRO has always maintained a high level of information flow between scientists — both locally and overseas — which has contributed to its reputation for excellence in research. Against a background of increasing public interest in scientific research and a growing demand for accountability, CSIRO has recognised the need to apply this quality of excellence to all communication and information activities.

The development of CSIRO's information and public communication policy has been based on the findings of several internal reports and independent reviews, the most recent being the review of CSIRO's external communication activities in 1985. This review has led to the appointment of a Director to head a newly formed Bureau of Information and Public Communication, and the endorsement by the Organization of a statement of policy on external communication.

External Communication Review

The external communication review committee, chaired by Melbourne businessman Mr Baillieu Myer, then a part-time Member of the CSIRO Executive, gave the Executive a simple message: the effectiveness of CSIRO's communication lags far behind its effectiveness in research, and communication is the responsibility of all members of CSIRO. It recommended that the Executive adopt a clear policy for external communication.

The Executive accepted almost all the recommendations of the review committee, and in its response acknowledged that communication was an integral part of the research process. The Executive's policy on external communication now requires the Organization to obtain the best possible advice from relevant sectors of the community about opportunities and priorities for research planning. Equally, these sectors must be kept informed by CSIRO about its activities and expertise.

Continued links with the international scientific and technical community are also essential as they condition CSIRO's ability to undertake world-class research. But research results, when achieved, must be actively promoted to ensure that they are applied by industries, governments and the community. In turn, this calls for a greater awareness within industry and the community of the importance of science and technology to Australia's economic and social welfare.

External Communication Policy

Communication is an integral part of CSIRO's research process, both in determining research objectives and in advising the results of research. The broad objectives of CSIRO's external communication activities are to:

- obtain the best possible advice from governments, industry, academic institutions and the community on research needs, opportunities and priorities as an integral part of the strategic planning process;
- inform governments, industry, academic institutions and the community of the Organization's research policies, objectives and priorities and the reasons for decisions;
- advise the national and international scientific and technical community of the results of research for inclusion in the scientific and technological knowledge base (subject to commercialisation considerations) and for peer evaluation;
- actively promote the full use of current technologies and the adoption of new technologies, processes and developments by industry, governments and the community and, where appropriate, assist in their introduction; and
- inform the community of research results and their implications and stimulate public debate on issues in science and technology through the media, community awareness programs and the education system.

In endorsing, with a few modifications, all but one of the 38 recommendations contained in the Myer report, the Executive decided that:

- communication planning should be integrated with research planning and priority setting at all levels in CSIRO;
- the major responsibility for external communication lay with Institutes, Divisions and Units;
- communication activities should be adequately funded. This included the

Students from Geelong East Technical College inspect a model of the secure area of the Australian Animal Health Laboratory. Their visit was part of the Laboratory's Science in Action Program.

establishment of a central fund to subsidise Divisions and Units for special communication projects;

- personnel policies for recruitment, training and promotion should recognise the importance of communication skills;
- CSIRO should have a strong, clear corporate image. This should be standardised throughout the Organization and supported by promotion of CSIRO through its communication with the general public.

Public Perceptions

The review committee commissioned an independent survey to examine the perceptions of CSIRO held by key opinion leaders and three community groups (farmers, teachers and manufacturers). The survey consultants concluded that the opinion leaders were greatly interested in CSIRO's contribution to Australia's economic and social conditions, but knew little about the Organization.

The survey highlighted deficiencies in CSIRO's communication effort which stemmed from certain traditional attitudes towards communication. It showed that CSIRO could no longer regard communication to industry and the public as the sole responsibility of specialist communication staff and senior management. While research staff successfully communicate through scientific publications, such communication rarely transfers technological innovation to industries or enhances public understanding of scientific issues.

The Executive has acted to overcome these deficiencies by implementing policies aimed at encouraging greater staff participation in communication and strengthening the application of existing corporate resources. Revised guidelines for promotion and recruitment give greater emphasis to communication skills and experience. Guidelines on public comment encourage staff to talk publicly about their work and to contribute to public debate on issues within their expertise.

Communication Resources

A key recommendation of the Myer committee accepted by the Executive related to the decentralised nature of communication resources throughout CSIRO. It stated:

> 'The major responsibility for external communication of research needs, opportunities, objectives, results, potential for application and implications should remain with Institutes, Divisions and Units.'

Most Divisions employ information/communication specialists, who provide services specific to Divisional communication needs and user groups. They assist with scientific writing and editing, photography, graphic design, media liaison, and other communication activities such as film production.

The Executive decided that the roles and objectives of these officers should be clearly defined by their Chiefs and that the resources allocated to Divisional communication activities should be identifiable in an Organization-wide communication budget. These officers should also be provided with appropriate training, data-base and information support, and assistance from central communication services.

In addition, the Executive decided that high priority should be given to increasing informal links with industry through direct, personal contact by the Executive, Directors, Chiefs, and research and other staff. They should also vigorously pursue other methods, both traditional and innovative, to communicate CSIRO's research role and capacity to industry and to learn more about the problems of industry. As examples of appropriate methods, the Executive cited short-term staff exchanges, specifically targeted publications and videos, industry-sector summit meetings, and the inclusion of industry leaders on Divisional advisory committees.

The Executive also identified the importance of centrally based communication services, to be integrated under the leadership of the new Director, Information and Public Communication. These services were formerly contained within the Central Information, Library and Editorial Section (CILES) and the Science Communication Unit (SCU), which together included approximately 215 staff.

Among the centrally based communication services are: a computer-linked corporate library network, a CSIRO computer data-base called INFOLINK, editorial and publishing facilities for the Australian Journals of Scientific Research and for CSIRO publications, science writing and graphic design, media liaison, speech-writing, film and video production, and science information services to industry, the education system and the community.

In relation to these services, the Executive decided that:

> 'The Director, Information and Public Communication, should develop, and obtain Executive endorsement of, a clear statement of the roles, functions and priorities of the central group.'

AUSTRALIS is a new on-line information retrieval service from CSIRO which provides computer-based access to a wide range of Australian scientific information.

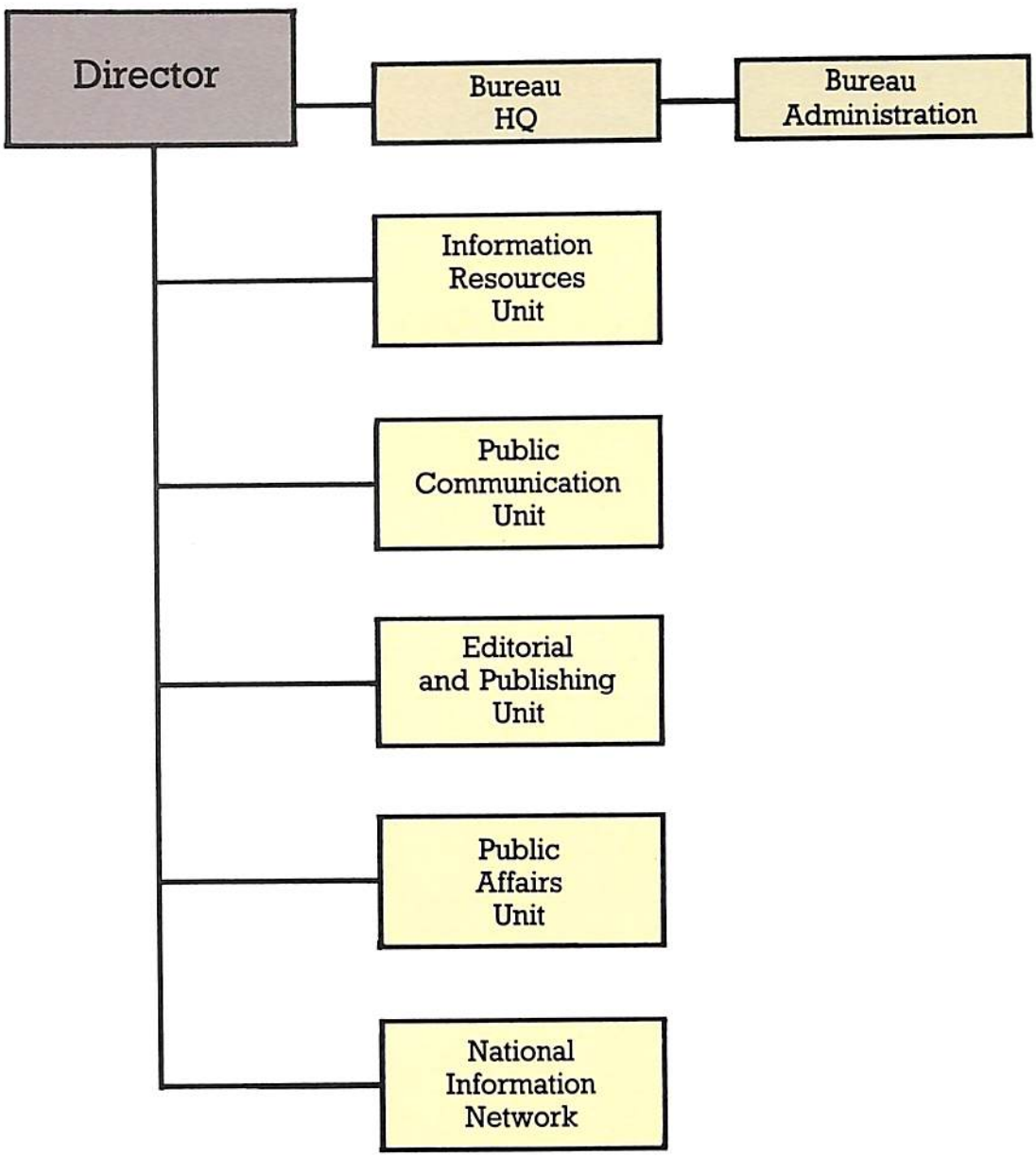
Such a statement was incorporated in a Bureau Action Plan prepared by Mr P.J. Dunstan, who was appointed in November 1985 as the Director, Information and Public Communication. The Executive endorsed the Plan for implementation from 1 July 1986. The Plan provides for a major restructuring of CILES and the SCU within the new Bureau of Information and Public Communication.

Structure of the Bureau of Information and Public Communication

The Bureau consists of five units providing strengthened information and public communication based on increased support for Divisional activities, additional attention to internal communication, and a more effective information service. The units are:

- an *Information Resources Unit*, responsible for providing information support to the Organization and cooperation in a national library and information service. The Unit will develop a scientific and technical information system of excellence, including library and bibliographic services, and data-base, inquiry and referral facilities;
- a *Public Communication Unit*, responsible for the corporate public communication program and the development of a corporate image. It will plan, organise, direct and evaluate the program and also provide professional advice and assistance to Divisions and Institutes on their specific communication policies. The Unit will provide media liaison services, produce publications, films and videos, organise exhibitions and foster community relations;

The new Bureau of Information and Public Communication



- an *Editorial and Publishing Unit*, responsible for providing the Organization's editorial, printing, publishing, and translation services;
- a *Public Affairs Unit*, responsible for managing public issues and current affairs. It will monitor political, economic and social trends to ensure that CSIRO's external corporate policies are relevant to areas of public interest. The Unit will develop an effective briefing service and provide professional advice on issues management;
- a *National Information Network*, responsible for maintaining, with Divisional collaboration, a nation-wide CSIRO information service for industry and the community. It will represent other Bureau Units in each State and Territory, develop marketing opportunities for the Organization's information products and services, and take steps to strengthen the regional nature of CSIRO's communication.

New Initiatives

Other initiatives taken towards meeting the objectives set down by the review committee include:

- setting up a communication grants scheme to encourage Divisional communication projects. Grants totalling $150 000, and matched dollar-for-dollar by the Divisions, were made in 1985/86;
- participating in several major public exhibitions to ensure a higher profile. These are: a guest exhibition at the Westpac Banking Museum in Sydney, the 1986 Australian National Field Days at Orange, N.S.W., the 1987 Melbourne Show, the International Technology Exhibition in Canberra in 1987, and the Australian Bicentennial Exhibition;
- a series of functions for community leaders to discuss CSIRO's role and work, as part of communication with specific target groups.

These activities will complement developments stemming from other policy initiatives. The developments include the setting-up of Divisional advisory committees, with representatives from industry, government and tertiary institutions; the formation of sector committees within CSIRO to examine CSIRO's role in relation to industry sectors and relevant areas of community activity; and the technology-transfer activities of SIROTECH Ltd.

Roger Seccombe and Sharon Kent, of the Film and Video Centre, prepare for an underwater sequence for the CSIRO video, 'Women in Science'.

CSIRO's restructured communication effort aims at stimulating a two-way exchange of information between the Organization and sectors within the community. The objectives are to ensure that CSIRO's research capabilities are directed towards the real needs of the Australian community, and that the community becomes increasingly aware of the importance of scientific research, knowledge and innovation in developing the national economy and our quality of life.

Key Areas for Improvement

- More effective advisory mechanisms and more visible response to community needs.
- Closer integration of research and communication planning.
- Increased communication with non-technical audiences, particularly decision-makers.
- More effective communication with industry and increased rate of technology transfer.
- Increased contribution by scientists to public debate.
- Improved inquiry service.
- Better targeting and evaluation of communication activities.

5. Research Reviews

Completed Reviews

Division of Food Research

In December 1985, the Executive considered the recommendations of the committee which reviewed the Division of Food Research and reached decisions on the report.

Although the review commenced before the introduction of new guidelines for Divisional reviews, providing for a more open and consultative process, the review committee produced a draft report as a green paper that was circulated to Divisional staff and selected individuals and groups outside the Division.

The Executive agreed with the review committee's assessment of the potential benefits to Australia from food research and on the need to maintain strong links with industry. It decided that the Division of Food Research (comprising the Food Research, Meat Research, and Dairy Research Laboratories) should continue as a single entity, but that the Tasmanian Food Research Unit (the seafoods research group) should become part of the Division of Fisheries Research, with the aim of strengthening links between that Division and industry. The Tasmanian group would continue to work on fish as food and maintain strong links with the Division of Food Research.

In terms of CSIRO growth areas the Executive agreed on the importance of carrying out strategic research for the food industry, but decided that such research should not be given enhanced status within the processing of raw materials growth area in 1986/87. The Executive agreed that a case should be developed for this research to be considered as a possible growth area in its own right in 1987/88.

While the Executive recognised that the Food Research Laboratory in particular should become more interactive with industry and seek increased industry support for tactical research, it noted the need for an examination of the balance between strategic and tactical research in that Laboratory.

Review of Materials Science and Technology and Related Review of the Division of Chemical Physics

As foreshadowed in the 1984/85 Annual Report, the Executive considered, during 1985/86, the recommendations of the two committees which reviewed the related topics of materials science and technology in CSIRO and the Division of Chemical Physics. As a result new arrangements have been made for handling a large part of CSIRO's materials research.

The review of materials science and technology was commissioned following a recommendation of the committee reviewing the Division of Materials Science in 1982/83. The review of the Division of Chemical Physics was established in line with normal CSIRO procedure because of the approaching conclusion of Dr L.T. Chadderton's appointment as Chief of the Division.

The review of materials science and technology recommended separation of the two constituent parts of the Division of Materials Science — the Advanced Materials Laboratory and the Catalysis and Surface Science Laboratory. It also recommended the development over a period of the Advanced Materials Laboratory into a new Division of Materials Science and Technology. Thus, with the Division of Chemical Physics, there would be three separate but coordinated materials-oriented Divisions on CSIRO's Clayton site. It was proposed that research interests would focus on physical metallurgy, surfaces and coatings, corrosion, composites, polymers and adhesion, as well as ceramics.

After lengthy consideration, the Executive preferred the somewhat different arrangements proposed by the committee reviewing the Division of Chemical Physics. These entailed amalgamation of the current Division of Chemical Physics and Division of Materials Science to form a new Division to contain all the Organization's materials research in this general area; materials work will continue in a number of other Divisions.

The new Division will be called the Division of Materials Science and Technology. It will be a constituent Division of the Institute of Physical Sciences, be located at Clayton and will come into being when a new Chief has been selected, probably in the second half of 1986.

The Executive also decided that the new Division's objective would be:

> 'To assist Australian industry by developing new and improved materials, as well as relevant processes and instruments, by methods that include the study and modification of the microstructure of solids and their surfaces.'

In addition to organisational arrangements, the reviews gave attention to the key areas of materials science and technology that CSIRO should enter or expand. However, the Executive

believed that the review committee's suggestions for such areas needed to be refined into a short list of specific areas through detailed applications-oriented studies carried out in consultation with industry. The Chief of the new Division will be asked as a matter of urgency to identify applications-oriented priority areas for CSIRO's materials research.

Division of Manufacturing Technology

In June 1986, the Executive considered the recommendations of the committee which reviewed the Division of Manufacturing Technology and reached decisions on the report.

The Executive accepted most of the review committee's recommendations and agreed with the high assessment of the Division's achievements, its interaction with industry and its contribution to the technological capability of Australia's manufacturing industry.

As a result of the Executive's decisions the Division will continue to concentrate its research effort on the metals and related engineering industries. When appropriate, research will be extended to other materials, with the overriding aim of contributing to improved competitiveness, particularly of export-oriented industries. The Executive generally endorsed the review committee's proposals for the areas of research the Division should develop.

The Executive agreed that the Division of Manufacturing Technology should continue to grow and that increased external funding of the Division by industry should be sought, with the aim of at least 30% of total funds being obtained from industry.

Reviews in Progress

Water Research Review

During 1985/86, the Organization's policies on water research underwent considerable examination (see also chapter 8). No significant change had been made to these policies since 1982, when CSIRO's national role in such research had been defined.

Reviews have been completed in the Divisions of Groundwater Research, Water and Land Resources, and Environmental Mechanics during 1985/86. As well as being relevant to the examination of CSIRO's role in water research, the reviews of the Divisions of Groundwater Research and Water and Land Resources were conducted as part of the general review process undertaken when Chiefs of Divisions approach retirement or near the end of their terms of appointment. Both review committees endorsed the need for a single CSIRO 'water' Division to improve the coordination and organisation of water resources research. A review committee also examined the programs of the Division of Environmental Mechanics to see how the Division might best continue to carry out its applied or strategic research in relation to environmental problems, including water research.

Early in 1985 and before these reviews, Dr A.J. Peck, of the Division of Groundwater Research, chaired a working party set up to examine issues of the funding, coordination and organisation of water research at the national level. The working party, which included research staff from Divisions involved in water research, had found that the coordination and organisation of this research was below optimum. In December 1985, a discussion paper based on the report of the Peck working party was circulated to CSIRO staff for comment. Of the organisational options proposed, the aggregation of most of CSIRO's water research into one Division appeared to be the most favoured.

This option was accepted by a Chairman's Committee formed to draw together the main issues raised by the reviews, and in turn by the Management Committee in June 1986. The Management Committee agreed to recommend to the Executive that the two Divisions of Groundwater Research and Water and Land Resources be amalgamated to form a new Division of Water Resources Research, incorporating elements of research groups in other Divisions involved in water research.

The Management Committee also agreed to recommend to the Executive that the Division of Environmental Mechanics be retained as a separate Division, but that there be some adjustment to the balance of its research programs to take into account close collaboration with the new Division of Water Resources Research.

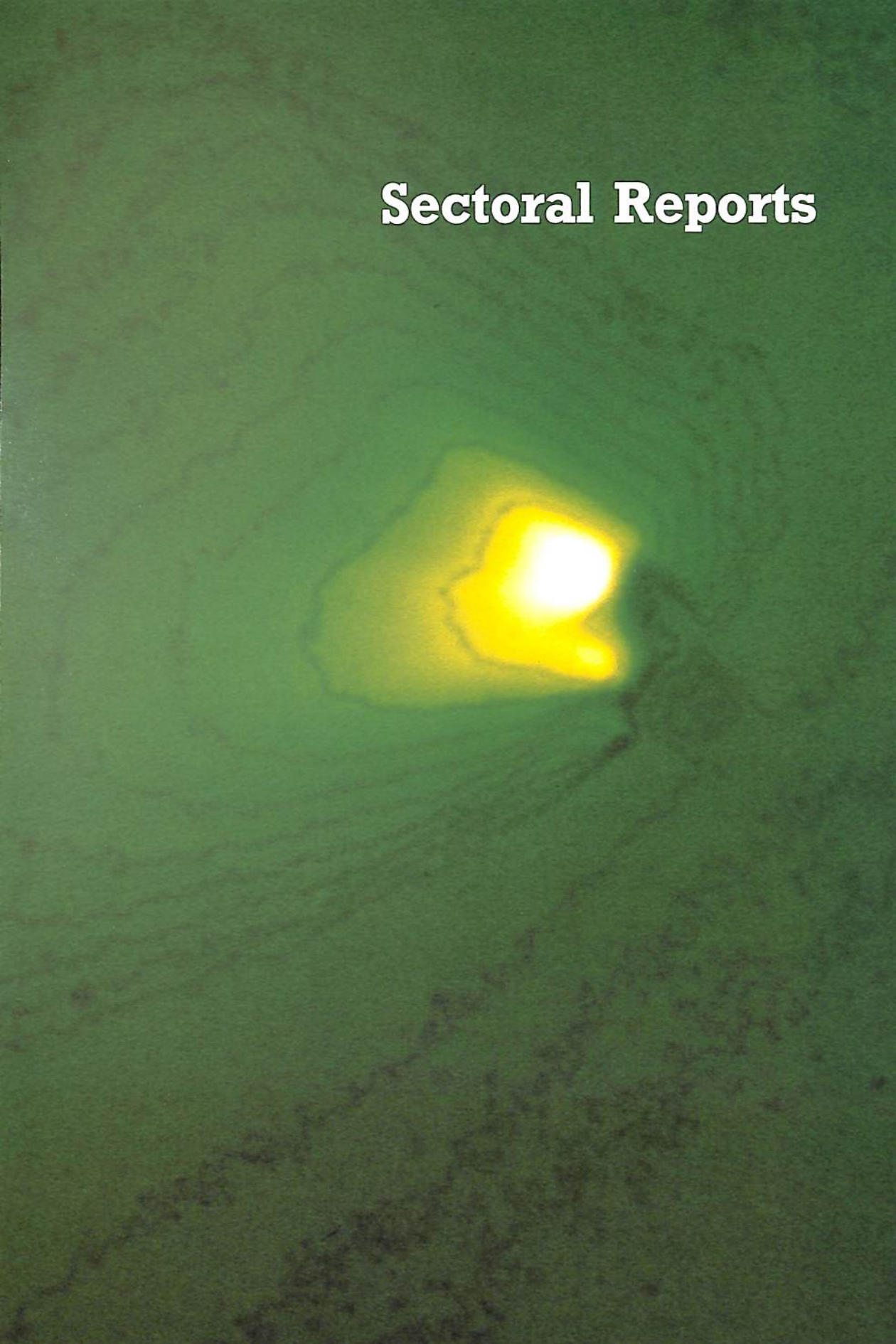
Division of Applied Physics

In June 1986, the Management Committee considered the report of the committee which reviewed the Division of Applied Physics. It agreed to recommend to the Executive that the Division should continue substantially unchanged, but with slightly amended objectives. The Executive is to consider the report shortly.

Division of Mineral Chemistry

Also in June, the Management Committee considered the report of the committee which reviewed this Division. The Management Committee recommended to the Executive that the Division's industry orientation should be improved and that the Division's objectives should be amended to reflect a greater emphasis on downstream processing of mineral materials. The Executive is shortly to consider this report also.

Sectoral Reports



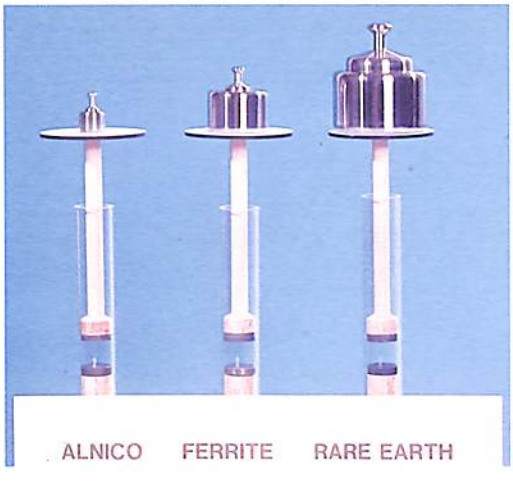
6. Manufacturing Industries

About half of CSIRO's Divisions currently direct part or all of their research activities to manufacturing industry. Each of these has, in the past year, improved its interaction with those segments of manufacturing industry to which it relates, and has made progress towards further implementation of CSIRO's policy for manufacturing industry as outlined in the 1983/84 Annual Report.

In the course of the year, the Executive allocated an extra $590 000 for the generic manufacturing technologies growth area — a previously defined sub-set of the manufacturing industry research area. These resources have been distributed between the Institutes of Industrial Technology (62%), Energy and Earth Resources (17%) and Physical Sciences (21%). In addition, Institutes and Divisions have internally redeployed resources both to the generic manufacturing technologies area and to other important areas of manufacturing industry (see chapter 2).

Several Divisions have restructured their research programs to address better the goals laid down in the policy statement. In the Division of Applied Physics research in measurement science is now directed more towards new techniques for industrial measurements, particularly the development of new instruments that can be manufactured and exported by Australian companies, and less towards fundamental standards. Research on fundamental properties of materials has been reduced and redirected, in part towards developing new rare-earth magnets that might be manufactured in Australia.

(Left to right). The relative strengths of conventional and rare-earth supermagnets.



The Division of Textile Physics has amalgamated its expertise in advanced instrumentation, computer science and image processing into a high-technology systems group. This combination of skills is seen as being an important factor in increasing the competitiveness of Australian industries.

The Division of Protein Chemistry has restructured its programs to address a specific goal in the policy statement to seek 'to maintain the export value of Australian wool by improving its utilisation in the world textile industry'.

A number of Divisions have taken other initiatives to help to develop local manufacturing industry. The Division of Applied Organic Chemistry has taken a step towards expanding the agricultural chemical manufacturing industry in Australia with the formation of a joint enterprise between CSIRO — through its agent SIROTECH Ltd — and Dupont Australia Pty Ltd. This enterprise will develop and manufacture in Australia for sale on the world market crop-protection chemicals discovered in the Division. The Division has also established a laboratory for development-scale chemical synthesis. This facility is available for hire by companies.

The Division of Materials Science has been working with the Victorian State Government and the Federal Government on ways of establishing a world-competitive ceramics industry in Victoria. Proposals for creating two centres of excellence for assisting an advanced ceramics industry, and for creating one new ceramics business and revitalising another, are being developed.

The Division of Molecular Biology has been instrumental in introducing to Australia a biotechnology process for the manufacture of small peptides for the animal, pharmaceutical, and process technology industries. A new company, Peptide Technology Ltd, has been formed, and five Divisional staff — four from the Division of Molecular Biology and one from the Division of Animal Production — will be seconded to the company to speed up its establishment.

Industry Liaison

Divisions continue to extend the range of their advisory mechanisms and refine the ways in which industry has an input to the selection of research projects. Industry input is achieved in several ways:

- by informal contacts made by Divisional staff;
- through collaborative research and staff exchanges;
- through the activities of SIROTECH Ltd;
- through seminars such as that conducted by the Division of Applied Organic Chemistry (mentioned below);
- by formal contacts made by companies; and
- by formal advisory mechanisms.

The Division of Applied Physics has established two new advisory committees: one for physics and technology, another for standards and associated calibration services. An advisory committee attached to the Adelaide Laboratory of the Division of Manufacturing Technology has been of assistance in defining new areas of research and increasing industry awareness of the Division's capabilities. A similar committee is being established for the Sydney Laboratory of the Division.

The Wheat Research Unit now has an advisory committee that has not only made an input to the general direction of research but has also played a leading part in some of the collaborative arrangements. Water-technology and wood-utilisation committees of the Division of Chemical and Wood Technology are fully active and contribute to the selection of research projects. The recently established advisory committee for the Division of Molecular Biology includes experts from the biotechnology, pharmaceutical and biomedical industries who will contribute to the future selection of projects.

In certain cases, it is helpful to make use of an advisory committee that represents a single industry segment. This is often difficult to achieve in the highly fragmented manufacturing sector; however, progress is being made. For example, the Division of Chemical and Wood Technology receives advice from a committee from the wood-utilisation industries; and the Federated Tanners Association of Australia has developed a plan for assessing the long-term needs of the tanning industry. This plan will assist the Division of Protein Chemistry in deciding its priorities for research on hides and skins.

Another policy development within the last year has been the establishment of sector policy committees — including the Manufacturing Industries Sector Policy Committee — to set long-term policies and priorities for the sector. The new committees are intended to ensure the effective alignment of CSIRO research with the needs of industry. Each committee will comprise appropriate Institute Directors and will be chaired by the Director of the Institute with major involvement in that particular sector.

An accurate torque transducer specially designed to fit in the limited space available in the front wheel drive axle of popular passenger cars.

The Division of Manufacturing Technology has given particular attention to ways of increasing industry awareness of technology and improving skills in manufacturing. In 1985, the Victorian CAD/CAM Centre — a company limited by guarantee and including CSIRO as a foundation member — was opened in a location adjacent to the Division's Melbourne Laboratory. The Centre has provided a valuable interface with industry personnel and has assisted many companies. When the Division moves to its new site at Preston the CAD/CAM Centre will be moved to an adjoining location. The possibility of establishing a high-powered industrial laser centre adjacent to the Division's Adelaide Laboratory is presently being examined in consultation with industry, and State and Federal authorities. The Division's recently established Sydney Laboratory is providing enhanced contacts with New South Wales manufacturing industry and has extended the Division's research capability in the integrated manufacturing area.

The Chief of the Division of Chemical and Wood Technology has been involved in setting up a National Association of Forest Industries, an association covering those industries specifically concerned with wood utilisation. Further, to improve contact with the forest industry, the

Division has begun publication of the *Forest Products Newsletter*. The Division has also initiated the formation of a group of Federal and State water authorities to support research in certain aspects of water purification technology.

Continuing its industrial awareness program, staff from the Division of Energy Technology have spent periods working in industry, at CSIRO's expense, on problems of mutual interest.

A seminar for the chemical and plastics industry held in the Division of Applied Organic Chemistry has resulted in constructive and continuing interchanges between the Division and industry sectors and a greater appreciation of the Division's expertise by industry. On-going discussions have given the Division's staff a greater appreciation of the capabilities and requirements of the industry itself.

During 1985, the CSIRO Office of Space Science and Applications (COSSA) was admitted to associate membership of the Association of Australian Aerospace Industries. Under its charter, the Association coordinates the promotion of Australian aerospace products and services to international clients. The Association currently has some 25 member companies and organisations.

COSSA is also actively involved in the affairs of the Australian Aerospace Industry Council, which works under the aegis of the Commonwealth Department of Industry, Technology and Commerce. The Council draws its membership from industry, unions, and government, and seeks to promote the interests of the industry in the domestic arena.

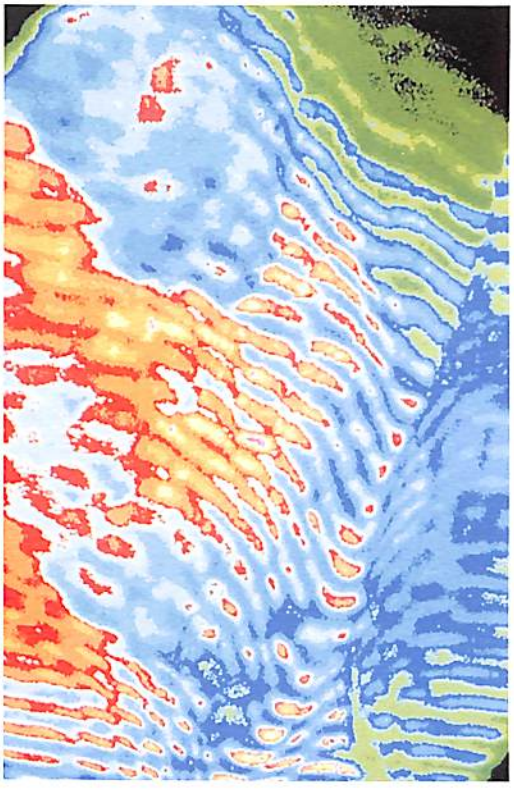
Industry Collaboration

The development of the CSIRO Manufacturing Collaborative Research Program has progressed, with advertisements in the press inviting companies to suggest projects on which they would like to embark in a collaborative program with CSIRO. In addition, direct approaches have been made to a number of industries — e.g. the automotive and the plastics industries — in an attempt to define strategic opportunities for collaborative research. The responses to the advertisements and the direct approaches are currently being examined by a joint CSIRO/ SIROTECH committee. Several programs will commence shortly in conjunction with appropriate Divisions.

Most of the Divisions engaged in manufacturing industry research have increased substantially their direct involvement with industry through collaborative projects and commercialisation agreements. The Applied Physics Industrial Program (APIP) of the Division of Applied Physics, now entering its third year of operation, currently involves 22 collaborative projects with companies. Significant increases in the number of collaborative projects have also occurred in the Divisions of Molecular Biology, Chemical and Wood Technology, Manufacturing Technology, Textile Physics and Energy Technology and the Wheat Research Unit. A number of Divisions are actively seeking commercial collaborators for a range of potential developments. For example, the Division of Materials Science is seeking partners to develop further a range of ceramics and other refractory materials.

As a result of the increase in collaborative agreements, many Divisions have increased their percentage of external funding. Manufacturing Technology, Energy Technology, Protein Chemistry, Applied Physics, and Chemical Physics have doubled their levels of the previous

The Division of Textile Physics has devised digital and optical techniques for studying surfaces. This photograph shows the use of the moiré fringe technique to determine the morphology of a rough surface.



Preparation of a thermal model for use in research into natural convection in enclosures sheltering electronic equipment.

year, and significant increases have occurred in the Divisions of Chemical and Wood Technology, Molecular Biology, Materials Science, Tropical Animal Science, Radiophysics and Textile Physics and the Wheat Research Unit.

The Division of Mineral Engineering has continued its policy of insisting that all its projects are fully collaborative with industry, and the Division's level of contributory funding almost doubled in the year to a level of 25% of its total funding.

An important aspect of the Organization's manufacturing industry research policy is that there should be a continual exchange of staff between Divisions and the companies with which they are working. The number of staff exchanges has continued to increase and the Divisions of Protein Chemistry, Materials Science, Molecular Biology and Applied Physics have seconded staff to industry, while the Divisions of Chemical and Wood Technology, Applied Physics, Textile Physics, Chemical Physics, Manufacturing Technology, Mineral Engineering, and Energy Technology and the Wheat Research Unit have industry staff working in their laboratories. All the professional staff of the Division of Mineral Engineering spend some part of each year working in an industry laboratory.

Commercial Development of Research Results by Manufacturing Industry

The following new CSIRO products or processes have reached, or are about to reach, commercialisation:

- Satellite tracking antenna. The Division of Atmospheric Research has developed, in association with PCM Electronics Pty Ltd, an antenna and associated data acquisition hardware that has been produced and marketed by PCM Electronics under the name of SAT-TRAC.
- Image processing work station. The Division of Atmospheric Research, in association with CSIRONET, has developed image processing software that combines with state-of-the-art hardware developed by the Dindima Group Pty Ltd to create a high-performance stand-alone image processing work station. The work station, known as the Arlunya IW 1000, can be fully integrated with the SAT-TRAC antenna.

The above two developments when used together provide high-resolution processed images from satellites, including weather maps and other meteorological data, and earth resource information such as sea temperature profiles for fisheries, vegetation

Ms Jill Walker, of the Division of Atmospheric Research, operating the Arlunya IW 1000.

indexes for agriculture, and areas of potential or actual mineralisation. The first sale of this equipment has already been made in Australia. A large overseas market is expected to develop, especially in the Pacific region.

- Optimisation of engine cooling systems. Belt-driven fans of conventional design consume up to two kilowatts of shaft power in automobiles. The Division of Energy Technology, in conjunction with Davies Craig Pty Ltd, has developed an electrically driven axial fan that requires only an estimated 300 watts of engine shaft power. These fans are now being marketed in Australia and North America.
- Counter current extractor. Industrial installations of this equipment, developed by the Division of Food Research in conjunction with Bioquip Australia Pty Ltd, are increasing and there are now seven in commercial use.
- High-yield cheddar cheese process. A full-scale prototype of plant utilising this process was recently installed at the Cobram site of the Murray Goulburn Co-operative Dairy Company. The plant is designed to concentrate milk by ultra-filtration at the rate of 326 litres per hour. The cheese-making process, which increases yield by incorporating about half the soluble whey proteins in the cheese, is fully automated and is attracting world-wide interest. It was developed by the Division of Food Research's Dairy Research Laboratory, at Highett, Vic., in collaboration with the APV Group.
- Electron multiplier. The Division of Chemical Physics has developed a new type of miniature electron multiplier with replaceable emissive surfaces for use in mass spectrometers and for the detection of charged particles. The multiplier is made under licence by ETP Pty Ltd, of Sydney, and significant overseas sales have already been achieved in highly competitive markets. In addition to compactness and the availability of a kit to refurbish the assembly, the multiplier's other advantageous features include substantially improved performance and ease of manufacture.
- On-stream analyser for iron ore. An on-stream analyser that continuously measures the iron content of the iron ore on a moving conveyor belt has been developed by the Division of Mineral Engineering, in collaboration with Hamersley Iron Pty Ltd and Mineral Control Instrumentation Pty Ltd (MCI). The analyser can be mounted on existing conveyor belts. It provides rapid information on ore grade and has application at the mine and at the point of export. It will be manufactured by MCI under licence to CSIRO.
- In-stream analysis of coal slurries. The SIROASH coal slurry gauge that determines the solids weight fraction and ash content of coal and slurries has been licensed to AMDEL. The commercially produced gauge from AMDEL was successfully demonstrated at its first plant trial at the Oaky Creek, Qld, coal preparation plant.
- Thin films. The Division of Applied Physics is transferring to industry the results of its research on thin films. A prototype facility to apply hard coatings to machine tools is being made for Sutton Tools Pty Ltd, Melbourne, and a facility for ion-assisted deposition for the coating of optical components is being made by A.G. Thompson Pty Ltd, Adelaide. This is supported by the Applied Physics Industrial Program.

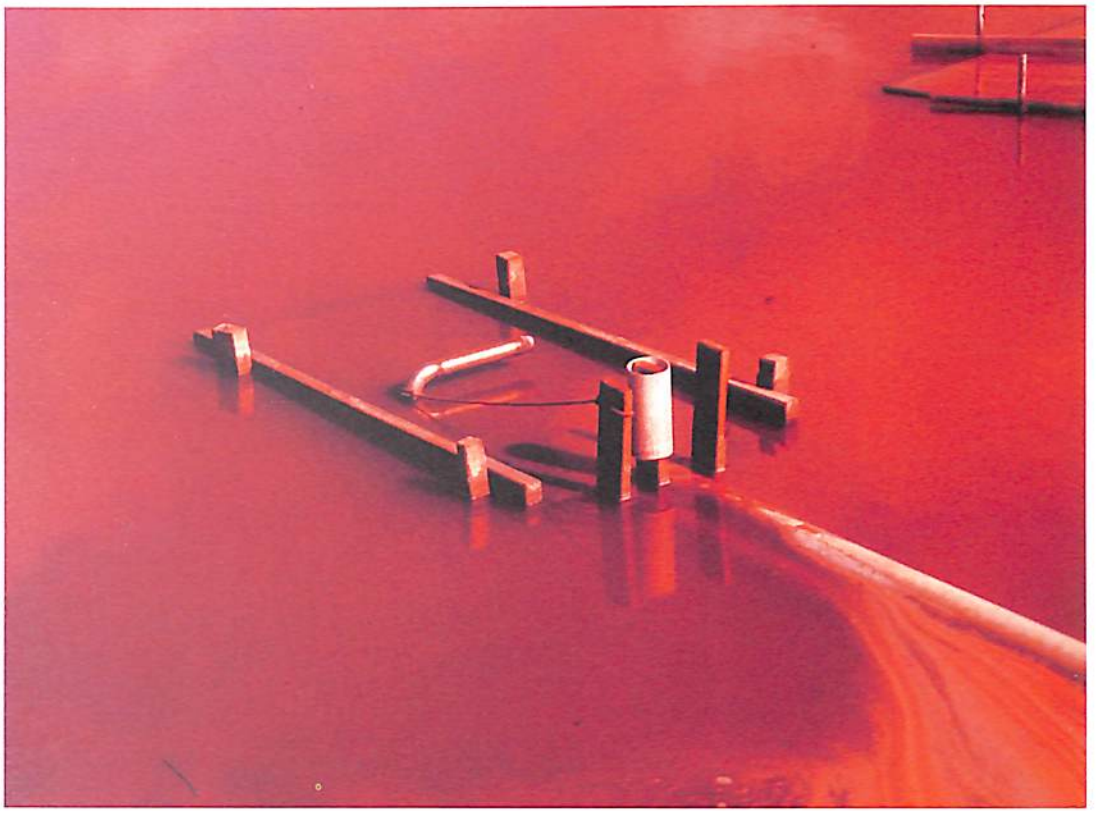
These tools were coated with TiN by physical vapour deposition at the Division of Applied Physics to increase significantly their wear resistance.

- A special pigment printing system for textiles. The Division of Protein Chemistry, in conjunction with Albright & Wilson (Aust.) Ltd, has developed a novel class of acrylic co-polymer emulsions suitable for bonding synthetic and cellulose textile fibres. These polymers form the basis of a new water-based pigment process for printing textiles. The process offers technical and environmental advantages over solvent-based processes. Initial reports have been favourable. The company is confident of obtaining a substantial portion of the local market and will investigate the potential for export markets.
- Acetic acid surface treatment of meat. The Division of Food Research's Meat Research Laboratory at Cannon Hill, Qld, has

developed a technique for extending the shelf-life of vacuum-packed carcasses or cuts of meat. The treatment consists of a ten-second dip or spray with dilute acetic acid to reduce the surface bacteria count. Shelf-life is extended by up to 50%. This allows penetration of overseas markets with chilled product by sea transport instead of the air freight that has to be used if such treatment is not applied. With technical advice from the Division and the Australian Meat and Livestock Corporation, Richardson's Meats of Tasmania has already made commercial shipments to Europe and the Middle East. Other companies are currently making trial shipments.

- Scrimber®. The South Australian Timber Company at Mount Gambier is erecting a prototype commercial plant to build large structural beams in Scrimber®, the reconsolidated wood product developed by the Division of Chemical and Wood Technology. An extensive program of testing will then be embarked upon in conjunction with building authorities.
- In Whyalla, S.A., Betatene Ltd has built Australia's first production plant for extracting beta-carotene from a natural source using a

Reconsolidated timber, produced by the Scrimber process, can be worked in the same fashion as conventional timber.



Pumping *Dunaliella salina*, the source of beta-carotene, to the Whyalla plant from this brine culture pond.

process developed from research on algae at the Division of Chemical and Wood Technology. Beta-carotene, a vitamin precursor and food colourant, has hitherto been manufactured by an elaborate chemical synthesis. Betatene has secured an export contract worth in excess of $2 million, and shipped its first batch of the natural product to the U.S.A. in March 1986.

- High-grade magnetic separation. Superconducting magnets, which produce very strong fields, are able to separate slightly magnetic material from non-magnetic material. This principle is being used in the Division of Applied Physics to solve a major problem in the mineral processing industry, that of separating very finely divided ores from 'waste'. Such work has received renewed emphasis with the collapse of the world tin market, making tantalite a far more important by-product of tin mining. 'This project is part of the Applied Physics Industrial Program, and is also supported by Greenbushes Tin Ltd of Western Australia.
- Ultrasonic method of measuring eccentricity of tubing. The Division of Applied Physics, in collaboration with Metal Manufactures Ltd, of Port Kembla, has developed an ultrasonic device for measuring the eccentricity of extruded copper tubing. Such accurate measurement systems, designed for use in hostile environments, have wide potential application in other areas.
- SIROLIME unhairing of hides. The SIROLIME process, which has potential major benefits for the Australian leather industry, is a method for removing, intact, the hair from hides and for recycling the process liquors. Apart from the potential value of the hair, the tanning industry could reduce substantially its costs of sludge disposal, a major operating expense, particularly in city-based tanneries. The process has the potential for developing into a rapid method (less than 24 hours) for converting cattle hides into 'wet blue' leather. One Australian tanner has dedicated a processing vessel to full-scale production; several other companies are investigating the possibility of installing the necessary equipment to allow trials to be carried out.

- Hot-air splicing technique. The Division of Textile Industry has developed a new procedure for splicing yarns that can easily be implemented by modifying conventional pneumatic splicers. Splicing is an important technique in wool processing and this new procedure will improve the quality of the yarns in subsequent processing, improve the economy of processing, and enhance the quality of the final product — all important factors in helping to maintain wool's position as an economically viable textile fibre. The Division has worked with several Australian mills to apply the development locally. Schlafhorst AG Mönchengladbach launched the process at a recent textile industry exhibition in the United States.
- Improvement in worsted card speed. The Division of Textile Industry has developed a method for improving the productivity of worsted card machines by a factor of two while maintaining the quality of the sliver. A simple modification of the existing machinery achieves a significant advance in the technology of worsted processing. In the near future, the Division is to conduct a seminar at which these and other developments will be demonstrated and discussed with the local textile industry.
- Vision processing system. Following the successful completion of local and overseas field tests of a batch of board set components for a low-priced vision processing system that measures and processes objects in milliseconds, limited commercial quantities of the components will soon undergo final trials at selected field sites. The formal development phase of the collaborative agreement between the Division of Manufacturing Technology and Vision Systems Ltd is now complete. Vision Systems expect volume production of the components to begin by October 1986. The initial sale of board sets will be to existing vision system producers.
- Earth station antennas. A consortium comprising the Division of Radiophysics and two engineering companies, Macdonald Wagner and Johns Perry, has received an Overseas Telecommunications Commission

SIROLIME trials carried out in tanneries use drums for recirculating the processing liquors and a rotating screen for separating the intact hair.

(OTC) contract to design and build three 18-m-diameter antennas for the Intelsat network. Two, to be located in Perth, will be in service by October 1986. The other, in Sydney, is due for completion in October 1987.

- Simulation of discrete events. The Division of Manufacturing Technology has developed a new procedure for the simulation of discrete events. This provides a very rapid graphical display of movement of items such as manufactured goods around a complex environment. Applications of the system have been developed in collaboration with several manufacturing companies in Australia and tested in factories concerned with objects as diverse as shipping boxes, car bodies, and small engineering components. An arrangement for effective commercial exploitation of the simulation system is now being sought.
- Battery tester. A solid-state device for testing the characteristics of lead-acid batteries under discharge conditions has been developed by the Division of Manufacturing Technology in collaboration with Power Plus Batteries Pty Ltd. The research for this device arose from studies of the switching of large currents in pulse-welding commercial units, which were released onto the market in May.

Mr Anton Schubert, of the Division of Manufacturing Technology, tests a range of commercial lead-acid batteries.

7. Rural Industries

The export of rural products (37% of the total in 1984/85) is vital to Australia's prosperity. CSIRO's response to the continuing decline in terms of trade for these products is to direct research towards the reduction of production, handling and processing costs; the improvement of product quality and marketability; and the development of added-value and more profitable products.

Genetic engineering and other advanced technologies are being used to improve plants and animals directly, and to produce new-generation vaccines not only for disease and parasite control but also to modify characteristics such as growth rate and carcass composition. Additionally, priority is being given to addressing problems of low productivity in livestock, especially in the harsher climatic zones, by developing pastures with greater nutrient value and improving mineral nutrition.

Advances in food processing and product development are described in chapter 6.

The rural industries sector of CSIRO's research activities comprises agriculture, forestry and fisheries. The Executive's agricultural research policy was reported in the 1981/82 Annual Report. The policy for forest research emerged from the review of forest and forest products research and was also recorded in the 1981/82 Annual Report. The policy for fisheries research formed part of the Executive's marine science policy statement that appeared in the 1979/80 Annual Report.

Common themes in these policies are:

- CSIRO research will aim to establish principles, practices and technologies that will improve the efficiency and long-term viability of the industries concerned and form a knowledge base that will contribute to solving future problems.
- CSIRO will direct its research activities to aspects of the industries having widespread significance and requiring mid- to long-term research.
- CSIRO research will be selective. Research priorities expressed in policy statements and in Divisional and other reviews will be modified as new areas of scientific promise emerge and in line with changing national and international economic trends.

The research policies for agriculture, forestry and fisheries were not altered during the year and all high-priority research received attention. Various initiatives taken to strengthen research in the priority areas are reported below, as well as significant changes in emphasis where they occurred. Brief reference is made to selected research achievements for the three rural industries.

As part of its corporate plan the Institute of Biological Resources selected for special attention, commencing in 1985/86, four areas for research aimed at maintaining agricultural and forest productivity and resource conservation. The areas are:

- Heavy clay soils. These soils are usually fertile, yet difficult to work with machinery when wet, and on drying form hard crusts that hinder the emergence of seedlings. Studies are to concentrate on the structure of these soils and treatments for improving their mechanical properties for dryland and irrigated agriculture. Attention is being focused on clay soils in the major agricultural areas of northern New South Wales, southern Queensland and the Riverina.
- Heliothis. Heliothis moths are among the most damaging insect pests, causing serious losses in cotton and many other crops, including summer grains and horticultural crops. Recent evidence suggests long-distance migration of the insect. The research aims to assist in predicting outbreaks through studies of the genetics of resistance to insecticides, the ecology of the insect in crops — especially cotton — and migration behaviour.
- Tropical grazing systems. The grazing lands of northern Australia are a valuable resource. Options for increasing their productivity, including the use of legumes and fertilisers and mineral supplements for cattle, have been studied by the Division of Tropical Crops and Pastures. The feasibility of introducing these and other management options — for example, the early weaning of calves — and the economic implications at a whole-property level are now under consideration. Economic assessments have commenced, in conjunction with the James Cook University of North Queensland, and will be strengthened by the appointment of an economist to the Division. Economic analyses will also play a part in guiding future research on grazing systems in northern Australia.
- Tropical rainforest research. About a million hectares of tropical rainforest in north-eastern Australia represent a vital national resource. Their use for timber on the one hand, and their unique characteristics as ecological associations on the other, are the key concerns behind increased research effort on these forests.

  The aim is to improve our knowledge of tropical rainforests, their flora and fauna, ecology and reproductive and develop-

mental processes, to provide a scientific basis for management.

Two research priorities nominated by the Institute of Animal and Food Sciences were pasture development and mineral supplementation:

- Increases in productivity in the grazing industries have been due largely to the development of pastures fertilised with superphosphate; but the species sown are relatively poor nutritionally. An increase in production per head of livestock by improving the nutritive value of pastures is potentially more cost-effective than building up pasture supply and stocking rate. Institute scientists have defined the characteristics of nutritive value, but still have to explore the distribution of these characteristics between species and cultivars. Plant breeding to develop new cultivars high in nutritive value will be undertaken in collaboration with the plant Divisions of CSIRO, State departments of agriculture and universities.
- Because of the low available mineral content of most of our soils, Australian pastures, particularly when mature, contain insufficient minerals to support optimum growth of the grazing animal. Recent research indicates substantial separate responses in intake and digestibility to individual trace elements administered by intra-ruminal controlled-release devices. The responses appear to be mediated by increased rumen microbial activity. Priority will be given to developing and testing controlled-release devices in different field environments. Researchers will also attempt to define the role of the devices in complementing other means of improving mineral nutrition, such as fertiliser application, mineral blocks, or pasture species capable of greater mineral concentration from deficient soils.

Implementation of Policy

Soil-borne Plant Diseases

In its response to the recommendations of the committee reviewing plant pathology (1984), the Executive placed a high priority on root-disease research. It stated the need to maintain and strengthen strategic research on the epidemiology of soil-borne pathogens and on ecological interactions in soil in working towards the goal of improved management and control.

Implementation of this policy in 1985/86 centred on reorganising and strengthening work in Adelaide on plant nematodes and fungi as soil-borne pathogens of cereals.

Biological Defleecing

In its agricultural research policy the Executive recognised the potential of biological methods of causing fleece shedding in sheep for reducing the costs of shearing, a major component of on-farm costs. The Division of Animal Production has studied in detail the ability of epidermal growth factor (EGF), a naturally occurring component in animal tissues, to cause thinning of wool fibres. Depending on dosage levels, thinning can be induced to the point where the fleece can readily be removed by hand. The next major step will be the testing of EGF under field conditions. The formulation of EGF suitable for field use will be developed so that large-scale tests can be undertaken to obtain information on the variability of response to EGF within a flock.

National Bushfire Research Unit

The Unit was set up in response to government and public concern about the extensive and damaging wildfires occurring in Australia every year.

The Unit's objectives are to seek ways of reducing the impact of bushfires on the human, pastoral, and ecological resources of the nation. Systems for the management and suppression of bushfires will be developed and evaluated through a thorough understanding of the way fire interacts with the weather and the fuel variables that comprise the bushfire environment. The effects of fire will be studied through an understanding of heat-transfer processes.

The Unit is based at the Division of Forest Research in Canberra, with some staff also at the Division of Atmospheric Research in Melbourne. A Steering Committee, comprising the Chiefs of the two Divisions involved and representatives of State fire authorities and the Federal Government, has been established.

Australian Animal Health Laboratory

CSIRO research on the diagnosis and control of exotic animal diseases is the responsibility of the Australian Animal Health Laboratory (AAHL). In previous years AAHL concentrated on the diagnosis of various endemic diseases but, with the establishment of a high level of microbiological security in the Laboratory, research is being directed to exotic animal

Australian Animal Health Laboratory staff collect samples in the post mortem area of the Laboratory.

diseases. Immediate priority has been given to establishing diagnostic capabilities for foot-and-mouth disease (FMD), rabies, Aujeszky's disease, hog cholera, Newcastle disease, bluetongue, avian influenza and maedi/visna.

Of these, FMD poses the greatest potential economic threat to Australia. As a result of the Federal Government's prohibition on introducing live FMD virus into Australia before December 1987, when the matter will be reviewed, staff of AAHL have been working on the virus in Britain. The research has led to the development of improved diagnostic procedures that do not require the use of live virus. A three-year collaborative project in Thailand, which began in April1986, should greatly enhance the capabilities of the staff of AAHL in all aspects of field and laboratory work with FMD.

During the year, AAHL appointed a veterinary training officer as the first step towards meeting its responsibility to train field and laboratory personnel from the Commonwealth and States in the early recognition, diagnosis and control of exotic diseases. The program will be given high priority until a large proportion of field officers have received training.

Biological Control of Weeds

In its priorities for biological control projects, the Division of Entomology takes account of changing rural industry needs. A Biological Control Unit was established in Mexico during the year to facilitate the search for control agents for a number of weeds of Central and North American origin — notably *Mimosa*, a noxious weed of northern Australia, and silver-leaf nightshade. A Unit was also established in South Africa to study the natural enemies of spiny emex (three-cornered Jack). The Division's Biological Control Unit at Montpellier, France, which searches for insect species for the control of a number of weeds of European origin including heliotrope, Paterson's curse, St John's wort, blackberry and docks, has started a new project on the control of the *Carduus* species of thistle.

The Commonwealth has passed the *Biological Control Act*, the world's first legislation for biological control. The States will ultimately have complementary legislation. Following the injunction placed on CSIRO (reported previously), formal inquiries on *Echium plantagineum* (Paterson's curse/Salvation Jane)

have been carried out by the Industries Assistance Commission (IAC) and the Biological Control Authority, a body established by the Act. In 1985, the IAC recommended that all *Echium* species be declared targets, that all eight proposed control agents be declared agents and that CSIRO, with State assistance where appropriate, should conduct the control program, with the support of public funds. The Australian Agricultural Council subsequently recommended that the program should proceed. CSIRO is currently investigating mechanisms for the collection of insects from Europe so that, if the injunction is lifted and funding is available, the program can be restarted in Australia.

Screw-worm Fly

Following the successful completion of the research phase, CSIRO work on the control of screw-worm fly is now fully funded by the Commonwealth Department of Primary Industry. The insect is extremely destructive and could cause losses of $200 million a year to Australia's livestock industries if it were to gain a foothold on this continent. The Division of Entomology's past research culminated in a successful demonstration in field trials of the sterile male release strategy for controlling this livestock pest and the development of facilities for the mass rearing of mutant flies. The work was carried out in Papua New Guinea with the cooperation of its government. The Division retains responsibility for maintaining the facilities, which have been expanded under Department of Primary Industry funding, ready for use in the event of an outbreak of screw-worm fly in Australia.

Consolidation of Fisheries Research

The Division of Fisheries Research began streamlining its research programs by reducing the number of projects. The Division will concentrate on the population dynamics of commercially important species, especially factors affecting the recruitment processes of tiger and banana prawns, western rock lobster, southern bluefin tuna and scallops. These four fisheries together account for more than 80% of the value of Australia's fishing industry.

Changes of Emphasis in Research

Increasing the Productivity of Cattle in the Tropics

The Division of Tropical Animal Science is pursuing several new approaches to increasing the productivity of cattle in the tropics. Previously studies were made of the physiological nature of adaptation to tropical conditions, such as resistance to heat stress and cattle tick, as a basis for breeding and selection. Attention is now being focused on options for gaining higher productivity with already adapted cattle. For example, anti-thyroid drugs might be used to depress metabolic rate with the aim of minimising weight loss during the dry season, when cattle usually suffer serious undernutrition. Weight gains have been recorded experimentally on near-maintenance diets using such drugs.

Hormonal and nutritional approaches to overcoming postpartum anoestrus, a major cause of the relatively poor reproduction performance of tropical breeds of cattle, are also being examined.

The objectives of the Division's cattle-breeding program have been partly redirected from selection for characteristics such as tick resistance and fertility to issues of more direct concern to producers. These include the selection of bulls with high productivity in the field, and the genetic improvement of herds. Stud bulls are usually carefully maintained free from parasites and on a high plane of nutrition. Producers want to be able to predict how these bulls will perform under commercial conditions and the genetic gain that can be expected in breeding herds from particular bulls. Such predictions, as well as the measurement of the relative genetic merit of herds, may be determined only by broad comparative studies. The Division is cooperating with a number of breeding societies and their members in carrying out carefully designed experiments using objective measurements of performance so that the genetic merit of bulls under different environmental conditions may be compared.

Immunisation against Sheep Blowfly

Blowfly larvae are external parasites of sheep that ingest the body fluids of the host when eating into the skin and muscle. Following success with the experimental immunisation of cattle against the external tick parasite (see the 1984/85 Annual Report), a potential new direction for controlling sheep blowfly was recognised. The Division of

Tropical Animal Science has launched a research project based on the anti-tick-vaccine approach. The vaccine will comprise proteins from the blowfly larvae. If the project is successful, antibodies in the blood of vaccinated sheep ingested by larvae will cause the lethal breakdown of cells in their intestines.

The project was made possible by a gift from Mr Les Bett, a retired grazier living in Victoria.

Special Studies on Research Strategies

As indicated in the 1984/85 Annual Report, several aspects of CSIRO's agricultural research were to be studied to determine future research strategy. One of these was tropical horticultural research (see below). The others were:

- CSIRO's role and future involvement in the genetic improvement of crop and pasture plants. Studies revealed the need for CSIRO to undertake a wide range of research in this field, from development of methodologies, through genetic manipulations to make available genes for improved plant characteristics, to the breeding of commercially acceptable varieties — the latter only where CSIRO had special skills for the work. Further study is now being undertaken against this background, employing scientific, economic and marketing perspectives to determine where the research effort should be placed.
- The organisation of ecological research in CSIRO. Basic agreement has been reached on strategies and practices designed to improve teamwork and effectiveness in selected priority areas without resort to extensive organisational change. A set of research foci that will impinge partly on the agricultural field is being developed.
- Development of an integrated inter-Divisional temperate pasture research plan in collaboration with relevant State departments. A basic plan is being developed in consultation with the Australian Wool Corporation, interested State departments and others, centring on a number of joint research activities selected for their importance.
- The balance of CSIRO's research work between temperate and tropical agriculture. Data on the distribution and regional relevance of research effort have been assembled and a report is being prepared.

Tropical Horticultural Research Unit

Following the review of plant research Divisions (reported in the 1984/85 Annual Report), the Executive sought further study of CSIRO's role in tropical horticultural research. A recent Bureau of Agricultural Economics study had shown that there would be a substantial increase in the production of tropical fruits and nuts over the next decade, especially in the central and north-east coastal regions of Australia. To improve the regional balance of CSIRO's horticultural research, the establishment of a Tropical Horticultural Research Unit in Brisbane is under consideration. The Unit's function would be to carry out mid- to long-term research complementing the more tactical work of the States. Attention would be given to reproductive performance and factors affecting fruit quality. CSIRO anticipates that the Unit would work primarily on crops grown mainly in the subtropics, such as avocado, lychee and macadamia nut. However, its work would be linked to that of a small existing unit of the Division of Horticultural Research in Darwin to cover interests in crops grown mainly north of the Tropic of Capricorn, such as mango and cashew nut, and would be supported by the expertise of Divisional staff in Adelaide and Merbein, Vic. The group would also work closely with the Division of Food Research and interested State departments of agriculture.

On-farm Recycling of Irrigation Water

The CSIRO Centre for Irrigation Research has adopted a new direction in research, aimed at improving the efficiency of water use in irrigated agriculture and reducing the pollution of river systems. The research is examining the feasibility of water recycling on the farm. Although water-use efficiency is increased, soils and crops may be adversely affected by using recycled drainage water in which salt and toxin concentrations have increased. Initial studies are focusing on the chemical quality of drainage water and the quantities of water available for recycling under various farm-management systems. Other aspects being examined are the effects of contaminated recycled drainage water on soil structure and organic matter content, the impact of soil structural changes on plant nutrient availability and the transport of toxins.

Myxomatosis and Rabbit Control

Past research by the Division of Wildlife and Rangelands Research has helped to provide a detailed understanding of myxomatosis as a biological control agent of rabbit populations in the higher-rainfall areas of Australia. This knowledge has formed a sound basis for developing the strategic use of myxomatosis. The research has now been redirected to provide a better understanding of the performance of myxomatosis in the arid zone, where its occurrence has been much more sporadic and it is less effective. In the arid zone the rabbit population still reaches very high and damaging levels when seasonal conditions are favourable.

Selected Research Achievements

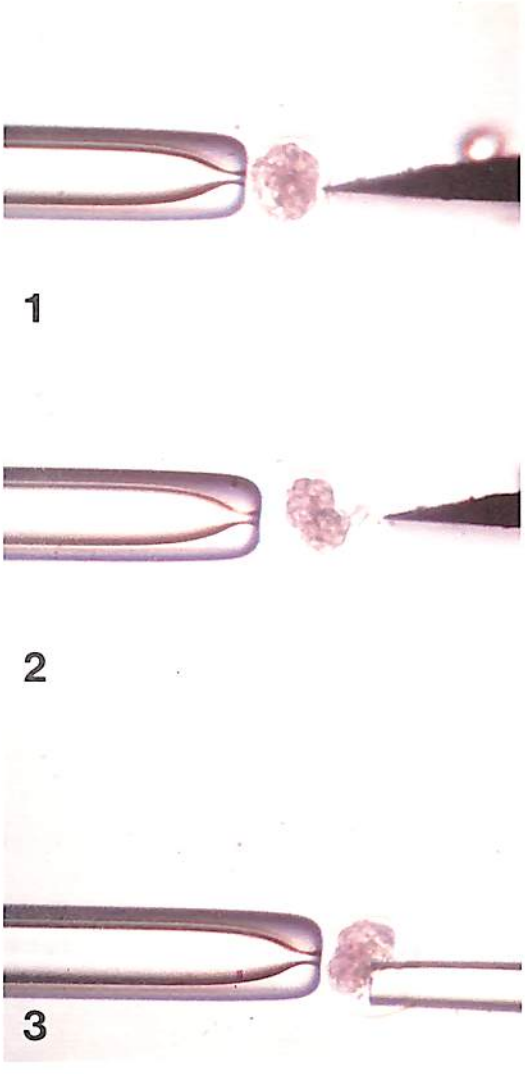
Division of Animal Health

- The Division has successfully demonstrated experimental immunisation of sheep and cattle against mastitis caused by infection with the bacterium *Staphylococcus aureus*. This form of mastitis costs the Australian dairy industry some $50 million each year. An industry partner is being sought to produce the vaccine for testing in dairy herds and ultimately for marketing.
- Developmental research and field testing by the Division, in collaboration with Murdoch University and the Western Australian Department of Agriculture, has led to the release of the first commercial vaccine against caseous lymphadenitis ('cheesy gland') of sheep. Vaccination is expected to reduce substantially the $5 million annual cost of this disease to the Australian sheep industry.
- In association with the New South Wales Department of Agriculture, Drenchplan, a strategic anthelmintic treatment program developed by the Division to control worm parasites of sheep in non-seasonal and winter-rainfall zones, was introduced into the south-west slopes area of New South Wales in 1985. It is being introduced progressively into the Central and Southern Tablelands in 1986. Drenchplan and Wormkill, a similar program for the summer-rainfall zone, have the potential to reduce the costs of worm control in New South Wales by more than $5 million a year.

Division of Animal Production

- In collaboration with Table Talk Pty Ltd, a further layer strain of poultry — the SIRO SB layer — has been developed and released commercially. Opportunities for export are being pursued.
- In collaboration with Tubule Pty Ltd, special feed supplements produced from cotton seed are being used to manipulate and modify the cooking odour and flavour of sheep meat for specific overseas markets.
- In collaboration with the pig industry and the Victorian Department of Agriculture, the Division has developed a computer model that predicts changes in growth and carcass quality in relation to dietary and physiological changes. The model should improve significantly the efficiency of feed use and result in substantial economic benefits to pig producers.

Dr Trevor Scott, Chief of the Division of Animal Production, with a 'transgenic' lamb. (Photo: John Nobley, Sydney Morning Herald.)



Embryos from Brahman and British cows are split and rearranged to produce chimera calves. (1) Breaking of the shell of the embryo; (2) the splitting procedure; (3) the split embryo and spare shell; (4) the split embryo is placed into the spare shell; (5) two new embryos formed from the split; (6) a Brahman cow with a chimera calf at foot.

- For the first time in the world scientists at the Division of Animal Production successfully transplanted a sheep growth hormone gene, an achievement that is a major step towards creating faster-growing, larger and leaner sheep. The first 'transgenic' sheep was born on 25 April, Anzac Day. Copies of the sheep growth hormone gene were introduced into a one-cell-stage embryo by micro-injection. The embryo containing the injected genes was transferred into a surrogate mother and normal foetal development followed.

Australian Animal Health Laboratory

- An improved diagnostic test for foot-and-mouth disease (FMD) that does not require the use of live virus has been developed. This test will be used by AAHL to test for the presence of FMD when outbreaks of diseases suspected to be exotic occur in Australia. The improved test is expected to be of considerable value in South East Asia in contributing to the control of the disease in the region.

- AAHL has developed a diagnostic technique that differentiates between bluetongue virus and epizootic haemorrhagic disease of deer virus, and between them and other closely related Australian viruses. The lack of specificity of conventional tests was resulting in animals giving false positive results for these viruses and being unnecessarily barred from export.
- AAHL has developed the capability to diagnose Newcastle disease, avian influenza, rabies, Aujeszky's disease, swine fever and contagious bovine pleuropneumonia.

Division of Tropical Animal Science

- The Division has demonstrated the feasibility of reducing weight loss by cattle, thus possibly averting death during periods of undernutrition in the tropical winter dry season, by treatment with drugs that decrease metabolic rate. In a typical experiment the feed intake required to maintain body weight was reduced by 20% compared with control animals.
- Three chimera calves have been born at the Division's field station near Rockhampton, Qld. These calves, containing Brahman and British-breed type cells, were produced by splitting embryos from Brahman and British cows and then rearranging the split embryos to produce embryos with a mixture of the genetic material of the two breeds. Nine other cows are pregnant with chimeras. It is believed that only three other similar calf chimeras have been produced in the world. Identical-twin Brahman heifers have also been produced by embryo splitting.

Division of Plant Industry

- The transfer of a gene for pea-seed protein into tobacco plants has been achieved. The techniques will be applied to this and other genes to improve the quality of proteins in pasture plants, especially lucerne and subterranean clover, and grain legumes used as stock fodder.
- Support for the Division's work on acid soils by the Australian Fertiliser Manufacturers committee has led to the development of a test kit for identifying toxic levels of aluminium and manganese in soil. The kit is similar to one developed for phosphorus and nitrogen and referred to in the 1984/85 Annual Report, and is now ready for commercial release.

Division of Horticultural Research

- The Division has developed a novel technique for selecting grapevines for resistance to the fungal parasite downy mildew. The method involves the culture of sterile rooted grapevine shoots inoculated with fungal spores. Foliar symptoms develop within 10 days and the order of ranking in resistance has been shown to correlate with field and glasshouse tests.

Division of Water and Land Resources

- Micro-BRIAN, a fast, relatively inexpensive system for processing satellite images, was launched by the Minister for Science, the Hon. Barry O. Jones, in February 1986.

  The original system, BRIAN, was developed at the Division and designed to survey the Great Barrier Reef. The savings in survey money and time have been estimated at $20 million and 10 years respectively. Micro-BRIAN has been taken up by an all-Australian company, MPA Pty Ltd, and is predicted to win a significant share of the computerised image-analysis market. Although the system was originally conceived to map shallow water and reefs, it can also be used for basic image processing and the mapping and monitoring of erosion, crops, forests and other vegetation.

Division of Wildlife and Rangelands Research

- Research has shown that the strategic use of fire is the key to the management of large areas of shrublands when extensive growth of shrubs has reduced stock-carrying capacity. Research has also shown that the suppression of wildfires in the past has exacerbated the problem. When fire is applied deliberately soon after the germination of the shrub seeds, the density of shrub is reduced. The fire not only kills seedlings but also checks the growth of more mature shrubs, which produce very little seed for the next 5 to 10 years. As a consequence, more pasture is able to grow.

Division of Forest Research

- A detailed computer simulation study of the use of aircraft for the aerial water bombing of bushfires has been completed. It showed that

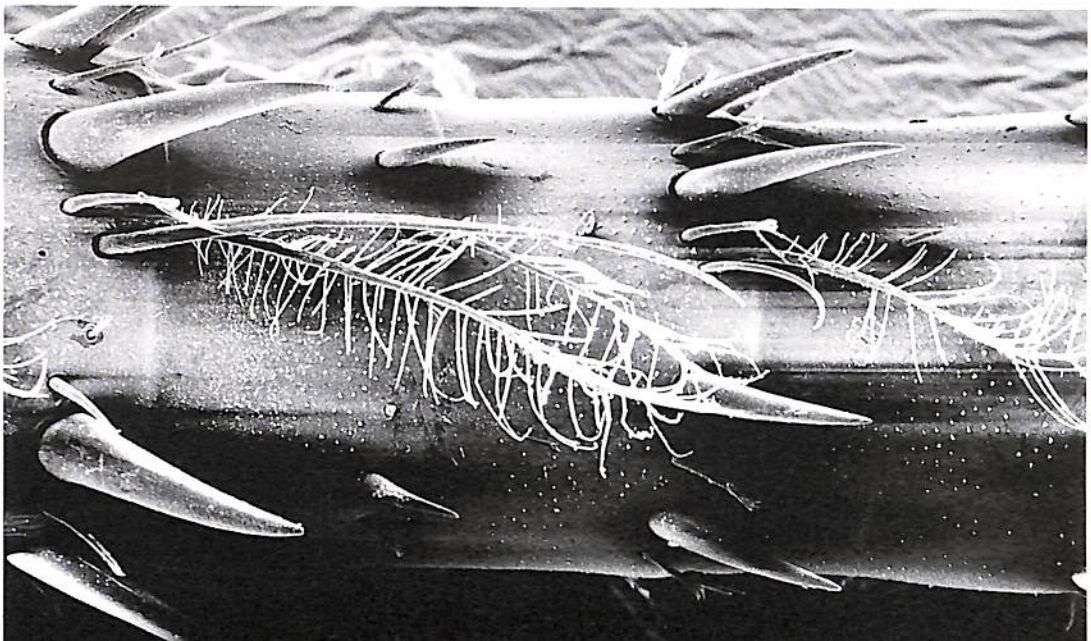
The strategic use of fire in managing large shrubland areas where stock-carrying capacity has been reduced.

in Victoria the use of some types of aircraft could offer economic benefits over a period of normal fire years. No aircraft would have had a significant effect on the major fires of Ash Wednesday 1983.

Division of Fisheries Research

- The Division discovered the presence in southern Tasmanian waters of plankton species dangerous to humans. Toxic dinoflagellates pose a health risk for people eating contaminated shellfish (diarrhoetic and paralytic shellfish poisoning). A monitoring program to document their seasonal abundance and distribution has been initiated in areas of shellfish farms in collaboration with the State Department of Sea Fisheries.
- A series of pinnate, interlocking hairs located on the antennae of the puerulus stage of the western rock lobster has been found as the likely apparatus by which the free-swimming puerulus detects underwater sounds that direct it to the coast during its 40–60 km swim across the continental shelf.
- Two species of tiger prawn not separated in commercial catches were shown to be associated with different types of sediment. It has since been possible to determine from commercial-catch data the impact of fishing on the two species for the past 14 years. This has revealed a significant decline in the catch per-unit-effort of *Penaeus esculentus*, indicating a need for careful management of this species.

Mid-section of the antennae of the puerulus stage of the western rock lobster, showing long and short spines and pinnate setae, forming an almost continuous linear fringe.



8. Mineral, Energy and Water Resources

Changes of Emphasis in Research Policies

Minerals

Considerable changes have taken place in the organisation of, and the emphasis on, minerals research during the year. The nomination of raw-materials processing as an Executive priority area has encouraged an expansion of research into the processing of minerals to add value to mineral-based exports. Seventy-five per cent of this expansion depends on the redeployment of internal resources so it will take some years to achieve the full effort planned.

The initial research concentration is in the field of high-intensity smelting processes for refining metals and in the development of advanced materials, such as zirconia and rare earths, from indigenous resources. Work on the SIROSMELT process was described in the 1984/85 Annual Report; the latest developments in the manufacture of zirconia are outlined later in this sectoral report.

On 1 July 1985, there was a restructuring of several minerals Divisions in the Institute of Energy and Earth Resources to improve their interaction with industry. The change consolidated the Divisions into geographically based multidisciplinary groups.

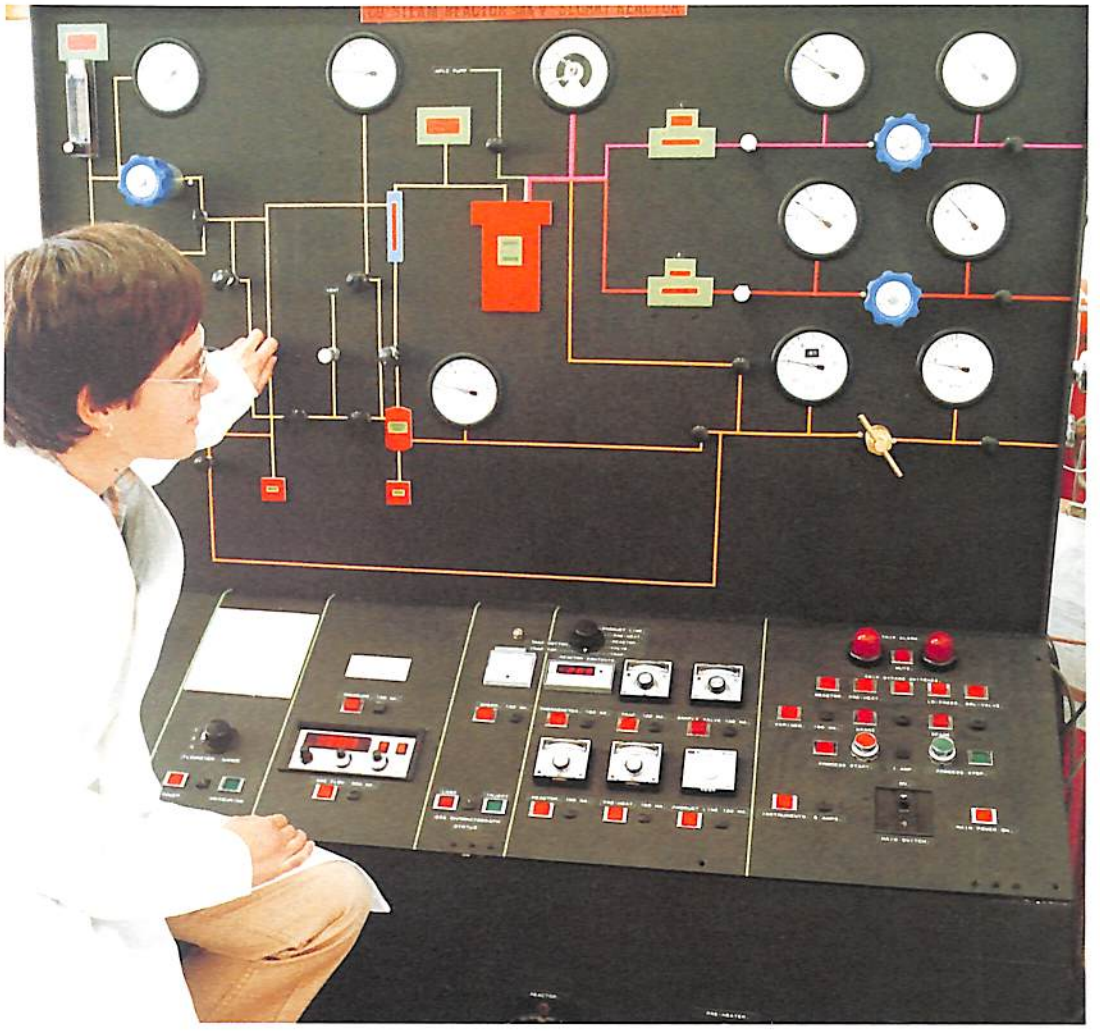
In Western Australia, the Perth laboratory of the Division of Mineralogy and Geochemistry combined with the Bentley laboratory of the Division of Mineral Chemistry to form the Division of Minerals and Geochemistry. This Division provides a range of expertise to assist the mining industry in mineral exploration and processing, and the treatment of process wastes.

The North Ryde, N.S.W., and Canberra laboratories of the Division of Mineralogy and Geochemistry combined with the North Ryde Mineral Physics laboratory to form the Division of Mineral Physics and Mineralogy, which concentrates expertise in geological, geochemical, geophysical and geobiological techniques of exploration.

The remaining Mineral Physics processing instrumentation groups at Lucas Heights, N.S.W., and Port Melbourne, Vic., have become part of the Division of Mineral Engineering to coordinate research on process instrumentation and control. This now gives a continuum in one Division from *in situ* and on-line measurement through to control of mineral and energy processes. The kind of assistance that can be provided to industry in this field is exemplified by the successful development of COALSCAN, the on-line coal ash gauge described elsewhere in this report.

A review of exploration research was carried out by the Institute after the restructuring and a decision was made to consolidate research into three new programs to commence in July 1986. These will be exploration techniques development, exploration in weathered terrain, and exploration for concealed ore-bodies. The changes, particularly those relating to exploration in weathered terrain, have been encouraged by the advice received from industry through the Divisional Consultative Committees. These committees of representatives from relevant

Fine particles of Milmerran coal burning in a laboratory-scale gas-stabilised flame, during studies of ignition and ash formation.



High-pressure slurry reactor system used for studies of the Fischer-Tropsch synthesis of liquid fuels.

industries, government agencies and academia were established during the year as part of CSIRO's new corporate planning strategy to seek external advice in the planning and conduct of its research activities. At the request of industry, gold and petroleum exploration techniques will receive immediate attention.

Water

Policies for water research have undergone considerable examination during the year (see chapter 5). CSIRO is moving to a position that gives more explicit consideration to water as a resource, and how its management and that of associated catchments can be improved to benefit industrial, commercial and domestic consumers.

In June 1982, when CSIRO's water policy was previously defined (see the 1981/82 Annual Report), the large metropolitan water authorities and the hundreds of smaller local authorities were concerned essentially with the engineering aspects of the supply of potable water, and research directed at the definition, use and management of the nation's water resources was not of high priority. Since then, a new generation of water managers and reorganised water authorities have emerged.

CSIRO has sought and received extensive internal and external advice about its water resources research in recent years. Early in 1985, CSIRO set up a ('Peck') working party on water

resources research to examine issues relevant to the subject, including the question of whether the current organisation and funding arrangements for water research were appropriate for future national needs. The working party reported in July 1985 and made several recommendations with significant import for the Organization's water resources research policy.

During its deliberations, the working party was informed repeatedly by the major users of CSIRO's water resources research — i.e., members of the water industry — that the coordination and organisation of this research was deficient. In general, the research was seen as being insufficiently responsive to the needs of the industry and evolving largely as a result of the needs and opportunities perceived by individual scientists. The separate allocation of surface water research and shallow groundwater research to the Divisions of Water and Land Resources and Groundwater Research, respectively, was also seen as being inappropriate to the needs of the water industry.

In December 1985, a discussion paper: The Coordination and Organisation of Water Resources Research in CSIRO, based on the Peck report, was circulated for comment to CSIRO staff involved in water resources or related research. Of the organisational options proposed, the aggregation of most of CSIRO's water resources research into one Division appeared to be the most favoured — based on the need for better organisation of research in this area and closer cooperation with users of the research. There was little support for the coordination options proposed, i.e. the establishment of an Office of Water Resources Research or enhanced coordination within existing structures.

Two committees reviewed the Divisions of Water and Land Resources and Groundwater Research in 1985–86 and they and the relevant Standing Committee of the CSIRO Advisory Council endorsed the need for a single CSIRO 'water' Division to improve the coordination and organisation of CSIRO's — and the nation's — water resources research.

A Chairman's Committee met in May 1986 to consider advice and recommendations on the organisation of CSIRO's water resources research. The Committee accepted that there was a need for a clearer focus to be given to this research and for better communication and interaction with the water industry. To achieve these ends, it concluded that a Division of Water Resources Research should be established. These conclusions were accepted by the CSIRO Management Committee, and the combined

Experiments in growing rice at Whitton, N.S.W., conducted by the CSIRO Centre for Irrigation Research, Griffith, N.S.W.

recommendations of this and the review committees will be considered by the Executive in July 1986.

Selected Research Achievements

Production of High-purity Zirconia

High-purity zirconia is the main component in the manufacture of a number of engineering and industrial ceramics that have applications in diesel engines, cutting tools, piezoelectrics, prosthetics and high-performance refractories. It is also used to make PSZ (partially stabilised zirconia), the ceramic developed by the Division of Materials Science and now manufactured by NILCRA Ceramics Pty Ltd.

The development of PSZ is very much dependent on the supply of suitable zirconia powders, which currently have to be imported from the United States, Europe or Japan. Australia produces about 60% of the world's supplies of zircon sand, but none is processed in this country. In order to meet the need for a reliable supply of zirconia powder, the Division of Mineral Chemistry began researching new processes for producing high-purity zirconia. When the work looked sufficiently promising the Division advertised for an industrial partner. ICI Australia Ltd was chosen and an agreement between CSIRO and ICI was signed in June 1984 to develop new technologies to manufacture zirconia and related products in Australia. Since then, each partner has contributed about $1 million in research and development.

The major CSIRO research has been performed by the Division of Mineral Chemistry and important collaboration has been provided by the Divisions of Applied Physics and Materials Science as well as Monash University.

After studying several process options, the joint CSIRO/ICI team has now developed and laboratory-tested a new process for producing high-purity zirconia with controlled particle size and shape. ICI has built a $500 000 pilot plant at the Division of Mineral Chemistry to produce samples for market evaluation. The plant is operated jointly by CSIRO/ICI personnel. Construction of a full-scale plant, at a cost of $12.5 million, is expected to commence at Kwinana, W.A., in the latter half of 1986.

While PSZ was the catalyst for the Division's move into zirconia research, the process developed is flexible enough to allow for the production of a wide range of zirconia powders for use in the fields of engineering, electronics, abrasives, ceramic colours and refractories, as well as zirconium chemicals used in an even wider range of products, e.g. paints, tanning agents, textiles, ceramic glazes, cosmetics and drilling muds.

In October 1985, CSIRO (through SIROTECH Ltd) and ICI Australia Ltd established a new company, Z-Tech Pty Ltd, to penetrate major overseas markets for zirconia products. The collaborative research and development program between the Division of Mineral Chemistry and ICI will continue for at least the next two years.

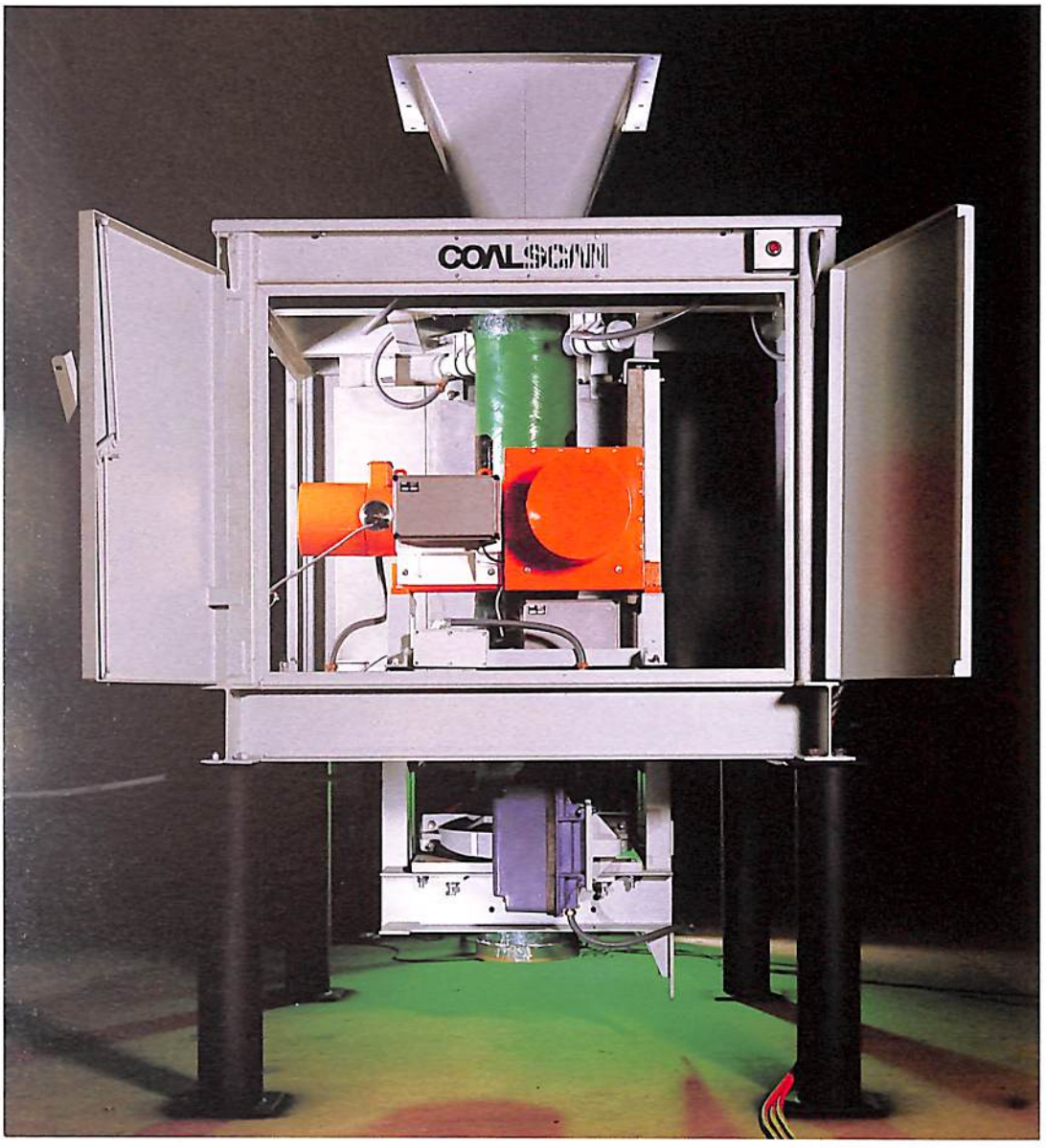
Zirconia commands a very high price in relation to zircon sand. Hence the quest to manufacture zirconia in Australia forms the basis of a high-technology industry capable of producing value-added products that can be sold on world markets. It also provides the critical link between Australia's current position as the major world supplier of zircon sand and the pioneering work that has been done in this country in advanced ceramics.

COALSCAN On-line Ash Gauges

Coal as mined usually contains too much waste material for its direct use in steel-making and in operating electricity-generating power stations. The mined coal is washed and blended in a coal preparation plant at the mine site to yield a uniform product upgraded in combustible material and with reduced ash. The efficient operation of the preparation plant depends to a critical degree on the on-line determination of the ash content of coal to ensure the minimum wastage of the valuable combustibles.

The Division of Mineral Engineering has developed two techniques for this determination: pair production and dual energy gamma-ray transmission, both of which involve gamma-ray interactions that are dependent on the different atomic numbers of elements. These techniques can thus be used to determine the ash content of coal, because the ash contains mainly oxides of silicon and aluminium and so has a higher mean atomic number than the combustibles, which contain mainly carbon, oxygen and hydrogen.

The two nuclear techniques are the basis of the two COALSCAN ash monitors manufactured and marketed, under licence to CSIRO, by Mineral Control Instrumentation Pty Ltd (MCI), of South Australia. To date, 12 pair production and 13 dual energy gamma-ray transmission gauges have been installed or ordered. The development of these gauges has made a major contribution to the success of MCI, a small Australian high-



Dr Brian Sowerby, of the Division of Mineral Engineering, received the inaugural Sir Ian McLennan Achievement for Industry Award for inventing the COALSCAN gauge.

technology company, and has generated sales in excess of $4 million. Five of these ash monitors have already been sold overseas and significant sales to many major coal-producing countries are expected.

The importance of the technological achievement of the COALSCAN pair production gauge was recognised through two awards. The United States magazine *Research and Development* recognised it with one of its 1984 I-R 100 Awards, given for the 100 best technological products developed throughout the world and marketed for the first time that year. In 1985, the CSIRO Advisory Council presented its inaugural Sir Ian McLennan Achievement for Industry Award to Dr B.D. Sowerby for the invention of the gauge.

The widespread use of COALSCAN ash monitors will lead to Australia becoming more

competitive in coal sales on the world market by enabling Australian coal-miners to keep their product closer to contractual specifications, and by maximising yield. The potential savings are large: every 10% increase in the yield of product coal adds $40 million to the value of coal exported from Australia each year.

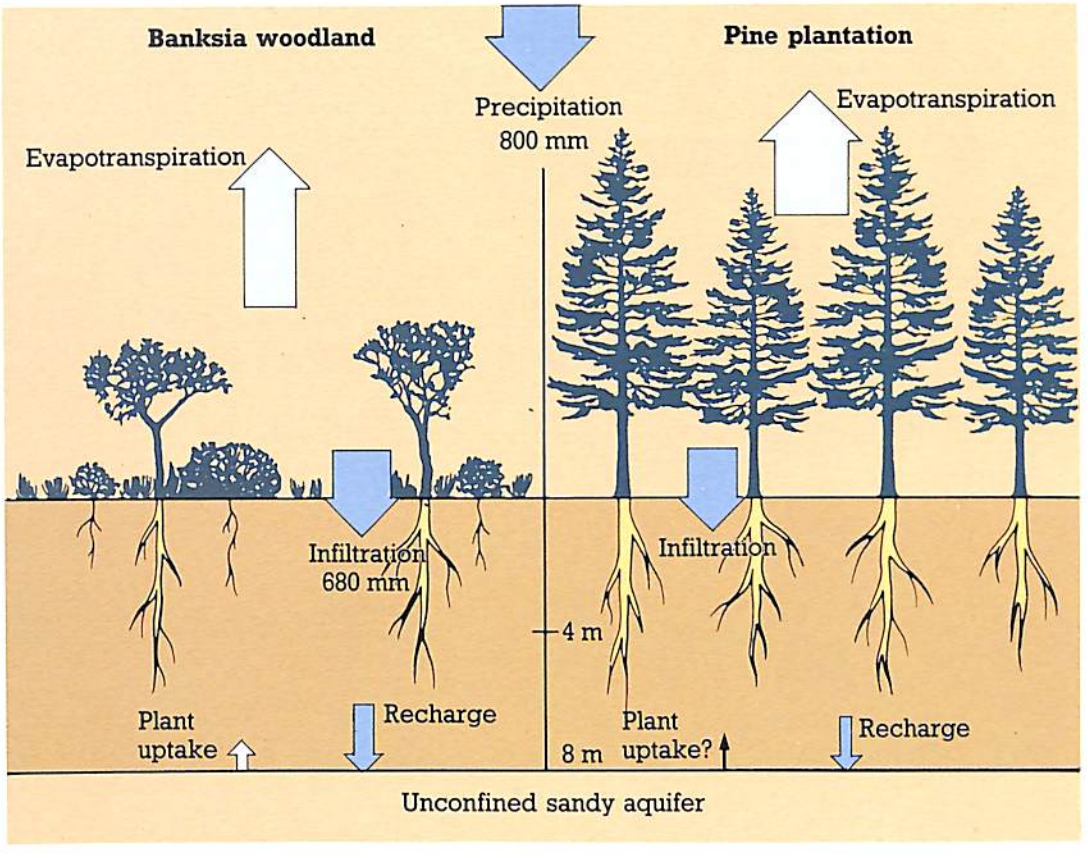
Monitoring Water Flow through Soil and Plants

Australia is unique in world terrestrial hydrology. The total precipitation received by Australia is only 57% of the world land average, while run-off per unit area is less than 12% of the world average. About 93% of the continent's precipitation enters the soil, but 92% returns to the atmosphere through evaporation and transpiration. The remaining 1% eventually reaches the groundwater after moving through mostly unsaturated soil (containing both air and water in its pore space). This 'arid-zone' hydrology is quite distinct from the 'main-stream' hydrology that evolved for the saturated soils of humid Europe and north-eastern America and requires different study techniques to aid water conservation and management.

Understanding and predicting unsaturated water flow in soils involves difficult mathematics. Particularly difficult are those problems in which the source of water is confined to a relatively small portion of the soil mass. However, these problems vitally affect both the quality and quantity of local groundwater. Leaky canals and underground pipes, buried liquid wastes, septic tanks, red mud lakes, centre point irrigators, ponds and streams are all important examples associated in Australia with unsaturated flow.

A recent major advance in predicting the flow of water or pollutants from such sources has been the discovery by the Division of Environmental Mechanics that the equation governing steady unsaturated flow in these situations is analogous to that describing the scattering of plane

Research on the Gnangara Mound, north of Perth, shows *Banksia* woodlands allow much greater recharge to aquifers than do pines.



harmonic waves from solid objects. Thus, a variety of mathematical techniques and results developed in more than 50 years of research into electromagnetism, acoustics and quantum mechanics can be applied directly to arid-zone hydrology. The Division has already exploited this scattering analogue to describe the flow rate of water from, and its distribution about, a variety of buried sources of differing shapes.

The application of theoretical advances, like the scattering analogue, to practical problems in hydrology relies on knowledge of soil hydraulic properties, which are notoriously difficult to measure rapidly and reliably in the field. Existing techniques disturb the soil, either by driving cylinders or drilling boreholes into it. Recently the Division of Environmental Mechanics perfected a much superior, non-disturbing technique based on a device called a disc permeameter. A wetted circular disc, from which water is supplied to the soil at a range of selectable pressures, is placed on the soil surface. Observations of the rates of water flow out of the disc yield measures of soil permeability and capillary properties.

Further, as flow occurs from a confined small source, it can be described by the scattering analogue. Analysis shows that the use of the disc permeameter is a far better technique than existing methods for theoretical as well as practical reasons. Earlier devices were poorly adapted to separating the two driving forces for water movement, gravity and capillary suction; the disc permeameter overcomes this serious problem. It is now possible to obtain simply, reliably and surprisingly rapidly, those measurements of soil hydraulic properties needed for predicting the water distribution around, and ultimately the groundwater recharge from, a large range of water pollutant sources.

In recent years about 40% of the water supplied to Perth by the Water Authority of Western Australia has been derived from the unconfined aquifers of the Gnangara Mound, located on the coastal plain north of the city. With the expansion of the city, the water requirement is projected to double from 1980 to the year 2000. Extensive development of the coastal aquifers is planned by the Authority to meet the increasing demand. Careful management to ensure optimal utilisation of the resource, consistent with environmental requirements, is called for, and this requires quantitative knowledge of natural recharge rates under different environmental conditions, such as the type and density of tree or vegetation cover.

The Division of Groundwater Research has developed field techniques for measuring rates of water movement to the aquifer, and for measuring the rates at which individual tree species withdraw or transpire water from the soil.

On parts of the Gnangara Mound, native *Banksia* woodland has been replaced by pines and further plantations of pines are planned. The research so far has shown that *Banksia* woodlands allow much greater recharge to the aquifer than do pines, and that dense pines can completely cut off infiltration.

Because of its direct relevance to the Perth supply, the research is being conducted in close cooperation with the Water Authority of Western Australia and the Geological Survey of Western Australia. It has been supported financially by the Water Authority.

The Division's research aims to develop general relationships between the various factors affecting the recharge process, with adequate accounting for time ranges from months to years and spatial ranges from hectares to square kilometres. The research, and the consequent management models, are not only of direct value to Perth, but will also have more general application elsewhere in Australia.

9. Conservation and the Natural Environment

The impact of human activities on the natural environment remains a major political and scientific issue in Australia and throughout the world. Because research is the key to sound decision-making about Australia's soil, water, flora, fauna, oceans and atmosphere, CSIRO intends to continue its work in all these areas. CSIRO is particularly aware of management needs and will structure its research programs to respond to those needs, using regular feedback mechanisms linking researchers and managers.

During 1985/86, an important Federal Government initiative was the report, Rainforest Conservation in Australia, prepared for the Hon. Barry Cohen, Minister for the Arts, Heritage and Environment.

CSIRO was represented on the working party which prepared the report and provided significant input, based on the experience of its well-established and expanding Tropical Rainforest Research Centre at Atherton, Qld. A significant recommendation was the commitment of greatly increased Commonwealth funding for rainforest research.

CSIRO is presently reviewing two aspects of research in this sector — soil conservation and ecology. In addition, the Director of the Institute of Biological Resources has initiated a review of land research within CSIRO.

Research in astronomy, previously classified within the conservation and the natural environment sector, has been transferred to the space-technology sub-sector. For the purposes of this report, activities in astronomy research are recorded in the sections to which they have particular relevance.

Policy Implementation

Soil Conservation Research Review

Governments recognise soil conservation as an urgent, major national problem. CSIRO has responded to this concern, not only by continuing its substantial research effort on soil conservation by the Divisions of Water and Land Resources and Soils and the communication of results to soil management authorities, but also by designating water and soils as a research growth area for 1985/86, and soil conservation research as a 'protected' area for 1986/87.

To provide the policy basis for decision-making in this area, the Institute of Biological Resources carried out an internal review of soil conservation/erosion research, seeking the views of State instrumentalities as well as studying the outcome of major reviews by CSIRO and national authorities over the past decade. The recommendations of the review and the mechanisms for their implementation will be considered by the Executive.

Review of Ecology

Following reviews of the three CSIRO Divisions concerned with plant research and a report to the Executive on the interactions and relationships between those Divisions, the Executive called for action on several critical issues that had emerged. One of these was ecological research and a report on this subject, with proposals for improvements to the integration and coordination of ecological research within the Institute of Biological Resources, has been prepared for consideration by the Executive.

Soils and Land Use

Pasture Management for Soil Conservation

More than two-thirds of Australia's cropping land — or 31 million hectares — is threatened by soil erosion; in South Australia 69% of cropping land had lost up to three-quarters of its topsoil after 70 years of cropping, and in some areas of eastern Australia soil erosion exceeds 300 tonnes per hectare per year. As well, the loss of topsoil through erosion threatens the long-term productivity of arable cropping over large areas of southern Queensland.

One of the most effective methods of decreasing erosion is to ensure there is vegetative cover on the soil surface during vulnerable periods. However, some important crops such as sunflower provide little protection during their growth cycle and leave little covering residue after harvest.

The Division of Tropical Crops and Pastures has investigated the concept of using legumes as ground cover under such crops to minimise soil loss. A wide range of legume types has been tested for their ability to grow and provide ground cover under sunflower without seriously reducing yield. Two promising legumes have been found and the search is continuing.

Determining the Rate of Soil Erosion

As a result of atmospheric testing of nuclear weapons from 1946 into the 1970s, the radioactive isotope caesium 137 was laid down evenly over

wide areas around the world, including large tracts of Australia. The isotope did not occur in measurable quantities in Australian soils before the testing began. In a collaborative study with the Australian Atomic Energy Commission, the isotope has been used as an indicator of recent topsoil erosion in a grazed poplar-box woodland in southern Queensland. The caesium isotope adheres to fine clay particles in the top few centimetres of soil. Soils that have undergone significant erosion since the early 1960s, the time of heaviest caesium fall-out in Australia, have less of the isotope in their topmost layers than comparable uneroded soils.

Data from this experiment demonstrate clearly that removal of tree and shrub cover in this semi-arid environment increases the rate of topsoil erosion. Even under normal grazing regimes, topsoil loss is significantly greater than in non-grazed areas, and in the long term may lead to serious degradation of the soil resource.

New Technique for Soil-water Research

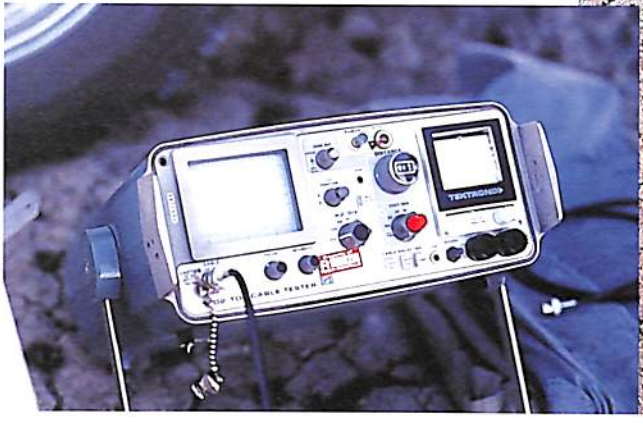
Scientists at the Division of Environmental Mechanics are helping to introduce to Australia a new technique for the rapid *in situ* non-destructive determination of soil water content. The technique, time domain reflectometry (TDR), operates by measuring the travel time of a high-frequency electromagnetic wave moving through a known path in the soil. Because TDR responds to the electrical conductivity of the soil, it can also be used to determine the relative salt concentrations in saline soils.

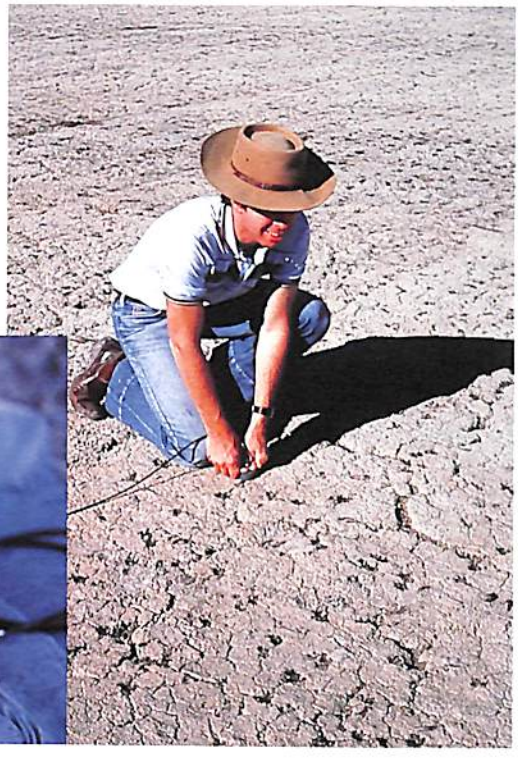
The value of TDR in the field has been demonstrated in tests carried out by the Division near Broken Hill, N.S.W., at a site characterised by stony, saline, and cracking clay soils. The salinity and water content in the top 15 cm of these 'difficult' soils were determined simultaneously at 1-m intervals; 202 measurements were made in 2½ hours. Only 20 or 30 measurements could have been made in that time using conventional techniques.

The speed and precision of TDR promise significant advances in applying soil physics theory to challenging environmental problems. For example, knowledge of water content near the surface of a soil is important for erosion prediction and control. Previously such information was virtually impossible to obtain but with TDR, measurements of near-surface water content are straightforward. Another novel application is measurement of the water content of large stored coal heaps. Leaching from these heaps can cause serious pollution in nearby streams.

Waterlogging in Forest Soils

Research at the Division of Water and Land Resources will provide foresters with a new management option — the planning of tree felling so that the area of resulting saturated soil is minimised. The model of hillslope hydrology





Field trials of the TDR technique, undertaken by the Division of Environmental Mechanics.

behind this option simulates the effects of removing trees, and can predict the growth or contraction of waterlogged zones according to the amount and location of forest cleared within a catchment.

In the absence of data on how well the soil of a particular catchment transmits water or on the quantity of water leaving a catchment as streamflow, the model, while unable to predict the exact wetness of zones, can determine with considerable accuracy that one zone will be, for example, four times as wet as another. Current work by the Division in forested catchments near Eden, N.S.W., should lead to further development of the model.

Ecology and Environment

Conservation of Native Grasslands

The prime source of food for Australia's northern grazing animals — native grasslands — is under increasing pressure. Large areas of sub-humid tall grass pastures in northern Australia either have been, or are potentially, exposed to overgrazing. This has prompted research by the Division of Tropical Crops and Pastures into the causes of instability in the grasslands. Understanding the causes will lead to definitions of grazing limits that will give optimal animal production while maintaining the resource.

Large-scale grazing experiments have indicated that native grasses in northern and southern tall grasslands differ in their ability to withstand heavy grazing, but few data exist on the causes of these differences.

To fill the knowledge gap, the Division has undertaken two lines of research; these involve:

- obtaining detailed information on the impact of grazing animals on the pastures;
- examining the response of individual plants to the interaction of the effects of environment and defoliation.

Using the data from this research, and more detailed information from grazing experiments, it will be possible to construct mathematical models to predict the specific regions and management practices under which the grassland would be most at risk.

Studying Water Taints and Odours

The Centre for Irrigation Research, at Griffith, N.S.W., has begun a collaborative study with the Sydney Metropolitan Water, Sewerage and Drainage Board and the Water Resources Commission of New South Wales to investigate taints and odours in the water supply. The taints and odours are associated with certain species of algae that are not removed by water-treatment processes.

Ecology Research for Management

The Division of Wildlife and Rangelands Research, on behalf of the Institute of Biological Resources, has begun a major series of seminars on developments in ecological theory with implications for research and resource management. The seminars will be given about six times a year at various institutions in Canberra and will be recorded on videotape for distribution to individuals and groups across Australia.

Flora and Fauna

Insects

The fauna of Australia is dominated by insects and related arthropods. Of the 108 000 species conservatively estimated in Australia, only about 60% have been gathered into research collections; only a fraction of these have been studied in detail. The vast majority of insect species are beneficial. Even those species regarded as nuisance, or even economic, pests can play an important role in the ecosystem. For example, without termites to consume dead and decaying wood and carrion flies to rid the country of carcasses, Australia could be a very unpleasant place to live. Insects can also be important indicators of the status of the environment.

Scientists at the Division of Entomology have studied the effects of sewage effluent on stream biology in Brisbane, using dragonfly larvae as indicator species. More recently, they have collaborated with researchers at the Division of Wildlife and Rangelands Research and staff of the Australian National Parks and Wildlife Service in the Northern Territory to investigate the biology of termites in the Kakadu National Park. This research is aimed at assessing the significance of termites in that region and their suitability as environmental indicators for use in developing management strategies for the Park.

The Australian National Insect Collection, maintained by the Division of Entomology in Canberra, comprises the largest collection of insects in Australia, with more than five million specimens. It acts as an important resource for Australian and international specialists interested in this continent's insect fauna. Biennial open days to enable the public to inspect the Collection and

A collaborative long-term study of tree-dwelling fauna in south-eastern New South Wales forests producing saw logs and wood pulp was undertaken by the Divisions of Wildlife and Rangelands Research, and Water and Land Resources, and the Forestry Commission of New South Wales at the request of the Australian Forestry Council. The factors determining the distribution of the fauna — such as this yellow-bellied glider — were mapped. The findings have provided a sound scientific basis for the Forestry Commission to refine its logging policies to ensure arboreal marsupial fauna are protected.

the facilities available for taxonomic work are especially popular.

Research by the Division on the biological control of pests and weeds by using other insects, pests and diseases has benefited Australia's natural environment as well as its agricultural enterprises. Biologists at the Division received the 1985 UNESCO Science Prize for work culminating in the successful control of salvinia in the Sepik River area of Papua New Guinea. Salvinia is a floating fern that infests the waterways of much of the tropics and subtropics. Earlier releases by CSIRO of the small weevil known as *Cyrtobagous salviniae* in northern Australia had reduced almost all serious infestations of this weed to manageable levels, thus restoring an ecological balance to internal waterways and the natural habitats of many native species.

Increasing Eucalypt Productivity

The discovery of a symbiotic relationship between the feeder roots of eucalypts and fungi could soon lead to the availability of eucalypt seedlings specially suited to particular sites. The relationship is based on a strategy developed by the eucalypts to improve their nutrient uptake by the formation of special root structures called ectomycorrhizas.

The Division of Forest Research in Western Australia has been examining this field. Its research suggests the need for the initial development of an ectomycorrhizal inoculation program, using superior ectomycorrhizal fungi for eucalypts that are to be planted out in areas previously not forested to *Eucalyptus* species, and where the availability of fertiliser is limited. The Division is providing information needed for a rational approach to inoculation programs in tree nurseries.

Oceans

Oceanographic Research from R.V. *Franklin*

The oceanographic Research Vessel *Franklin*, operated by the Division of Oceanography, completed a successful year of activity. Researchers on the vessel investigated sea mounts in the Tasman Sea, the origins of water masses in the thermocline of the Coral Sea, deep bottom fauna of the Barrier Reef shelf and adjacent Coral Sea, and hydrothermal venting on the sea floor of the western Woodlark Basin spreading system.

In a joint Australian-American Western Equatorial Pacific Circulation Study to investigate the variability of the upper ocean during monsoon peaks, the *Franklin* and two American research vessels made two cruises to collect data, which are now being processed and analysed at the Division in Hobart and in the U.S.A.

During this first year of operation the *Franklin* was used by researchers from the Divisions of Oceanography, Mineral Physics and Mineralogy, and Atmospheric Research; the James Cook University of North Queensland, Townsville, the University of Sydney, the University of New South Wales, the Australian National University and the Australian Institute of Marine Science. Overseas users were the Universities of Toronto, Hawaii and Miami, the Scripps Institution and the National Oceanic and Atmospheric Administration (NOAA).

Research in the ocean north of Australia enabled scientists from the Division of Oceanography to identify a process that controls variability of ocean temperatures in the region. By measuring the heat stored in the tropical oceans and the heat fluxes on the sea surface — solar radiation and evaporation — they demonstrated that evaporation by anomalous winds is a dominant process in ocean temperature variability, affecting not only the climate but, ultimately, the economies of Australia, South America, Africa and India.

The modification of equipment at the CSIRO Marine Laboratories in Hobart in April 1986 has facilitated the reception of images from the NASA Nimbus 7 satellite — these are in addition to those received daily from NOAA spacecraft. Nimbus 7 carries equipment that senses subtle changes in the colour of ocean water, providing information on, among other things, biological activity in the oceans.

Atmosphere

Investigating Antarctic Air Bubbles

The Division of Atmospheric Research has collaborated with the Antarctic Division of the Commonwealth Department of Science to investigate air bubbles trapped in antarctic ice. These air bubbles contain air trapped hundreds — even thousands — of years ago. Since an important question in atmospheric chemistry concerns the level of trace gases in the global atmosphere — and their effect on the earth's climate — the air bubbles allow scientists to establish past levels of these trace gases.

Predictions of how future emissions of, for example, carbon dioxide will affect the atmosphere require an accurate model of carbon

dioxide pools and their interactions going back many centuries. Air bubbles in the polar ice are supplying the necessary information.

Following the publication of data from Swiss scientists on carbon dioxide and methane concentrations going back 1000 years, CSIRO and Antarctic Division scientists compiled similar data for carbon dioxide, methane and nitrous oxide from the 17th century to the present day. The results confirmed that the level of carbon dioxide in the atmosphere before the industrial revolution was about 250 parts per million (the present level is 345 ppm), and that the level of methane had risen by 90%. The measurements for nitrous oxide — the first ever taken — showed that increases in this trace gas had taken place only since the industrial revolution.

Using the carbon dioxide results in subsequent investigations the researchers found that carbon dioxide currently released through the destruction of forests by slashing and burning was being matched by an almost equivalent amount taken up by the remaining vegetation, and that the increases in atmospheric carbon dioxide were due to man's use of fossil fuels. The Australian scientists now plan to measure the relative abundance of the stable carbon isotopes carbon-12 and carbon-13 in air trapped in ice cores to confirm these results.

Drought Research

During the year the Division of Atmospheric Research re-established a strategic program aimed at understanding the causes of drought initiation and breaking as part of an Institute of Physical Sciences priority-research initiative.

While not all the causes of drought have been identified, observational studies have shown that drought in Australia is related to anomalies in sea surface temperatures — normally of only 1–2°C — in the oceans around Australia. To determine how such anomalies affect the atmosphere, an international observational program involving Australia and named the Tropical Oceans and Global Atmosphere (TOGA) study has been established.

The main approach to drought research adopted by CSIRO involves the use of computer models based on the mathematical physical equations governing the behaviour of the climatic system. With suitable models it should eventually be possible to predict large-scale, intense droughts several months ahead.

Special attention will initially be given to a phenomenon called El Niño — a large-scale warming of the tropical Pacific Ocean off South America that produces a concurrent cooling in the ocean north of Australia. The latter cooling is primarily responsible for severe droughts over the eastern half of this continent. By inserting sea surface temperature anomalies similar to those experienced during an El Niño episode into a model of the atmosphere, it should be possible to understand how droughts are produced and how their individual spatial patterns arise.

The basic model has already been tested in a 10-year simulation of the atmosphere. It will now be coupled with an ocean model that will permit the combined system to produce its own sea surface temperature anomalies and thus droughts.

Environmental Protection

Detecting Trace Elements

As a result of CSIRO-industry collaboration, a Western Australian company, Chemtronics, is manufacturing and marketing an instrument for trace metals analysis in the 'parts per million' range. The portable digital voltammeter has a number of applications, including environmental surveys and pollution control. The Western Australian Department of Transport is testing the instrument in monitoring unleaded petrol to ensure that levels are below 13 mg/l.

Industrial Waste

Bauxite refineries in Western Australia generate about 11 million tonnes of residue each year. The residue, known as 'red mud', represents more than 40% of the total produced in the world, and poses an enormous disposal problem. Work by the Division of Minerals and Geochemistry in Perth has shown that the fine alkaline red mud can be mixed with gypsum — also a disposal problem for a fertiliser manufacturer in the region — and used in a variety of applications to counter acid sandy soils in the region of the refineries.

On experimental plots set up by Alcoa of Australia Ltd, 200–2000 tonnes of the red mud mix were incorporated into each hectare of sandy soil, typical of the region. Medics and subterranean clover pasture were then planted into the plots. The treatment significantly increased second-year pasture yields on all sites. The 'amended' red mud, which has a loamy texture, increased soil water and potassium retention and the legumes' Rhizobium nodulation.

Alcoa also found that the residue had a greatly enhanced capacity to retain phosphorus — often lost into groundwater — from applied superphosphate.

Trees and Atmospheric Fluoride

The Division of Forest Research is carrying out a project in the south-west of Western Australia to determine the physiological effects on trees of exposure to low concentrations of fluoride over long periods and to determine the rates of fluoride uptake as a function of atmospheric concentration.

Native tree species from forests in south-western Australia — *Eucalyptus gomphocephala* (tuart), *E. marginata* (jarrah), *E. calophylla* (marri) and *Agonis flexuosa* (peppermint) — are continuously exposed to air containing low concentrations of fluoride in open-topped chambers for up to one year under field conditions. The Department of Conservation and Environment of Western Australia, several other State government departments and Murdoch University are collaborating with the Division in the project, which is supported by funds from the International Aluminium Smelter Consortium of Western Australia.

10. Service Industries

CSIRO's activities in support of service industries are dictated by the special skills of the Organization in those areas and the responsibilities of other government agencies.

Research in urban and civil engineering aims to assist parts of the construction and transport industries and to develop advanced techniques in urban planning. Health aspects involve nutrition and food safety and, to a lesser extent, medical technology, where the special expertise of some of the physical science Divisions can be employed. The third area of support for the service sector is that of the establishment, maintenance and dissemination of Australia's physical standards of measurement.

Urban and Civil Engineering

Research in the Urban and Civil Engineering sub-sector covers a wide range of projects in transport systems, geo-engineering, construction and urban planning. The work is primarily undertaken in the Division of Building Research, where the projects are designed to support the construction industry and to satisfy the needs of urban planning. Research in the Divisions of Chemical and Wood Technology, Water and Land Resources and Groundwater Research also contributes to these objectives to a smaller degree. The Division of Energy Technology undertakes research into transport systems, while the Divisions of Soils and Geomechanics carry out civil engineering work.

In the Division of Geomechanics civil engineering research in mine structures and mine stability has been extended through the appointment of additional research staff to broader applications covering foundations for both on-shore and off-shore structures and engineering stability in tunnels and underground openings. A more detailed statement on this work covering progress towards its objectives will be included in the Annual Report for 1986/87.

This report focuses on research in the Division of Building Research in support of urban infrastructure and the building and construction industry, with particular emphasis on the

Left to right: Dr Peter Newton, CSIRO, the Minister for Science, the Hon. Barry O. Jones, and Dr Lex Blakey, Chief of the Division of Building Research, at the launching of a new book 'Microcomputers for Local Government Planning and Management' at a special function at the Division in May.

long-term durability of capital works and infrastructure.

Australia's Aging Infrastructure

The onset of the substantial deterioration of Australia's urban infrastructure and buildings in the near future is the focus of some 50% of the research effort of the Division of Building Research.

The salvaging of the nation's aging infrastructure, which encompasses most publicly owned facilities and constructions, is increasingly concerning Federal and State Governments, academia and many public and private-enterprise sectors. A pattern of deterioration and obsolescence in Australia's cities and towns is following closely the experiences of the U.S.A., Britain and other industrialised areas of the world.

A National Infrastructure Forum, held in Canberra in October 1985 and attended by 350 representatives of involved bodies, reflected the concern felt for the deterioration of Australia's building and infrastructure fabric — and its effect on our living standards and industrial efficiency. As a result, Dr F.A. Blakey, Chief of the Division of Building Research, was appointed chairman of a National Infrastructure Committee. Subsequently, in May, the House of Representatives Standing Committee on Expenditure announced a Parliamentary Inquiry into Australian Infrastructure. A submission from CSIRO is being prepared.

The thrust of the Division's four research programs — design for durability; safety and risk; life cycle performance; and shelter and infrastructure — is now directed even more firmly to studies of maintenance, durability, restoration, recycling and information technology.

Corrosion Studies

One of the major objectives of the design for durability program is to relate environmental factors to the ways that building materials degrade, and then evaluate the severity of the factors at various localities. This information can then be used for selecting materials with suitable characteristics for particular sites. As part of this study, the corrosiveness of a city (Melbourne) has been extensively mapped for the first time. The map has shown up unexpected zones of potentially severe corrosivity. The continued study of corroded receptors in one of these zones by scanning electron microscopy has established that salt spray and prolonged wetness of surfaces

Installing corrosion specimens on a telegraph pole is part of the design for durability program.

are responsible. Support for conducting a similar survey in Sydney is being sought because an earlier limited study showed that Sydney appeared to be the most corrosive of Australia's major population centres (Perth came second).

The wetness factor is also believed to be associated with the chalking degradation of paints, and can be estimated from relative humidity data recorded by the Bureau of Meteorology. Estimates indicate similar times of wetness from Melbourne to Brisbane, significantly shorter times from Adelaide to Perth and significantly shorter times again for inland Australia. A novel apparatus has been built to check these estimates for different surfaces at different localities.

New Railway Sleeper Technology

Adhesives are being used extensively in building and construction; consequently their long-term stability is of considerable interest. An instance of severe use is in bonding railway line base plates to sleepers instead of using dog spikes. Tests of bonding under repeated heavy loading have indicated that the method developed by the Division of Building Research withstands more than the equivalent of 12 years of on-track service.

The Division's system for attaching the rail plates has been provisionally patented and there are proposals for prototype sleeper units to be placed in lengths of Westrail track. This method will enable more readily available and cheaper preservative-treated pine and fabricated sleepers to replace hardwoods, such as jarrah. Sleepers with pre-bonded plates can be used in maintaining old, as well as providing new, tracks.

Combating Concrete Deterioration

Modern concrete may contain numerous additives and pozzolanic ingredients of varying activity and the consequences of the use of these are not yet fully understood, either chemically or physically. The durability of concrete appears to have degraded and 'concrete cancer' — the chipping, cracking and falling off of concrete cladding from buildings associated with corrosion and the expansion of the reinforcement — is occurring inexplicably in various locations.

The Division of Building Research, supported by the cement and concrete industry, is developing techniques to define concrete quality in terms of carbonation rate and surface moisture absorption. Carbon dioxide absorbed by the concrete changes its free lime into calcium carbonate, destroying the protection the lime gives to the steel reinforcement. If enough water is present the steel will corrode. CSIRO procedures are enabling concrete mix designs and curing schedules to be assessed in terms of durability factors, as well as the traditional parameter of strength.

Timber Bridges in Bushfires

Why and how do timber bridges burn and why are they so important in protecting life and property in bushfires?

The Victorian Road Construction Authority and the Division collaborated in a study, as part of the safety and risk program, to find the answers following similar studies on the performance of houses during the Ash Wednesday bushfires in 1983.

Thousands of timber bridges throughout Australia that do not normally carry large volumes of traffic often become vital links during bushfires as the only access to, and escape from, remote areas. The trapping of sparks or embers in the multicomponent sections of the bridge structure has been shown by laboratory and field tests — which involved the burning of a timber bridge in Victoria — to be the main cause of ignition.

Wind Loading

Another segment of the program concerns the formulation of a wind loading code by the Standards Association of Australia (SAA) to reduce the devastation caused to life and property by high winds and cyclones. One aspect which the Division examined — and which has now been incorporated in an Australia-wide SAA Code — was the wind loads on low-rise buildings. Studies using boundary-layer wind tunnel techniques showed for the first time that small construction details such as guttering could very significantly affect the loads exerted by highly turbulent, low-level winds.

The accuracy achieved in tests was sufficient to justify an average reduction in specified loads, resulting in an estimated potential saving of $20 million a year in construction costs.

Building Science into Building

Terotechnology — from the Greek *tereo* 'to take care of' — comprises all aspects of creating and maintaining buildings and infrastructure to

A test rig used for measuring the effect of climate variables on the long-term deformation of punched-tooth-plate connected joints.

achieve the optimal use of them over their lifetime.

As a rule the cost of the lifetime maintenance of a building exceeds the cost of the original construction. The annual Australian bill for the maintenance of buildings is almost $10 000 million. Therefore, reliable information is urgently needed and is being sought on maintenance costs in relation to age, capital expenditure, operating costs, life expectancy and client usage.

There is no documented, scientifically proven or comprehensive evidence on how much should be spent on maintenance and where funds should be applied. It is noteworthy, for example, that the cleaning costs of a building are normally higher than its heating costs, but are seldom viewed with the same concern. Consequently, the Division of Building Research is developing improved methods for assessing life cycle performance.

Current research covers:

- resolving how material, energy, skill and finance contribute to the life cycle performance of buildings;
- assessing the importance of maintenance facilities and how to plan for them;
- determining the physical causes of life cycle costs, their economic significance, and ways to predict their extent;
- appraising how well a building performs, i.e. does it keep out the elements and are its temperature, lighting and acoustics acceptable?

Some results of research so far achieved include a new format for collecting costs data on a nationally consistent basis, and a new method of predicting national and regional skill and materials requirements for housing programs.

CAD/CAP Programs

In the shelter and infrastructure program, knowledge-based systems and expert systems are being developed through a national research centre established in the Division of Building Research, in collaboration with the Association for Computer-Aided Design (ACADS), and the Victorian Department of Industry, Technology and Resources. These systems enable designers and planners to tap into, interrogate and use specialist expertise.

Some of this knowledge is being offered to small and large builders, architects, planners and local councils through computer-aided design (CAD) and computer-aided planning (CAP) programs ranging from layouts of building complexes (TOPMET) to traffic flow (MULTSIM) and traffic management (MULATM), pollution monitoring (POLDIF), the impact of retail developments, population projections, and location analysis of high-technology industries.

For the first time the Division is using the electronic media to disseminate information to end-users through videotex. In association with the Housing Industry Association, it is marketing an information package, QUOTE, on the Hiatex system. This package will enable small builders to obtain speedier and more accurate quotes for alterations and additions to houses and for new house construction. Details of project dimensions, quantities of materials required and their cost, as well as alternative options for specific jobs, can be kept by the user and updated on computer as prices and other factors change.

Damage inside offices caused by water penetration through windows is estimated to cost $50 million a year. A breakthrough resulting from Divisional research has been made this year through WATERPEN (water penetration expert system), which analyses ways in which water can penetrate window frames. The CSIRO program breaks new ground in the field through the extensive use of graphics. It is intended to help window designers check new designs before building a prototype for testing with SIROWET, a test rig devised by the Organization and now being used in constructing the new Parliament House in Canberra.

Larger real-time systems are also being explored for providing expert advice on the operational control of water supply and sewerage systems under emergency conditions.

Human Health

At the beginning of this century, two-thirds of people who died were killed by infections. Now, more than two-thirds of deaths are due to non-infectious diseases such as cancer, heart disease and stroke. These life-style health problems are the focus for much of CSIRO's current research on diet and disease.

The Executive's policies for medical research in CSIRO are reflected in the revised Medical Research policy (reported in the 1983/84 Annual Report), and in research priorities set following the reviews of the Division of Human Nutrition (1983/84 Annual Report) and the Division of Food Research (see chapter 5). The Division of Food Research carries out a small component of human nutrition research and all CSIRO work on food safety.

Various cancers, coronary artery disease and stroke have dietary links, and improved

knowledge of these links can contribute to preventing ill health. For example, cardiovascular disease may be totally preventable through nutritional means. Expenditure on preventive medicine in Australia, including nutrition research, comprised only a very small part of the country's direct health expenditure of some $15 billion in 1984/85.

The Division of Human Nutrition's research is aimed at understanding nutrition-related disorders, as well as optimum growth and development. Increased understanding of the relations between nutrients and health will assist in the preparation of better dietary advice and so contribute to improved quality of life generally and disease prevention. Food safety research is also concerned with preventing ill health. An estimated two million cases of food poisoning occur in Australia annually. While rarely fatal, food poisonings have a significant social cost through lost work time and temporary disability.

Human nutrition became a designated growth area in 1985/86 and the Division of Human Nutrition received additional resources to strengthen existing programs in accordance with the Executive's decisions on the Divisional review. The Division has initiated detailed discussions with Flinders University and the Flinders Medical Centre in Adelaide on establishing a joint Clinical Nutrition Unit, seen as an important facility for testing laboratory findings of the Division and other research bodies in a clinical setting. The Unit would be used for service and teaching functions as well as for research. The Organization would be involved in clinical studies on a collaborative basis only.

In addition to applying its research results to problems raised by the food industry, the Division of Food Research employs consumer and industry liaison officers to transfer research information on food safety directly to appropriate audiences. The Division's Industry Liaison Service, set up in 1968, is the main group in Australia disseminating food safety information. The Consumer Liaison Service is a more recent innovation and was set up in 1974 at the request of the then Minister for Science, the Hon. W.L. Morrison. The liaison officers have the backing of a unique spectrum of expertise in the Division, in areas ranging from food-processing technology through to public health microbiology. Consumer leaflets on the safe handling of foods are produced in 11 languages.

The Divisions of Applied Physics and Radiophysics have both contributed to medical technology, with particular emphasis on instrumentation. For example, a unique hearing-

Consumer pamphlets about food safety, published in 11 foreign languages.

aid system has been developed and will be installed in the new Australian Parliament House in Canberra. In November 1985, a meeting of the CSIRO Medical Research Liaison Committee was held in the National Measurement Laboratory (headquarters of the Division of Applied Physics) and some 20 medical scientists from Sydney were invited to hear papers on research by the Divisions of Applied Physics and Radiophysics relevant to medical technology. At the end of 1983, the Medical Engineering Research Association (MERA) was set up to help bridge the gap between the Australian medical device companies and research institutions. MERA has established its offices in the National Measurement Laboratory to facilitate this objective. Baxter Travenol, an international medical supply company with manufacturing plants in 17 countries, has also moved into the National Measurement Laboratory. The Travenol Centre for Medical Research is being set up by Professor P.C. Farrell, Director of the Centre for Biomedical Engineering at the University of New South Wales and Vice-President of Research and Development for Travenol in Japan.

There was some change of emphasis in research priorities of Divisions involved in human nutrition, food safety and medical technology during 1985/86. In the Division of Human Nutrition the new Chief, Dr P.J. Nestel, added a new research program, Nutrition and lipoprotein metabolism, which will concentrate on factors determining the levels of cholesterol and other fats circulating in the blood. High levels of these lipids are recognised risk factors in

atherosclerosis and hence in coronary artery disease and stroke. Studies will range from dietary intervention trials that should help improve dietary advice to the public, through to studies at the cell level. The latter will give a more detailed understanding of the metabolism of these lipids in the body.

Selected research achievements during 1985/86 included:

Division of Human Nutrition

- Identification by the epidemiology group of certain eating patterns that are strongly associated with, and may give rise to, cancer of the colon — the cause of 6% of all deaths in Australia. The most consistent factor identified was high dietary protein. Excess calories, frequent meals and the excessive consumption of alcohol were other significant correlates.
- The finding that certain unsaturated fatty acids (especially those occurring in fish oils) afforded great protection against abnormal heart rhythm when fed to animals in which the coronary circulation was reduced. Abnormal heart rhythm is a major cause of sudden death. This has obvious implications for the diet of a nation in which coronary disease is the greatest single cause of death.
- Achievement of substantial progress in identifying new circulating growth factors likely to prove beneficial in clinical disorders in which muscle wasting and protein loss from the body are critical factors.

Division of Applied Physics

- Development of an instrument to measure magnetic fields in the human body, which are 100 million times weaker than the earth's magnetic field.
- Development, in collaboration with Intra Optics Laboratories Ltd and Radiation Research Laboratories Ltd, of an infrared carbon dioxide laser having medical and surgical applications, The laser, which is much more compact and hence cheaper to manufacture than existing products, is under construction.
- Production of new electrodes for heart pacemakers having the dual properties of stimulating the heart muscles and determining if the heart is functioning correctly. This work was conducted in association with Nucleus Ltd.
- Devising a method of measuring the flexibility of ear (cochlear) implant devices manufactured in Australia for the profoundly deaf. Flexibility is critical in the implantation process. Measurement data were required by the U.S. Food and Drug Administration before the sale of the device was approved in the U.S.A.

Standards for Manufacturing and Service Industries

Almost every field of human endeavour makes use of physical measurements. Measurement is such a pervasive activity that studies in the U.S.A. and the U.K. show that it consumes about 6% of the gross national product of each country.

In every industrially developed country the government accepts responsibility for promoting a national measurement system and, in particular, for providing for uniform units and physical standards of measurement. Measurement uniformity, both nationally and internationally, is a basic requirement for quality assurance and component interchangeability in manufacturing, for the orderly conduct of trade and commerce, for a wide range of governmental regulatory activities, for communications and defence, and for the continuing progress of science and technology.

Australia's national measurement system provides for a hierarchical calibration network (see Figure 2). The Australian legal units are based on the International System of Units (SI), which is coordinated internationally by the General Conference of Weights and Measures under the Convention of the Metre. The standards of physical measurement used at any one level in the system were calibrated at a higher level and are thus 'traceable' to the Australian primary standards.

CSIRO's Standards and Calibration Functions

CSIRO's standards and calibration functions are defined in the *Science and Industry Research Act* 1949 and, more specifically, in the *National Measurement Act* 1960. The latter Act requires CSIRO to maintain 'such standards of measurement as are necessary to provide means by which measurement of physical quantities for which there are Commonwealth legal units of measurement may be made in terms of those units'.

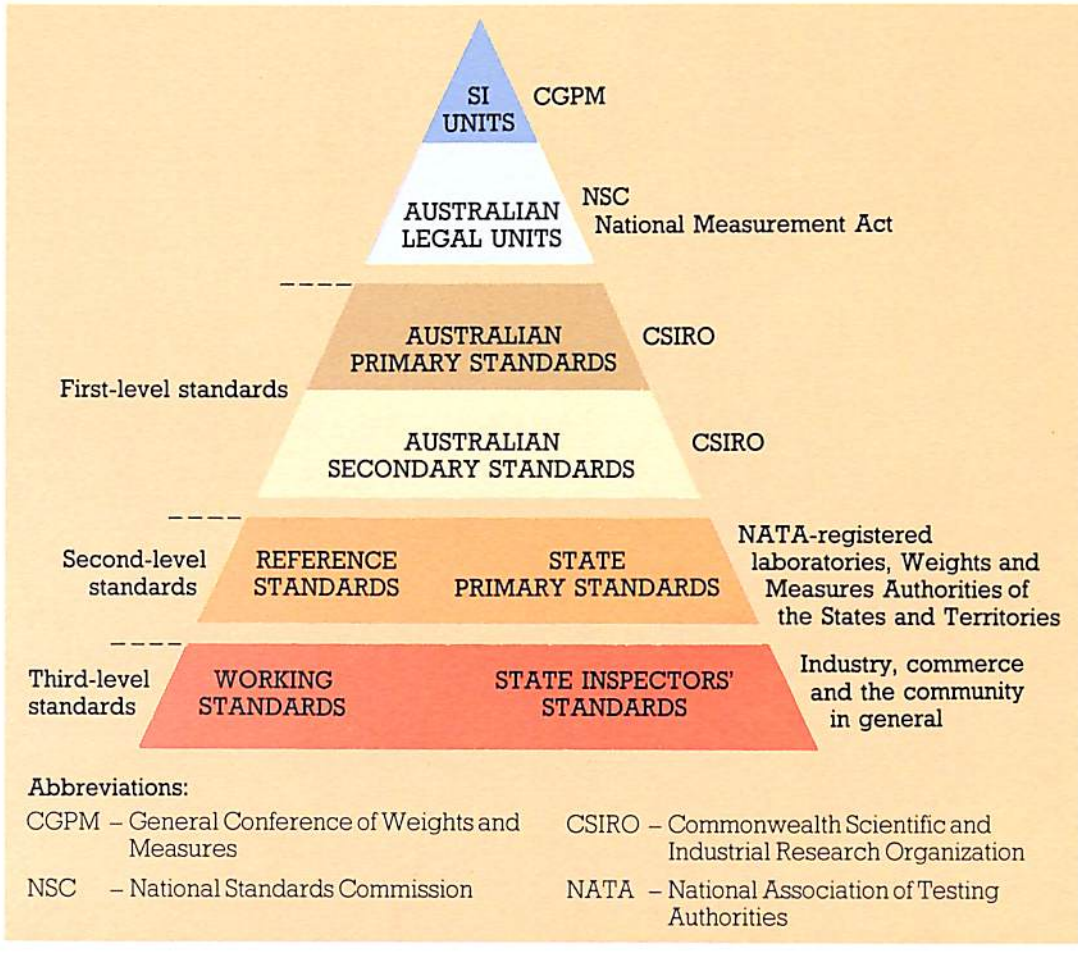


Figure 2. Australia's hierarchy of physical units and standards.

Within CSIRO, this responsibility has been delegated to the National Measurement Laboratory of the Division of Applied Physics. The standards maintained by the Laboratory are chiefly for the physical quantities indicated in the Box.

Standards of ionising radiations are maintained by the Australian Atomic Energy Commission and the Australian Radiation Laboratory, both these organisations having been formally appointed as agents of CSIRO for this purpose.

If measurements throughout Australia are to be uniform, and receive legal recognition and international acceptance, they must be consistent with the standards maintained by CSIRO within appropriate limits of uncertainty. The National Measurement Laboratory provides a calibration

Standards maintained by CSIRO

- Length
- Angle
- Mass
- Volume
- Density
- Force
- Power
- Pressure
- Acceleration
- Time interval
- Frequency
- Temperature
- Thermal conductivity
- Viscosity
- Roughness
- Electromotive force
- Electric resistance
- Electric capacitance
- Electric inductance
- Luminous intensity
- Luminous flux
- Radiance
- Irradiance
- Magnetic flux
- Magnetic flux density
- Microphone sensitivity
- Sound pressure
- Hardness
- Humidity

service to promote this objective. Since only a small fraction of the total number of calibrations required can be provided by a single organisation, this service is restricted as far as possible to the reference standards used by second-level laboratories, and relies on those laboratories to provide lower-order calibrations. Thus the principal clients of the CSIRO service are the many laboratories accredited by the National Association of Testing Authorities (NATA), the National Standards Commission (NSC) and the Verifying Authorities appointed by it, and the Weights and Measures Authorities of the States and Territories.

During 1985/86, the Division undertook some 1080 calibrations, and fees chargeable amounted to $506 600. Clients using the calibration service were as follows:

Private industry	521
Government	341
CSIRO	121
Others	97

Equivalence of Standards

In October 1985, another chapter was added to the National Measurement Laboratory's long history of collaboration with the British National Physical Laboratory (NPL) and the United States' National Bureau of Standards (NBS). Six documents were exchanged with each organisation formally recognising the equivalence of the Australian and British national standards, and the Australian and U.S. national standards, for length, time interval, temperature, and electric potential, capacitance and resistance.

This mutual recognition of equivalence is expected to help many Australian businesses, especially manufacturers of high-technology products who are required to satisfy stringent technical specifications set by British or American partners. Such requirements often appear in contracts arising, for example, from the Federal Government's offset manufacturing policy. In the past it has sometimes been difficult to convince foreign companies that Australian-based measurements would fully satisfy their needs.

Each of the documents exchanged gives a numerical estimate of the degree of equivalence for the standards concerned. In the case of NML and NBS, for example, the standards of time interval are recognised as equivalent to within 1 part in 10^{13}, whereas, at the other extreme, the temperature scales over the range 1064–2300°C are recognised as equivalent to only 1 part in 10^3. The documents also quantify any known, small, systematic differences between the national standards, and between the standards and the corresponding SI unit.

It is proposed to exchange further documents with NPL and NBS in due course — for example, for the important quantity, mass. Similar statements of equivalence are also being negotiated with the national laboratories of Canada and New Zealand.

CSIRO Standards Advisory Committee

The 1984/85 Annual Report detailed a review during 1984 of the calibration services offered by the National Measurement Laboratory. In response to that review, a Standards Advisory Committee has been established to provide continuing advice to CSIRO, through the Director of the Institute of Physical Sciences, on the present and future needs for standards and associated calibration services. The inaugural Committee is chaired by Professor A.G. Klein of the University of Melbourne, and includes representatives from industry, the Department of Defence, Telecom Australia, the Standards Association of Australia, the National Standards Commission, the National Association of Testing Authorities, and CSIRO. Its first meetings took place on 28 November 1985 and 13 June 1986.

Time Coordination within Australia

For many years the National Measurement Laboratory has contributed to Coordinated Universal Time for Australia (UTC Aust). This has been achieved by comparing one-second pulses from the Division's caesium clocks with clocks in other laboratories around Australia, in particular with those of the Department of Resources and Energy's Division of National Mapping in Canberra. The resultant time and frequency scale is disseminated to a wide range of users.

The method of transfer over the past 20 years or so has been to use superimposed synchronising pulses on specific ABC television programs. Now that the AUSSAT system is operational, however, the ABC is discontinuing this service, and new ways of synchronising Australia's clocks have to be found. In 1983, a working party recommended that the U.S. navigational Global Positioning Satellite (GPS) be used as a means of setting up a time link between major centres in Australia; recently, a GPS receiver was established at the National Measurement Laboratory and is being used collaboratively with other centres in Canberra

Portable equipment for measuring the geometry of large gears.

and Melbourne. The use of AUSSAT for time synchronisation within Australia is also being investigated. Further, an additional international time-link is being established, using Japan's Geostationary Meteorological Satellite GMS3. It is expected that such links will obviate the need for the continued use of travelling atomic clocks from the United States Naval Observatory. These clocks have, in the past, provided a link to international UTC.

Digital Electronic Meters

Precision digital electronic meters are being used increasingly by industry as reference standards for a wide range of electrical measurements. Until recently the stability and general reliability of these instruments was such that the National Measurement Laboratory considered them unsuitable for use as first-level standards. Nevertheless, the performance of such instruments has been monitored by the Laboratory, and it is now believed that some instruments have reached a level of maturity at which they can be accepted as standards. This, coupled with a recent move by the National Association of Testing Authorities to consider registration of certain laboratories that use a multiplicity of digital instruments as standards, has persuaded the Laboratory to introduce a calibration facility for high-quality, high-precision digital electronic instruments.

Optical-fibre Technology

Following the review of calibration services, the Laboratory formed a small working party, including a representative of Telecom's Research Laboratories, to report on any need for new calibration services resulting from Australia's rapid adoption of optical-fibre technology, particularly in communications. The most urgent need recognised by the working party was for a calibration service for near-infrared detectors and optical power meters used with fibre systems. The Laboratory has decided therefore to begin a project on optical-fibre standards, with an optical power calibration service as the first priority.

Applied Physics Industrial Program

In recent years, CSIRO has placed increased emphasis on the transfer of technology to industry, and to the community in general. The Applied Physics Industrial Program (APIP) is part of this emphasis, and many of the 20 or so projects in the Program have their origins in standards-related work, covering such areas as medical lasers, a portable voltage standard, a portable device to measure the profiles of large gears, a new form of gas meter, an on-line colour sensor, a digital voltmeter calibrator, and a power amplifier. Two of these projects are highlighted here.

Large-gear profiles. Australian sugar mills and mining companies use some of the largest gears in the world — up to seven metres in diameter. Further, local production of large gears for a wide range of excavating, conveying and processing applications is increasing. However, the manufacture of large interchangeable gears to replace worn or failed ones is a difficult task, particularly when the gear to be replaced is one of a pair, and measurements must often be made on site. This latter requirement suggests the use of a portable instrument, yet no such commercial equipment is available.

To fill this gap the National Measurement Laboratory has undertaken a three-year APIP project to develop improved portable instrumentation for the dimensional measurement of large gears. The project is being supported financially, and gears provided for testing, by the Sugar Research Institute, the Ordnance Factory, Bendigo, A. Goninan and Co. Ltd, and Utah International Inc.

The commercial production of an *electronic, voltage-transfer-standard instrument* is the outcome of another APIP project having its origins in standards-related research. Staff in the Laboratory have worked over the past 18 months in collaboration with Statronic Power Supplies, a Sydney-based electronics company, to develop a precision instrument as a replacement for the conventional electrochemical standard or Weston cell. The VS4, as the new instrument is known, has proved to be such a versatile, robust, and low-cost device that it is finding application in industrial calibration and repair facilities, and in the college and university sector. A further project involving the use of the VS4 in a complete digital calibrator is being undertaken.

11. Multi-sectoral Technologies

Biotechnology

In the 1984/85 Annual Report CSIRO described in some detail its biotechnology research projects. They ranged from the development of vaccines against animal diseases, both endemic and exotic, and diagnostic probes, comprising specific nucleic acid molecules and monoclonal antibodies for plant and human diseases, to gene transfers in plants and animals aimed at improving productivity. This research continued in 1985/86 and in several cases reached the stage of collaborative work with commercial firms or actual marketing of products.

Research groups in universities, medical research institutes and CSIRO were quick to enter the field of biotechnology in the latter half of the 1970s. Other biotechnology groups were developed in the small but growing number of specialised high-technology firms. A series of novel products and developments in pharmacy, food, health and agriculture followed. However, not all the results have been realised in the market-place — partly because industry was generally slow to apply the new techniques involved in biotechnology, and partly because of the significant gap that frequently exists between successful laboratory research and commercial production.

The pace of industry involvement is accelerating through government encouragement in a number of ways, including the 150% tax deduction introduced in July 1985. The Executive responded to government policy by continuing to foster biotechnology within the Organization by providing additional resources (see chapter 2).

In some areas of potential application of biotechnology for plant improvement, CSIRO is finding limitations because of the lack of fundamental knowledge of the biology underlying plant characteristics. Examples of problem areas in this regard are plant yield and quality, and resistance to salinity, waterlogging or some diseases. Similar limitations can be expected in animal gene research. These difficulties signal the need for a greater national commitment to strategic research to allow the best use of the technical potential offered by biotechnology.

Some of CSIRO's biotechnology research is of world-wide significance. Examples of important research developments during the year follow.

Insect Control by Nematodes

Insect pathogens, including fungi, bacteria and the microscopic parasitic worms known as nematodes, are important in the natural control of pests and can often be manipulated. Nematodes were used to control the sirex wasp, a serious pest of pine trees in Australia. Nematode parasites of the currant borer moth and black vine weevil, important horticultural pests, particularly in Tasmania, have been found to exercise effective control. CSIRO has developed techniques for the mass-rearing of nematodes and their formulation into a spray for field use. Commercial development is being pursued in collaboration with Biotechnology Australia Pty Ltd.

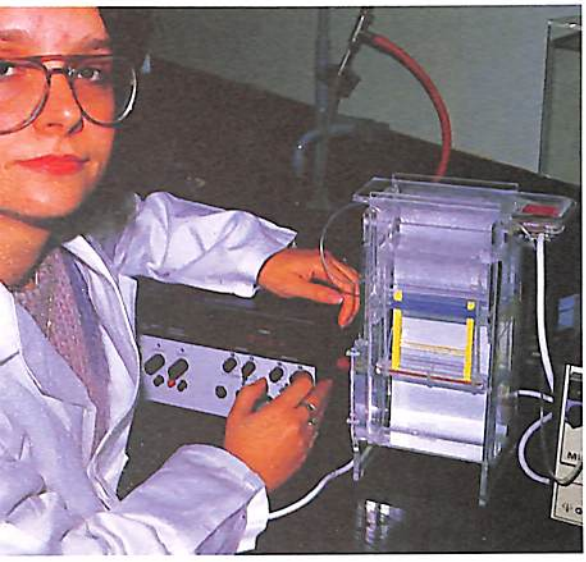
Treating Sewage

The Division of Chemical and Wood Technology, in conjunction with the Department of Microbiology at the University of Melbourne, has applied for a patent on a new method of sewage treatment called the Alternating Aerobic/Anaerobic Completely Mixed Activated Sludge System (AAA-CMAS). The system involves control of the alternating aerobic and anaerobic treatments of the sludge by an oxygen probe rather than a timer. The aim is to apply oxygen stress to the biomass of the system so as to reduce aeration energy and sludge production and, as well, to remove completely the nitrogen nutrient. Unlike other sewage treatments, the influent and effluent flows of the AAA-CMAS process are continuous rather than intermittent. Recycling of the sewage or the use of separate reactors for the aerobic and anaerobic stages are not required. A simultaneous chemical dosing technique for removing phosphorus from the effluent has been devised.

Food Research Initiatives

The enzymic treatment of gluten protein separated from wheat is proving successful in providing high-value protein isolates for new food and industrial uses. A range of modified gluten products designed for specific applications has reached pilot-scale production and evaluation. The Wheat Research Unit and Fielders Gillespie Davis Pty Ltd are collaborating in this research.

Monoclonal antibodies to wheat-grain proteins have been screened to select those with specificities suited to several food analysis requirements. This work was done by the Wheat Research Unit in collaboration with the Division of Molecular Biology. Adaptation of the antibodies to test-kit form has begun under the terms of a commercialisation agreement between CSIRO and Biocon (Australia), part of an international



'Gradiprep' accessory and coloured marker proteins for gel electrophoresis — an indispensible laboratory tool for clinical use and for the biotechnology industry.

company supplying enzymes and biologicals to the food industry. The first application will be testing for the presence of gluten in processed foods and will be of benefit to people with wheat intolerances, such as occurs with coeliac disease. Further kits will analyse for gluten and starch in waste-water from starch-gluten manufacturing.

Research in the Wheat Research Unit on new approaches to protein fractionation and characterisation has led to a series of new products, including equipment for preparative electrophoresis and electroblotting (for immunological evaluation), new precast gels for electrophoresis, and novel protein-staining kits. These products are being manufactured and marketed by Gradipore Ltd, a biotechnology company listed on the Sydney Stock Exchange in May 1986. Gradipore Ltd grew out of an earlier company, Gradient Laboratories Pty Ltd, and the expansion of its activities has been partly due to the input of CSIRO research.

Vaccine Developments

In association with the Divisions of Protein Chemistry and Chemical and Wood Technology, research by the Division of Animal Health on a recombinant DNA vaccine against infectious bursal disease virus of chickens is proceeding towards commercialisation with an Australian manufacturer.

The Division has also entered a cooperative venture with Biotechnology Australia Pty Ltd to develop vaccines against coccidiosis of chickens. Three CSIRO Divisions — Animal Health, Molecular Biology and Protein Chemistry — and the University of Sydney have been involved in research on a recombinant DNA vaccine against footrot in sheep. The work is entering the commercialisation phase, the commercial partners being Biotechnology Australia Pty Ltd and Arthur Webster Pty Ltd.

High-quality-protein Lucerne

A research group at the Division of Plant Industry has successfully achieved the transfer of a gene for high-sulphur protein from pea seeds into a tobacco plant. The engineered plant has no economic usefulness but serves as a convenient laboratory subject. The group hopes to transfer the same gene into lucerne within 12 months. If this is successful, it will then seek to create a high-sulphur version of Australia's most important pasture plant, subterranean clover.

CSIRO has already demonstrated that sheep with a diet supplemented by sulphur can grow up to 30% more wool. The challenge now is to deliver the extra sulphur to sheep in a more natural form, preferably through the animal's normal diet. High-sulphur-protein feed provides a way of doing this.

Artificially Created Twin Calves

Researchers at the Division of Tropical Animal Science have copied the natural process involved when identical twins are created to produce the first artificially created twin calves born in Australia. By removing an embryo from a cow seven days after conception and dividing it for implantation into a host mother cow, twin Brahmans were produced.

The technique involves the use of a micro-manipulator and blade to divide the 64-cell embryo, one half remaining in the protective outer membrane of the embryo and the other being placed in another membrane from an unfertilised egg. The two 32-cell embryos are then implanted into the host cow, which subsequently gives birth to identical twins.

Widely used in the United States, where it was developed, this bisection method has important implications for Australian breeders. It should be of particular value in breeding for certain

characteristics — tick resistance, for example — and in the breeding of high-value animals, because it greatly improves the success rate of embryo transplantation.

Biomaterials for Medical Engineering

The Division of Molecular Biology, under a National Biotechnology Grant to CSIRO and Teletronics Pty Ltd, is developing the expertise to design and invent biomaterials that might have special value in medical engineering.

Such biomaterials include polymers, modified polymers, or composites of natural and synthetic polymers that become the interface with human tissues. These materials may be used, for example, for synthetic arteries and heart valves, and synthetic organs such as the heart and the kidney. Additionally, such materials may have a special advantage in the mass culture of specific mammalian cell types for the production of fine biochemicals or other bioactive substances.

The Division is also studying materials/tissue interactions to improve the performance of prosthetic implants such as cardiac pacemaker electrodes. In research funded by Biota Holdings Ltd, the Division is working on the development of bioactive substances that control blood-vessel development and can be used in surgical repair.

Biotechnology for the Cosmetics Industry

The cosmetics industry is interested in the contribution of extra-cellular matrix components (such as collagen and elastin) to improvement in skin growth or repair. The Division of Molecular Biology is currently investigating the influence of collagen on the growth and other functions of human keratinocytes. This work is being funded by Nutri-Metics International Australia Pty Ltd.

Information Technology

The Division of Information Technology was established in January 1985, when nine staff from the former Division of Computing Research were transferred to form the initial core of the new Division. The Foundation Chief, Dr G.E. Thomas, former Director of the University of Edinburgh's Regional Computing Centre, took up his appointment in August 1985.

During the year the Division has concentrated on the priority areas recommended to the Executive in February 1984 by a specially constituted study group. These are:

- software engineering and related hardware
- man-machine interface
- computer networking
- information management
- devices and systems hardware technology.

The Division is expected to take five years to mature fully across the spectrum of these priorities. Although priorities may change in the interim, they will remain within the information technology definition: 'the acquisition, storage, manipulation, display and transmission of information by electronic means'.

Use of Resources

The initial group of nine staff have been assigned to projects inside the Division or are being seconded to other areas of CSIRO. Some of the latter, located in Canberra, are working with Australian National University computer scientists on geographic information systems. Another 18 staff are being recruited for Sydney and Melbourne, to be located at North Ryde, and close to the University of Melbourne and the Royal Melbourne Institute of Technology, respectively.

Information technology development is being supported throughout the Organization. For the third successive year specific funding has been made available for projects regarded as particularly relevant to CSIRO's Information Technology Program. Collaborative work between universities, industry and CSIRO also qualifies for funding either through a special information technology fund or one of the specific university/CSIRO research funding schemes.

The Division's resources are assigned to the support of specific projects within each of the five listed priority areas and of demonstration projects that bring together two or more techniques and show the effectiveness or otherwise of these techniques in a demanding environment.

Planning Priorities

The new Division's planning priorities are to:

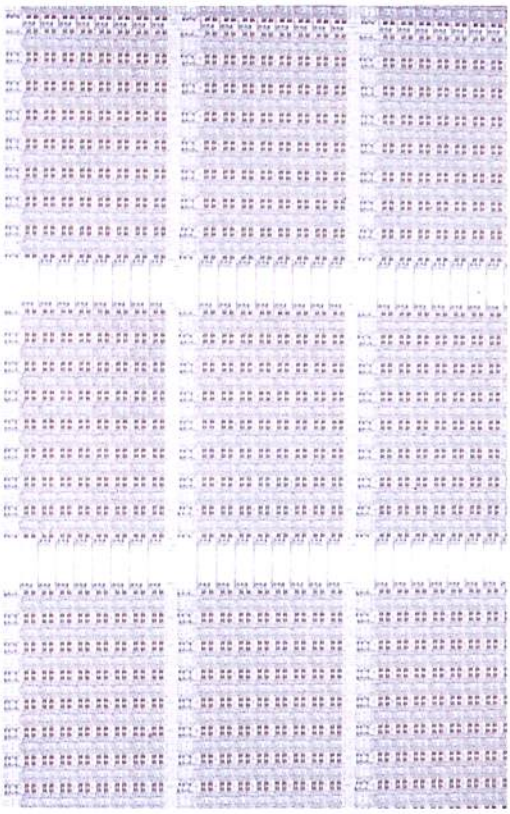
- coordinate the various information technology and related programs of the new Division and other Divisions engaged in this area;
- collaborate with educational and research bodies engaged in training information technology professionals;
- relate the Division's work to economic planning models developed at Federal or State level;
- utilise the market intelligence and marketing potential of the transnational information technology companies as a means of directing and exploiting original concepts and products generated in Australia; and
- seek the widest possible exploitation of information technology products in terms of social and financial benefits for the Australian community.

Reimplementation of SIRATAC

In association with the New South Wales Department of Agriculture, the Cotton Research Unit of the Division of Plant Industry developed a computerised expert decision support system called SIRATAC, which came into commercial use in 1981, to help cotton farmers manage their pesticides. It is now used on more than 25% of the Australian cotton crop.

The SIRATAC programs were developed more than 10 years ago and needed revision to make them more useful to growers. However, it would have been difficult to extend the capability of the programs, so in 1985 it was decided that they should be completely rewritten — taking advantage of recent advances in techniques that would make the programs easier to understand and allow further changes.

The Division of Information Technology, which has undertaken to produce the new SIRATAC, regards this as an opportunity to demonstrate the effectiveness of new techniques generated by the emerging discipline of software engineering. Data-base management offers better ways of keeping track of the data recorded on crop development and insect control; knowledge representation allows the expertise of the researchers to be made available to growers; networking enables several computers and many terminals to work harmoniously together; and dialog management permits users to give correct information to the system, thus assisting with the most expensive and error-prone parts of a computer system.



The largest chip — containing more than 21 000 transistors — so far produced by the University of New South Wales, using VLSI circuit design tools.

VLSI Agreement

During the year the Division of Information Technology and the School of Electrical Engineering and Computer Science at the University of New South Wales concluded a three-year agreement enabling two CSIRO scientists and considerable equipment to be located within the VLSI Circuit Architecture, Design and Tools Group at the University to facilitate research and industrial collaboration.

The objectives of the Group include:

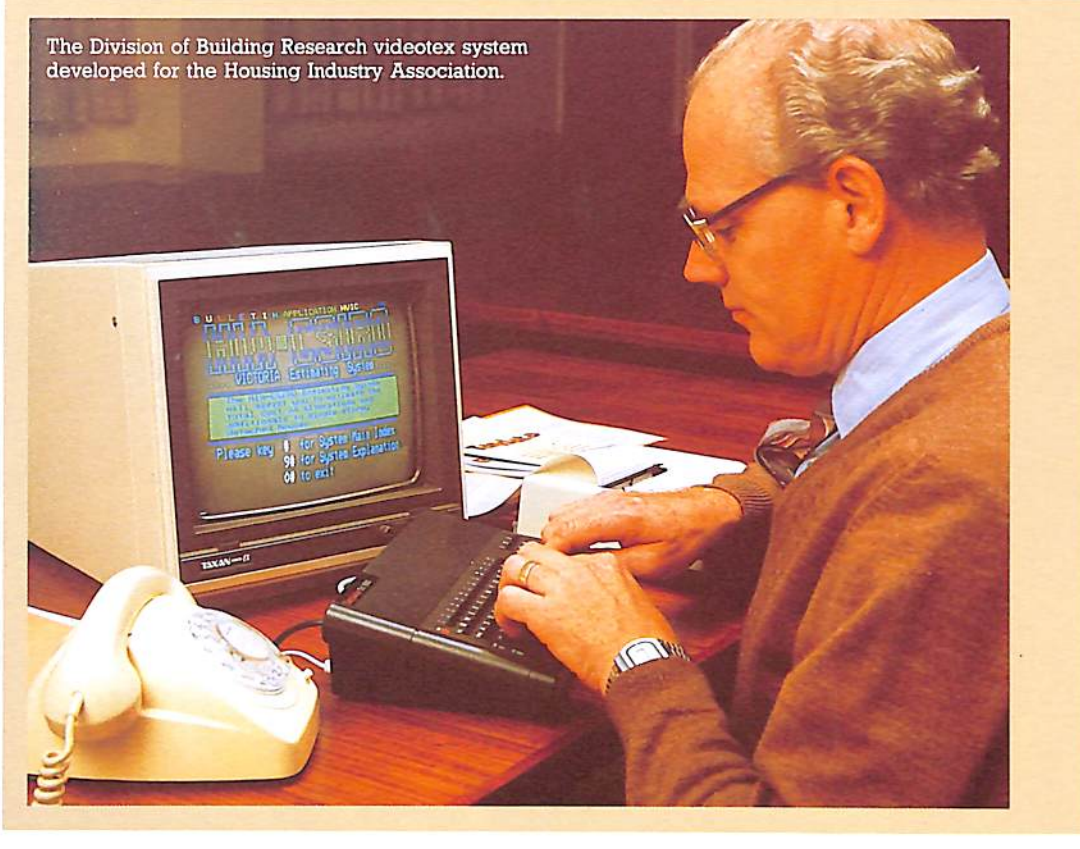
- solving fundamental and applied problems relating to the automated synthesis of systems in silicon;
- continuing development of more efficacious VLSI (very-large-scale integrated) circuit design tools to augment existing University design capability;
- industrial collaboration and technology transfer, with particular reference to:
  — integrated circuit design

— installation of University VLSI design tools in industry and research and teaching institutions
— training in the use of University VLSI design tools.

CORGIS Project

The Collaborative Reef Geographic System (CORGIS) is a data base on the geography, biology and uses of the Great Barrier Reef. Work is proceeding to improve the man/machine interface so that managers, planners and scientists can make more effective use of the data base.

A colour video monitor is the basic medium for displaying Reef maps on which the user can scribe a particular region of interest, e.g. the coral reefs within 10 km downstream of a reef with a known crown of thorns infestation. The ability to restrict the scope of a data-base request to a geographic region poses some technological problems that Divisional staff are investigating, along with other data-base problems of a spatial nature.



The Division of Building Research videotex system developed for the Housing Industry Association.

CSIRO Divisions providing scientific assistance to a specific industry are expected to provide the first level of advice on the utilisation of information technology by that industry. Consequently, many Divisions are involved in information-technology-related projects:

Division of Building Research

- Collaborated with the Housing Industry Association in a videotex information package for small builders, enabling them to quote more quickly and accurately for altering and extending homes and for new home construction.
- Developed WATERPEN, an expert system that analyses ways in which water can penetrate window frames. The system allows designers to check new designs before building prototypes.

Division of Water and Land Resources

- Formed a group to pursue expert systems research and development because these systems are well suited to providing advice that would normally be obtained from specialised land management agencies or researchers.
- Developed AEGIS — Australian Environmental Geographic Information System — to allow researchers to build up a system from which highly specific maps, custom-designed and scaled to the user, can be produced.
- Applied the geographic information system, ARIS — Australian Resources Information System — to pastoral production in Australia's rangelands, the loss of forest and woodland since European settlement, the organisation of socio-economic data by federal electoral divisions, and a register and atlas of local-government land-use issues.
- Applied LUPLAN, a microcomputer-based software package for land zoning, to Dungog Shire, in the Hunter Valley of New South Wales, and to the Murrumbidgee River corridor near Canberra. The work was carried out in collaboration with the authorities concerned. More than 100 inquiries about LUPLAN, now available commercially, were received during the year.

Division of Applied Physics

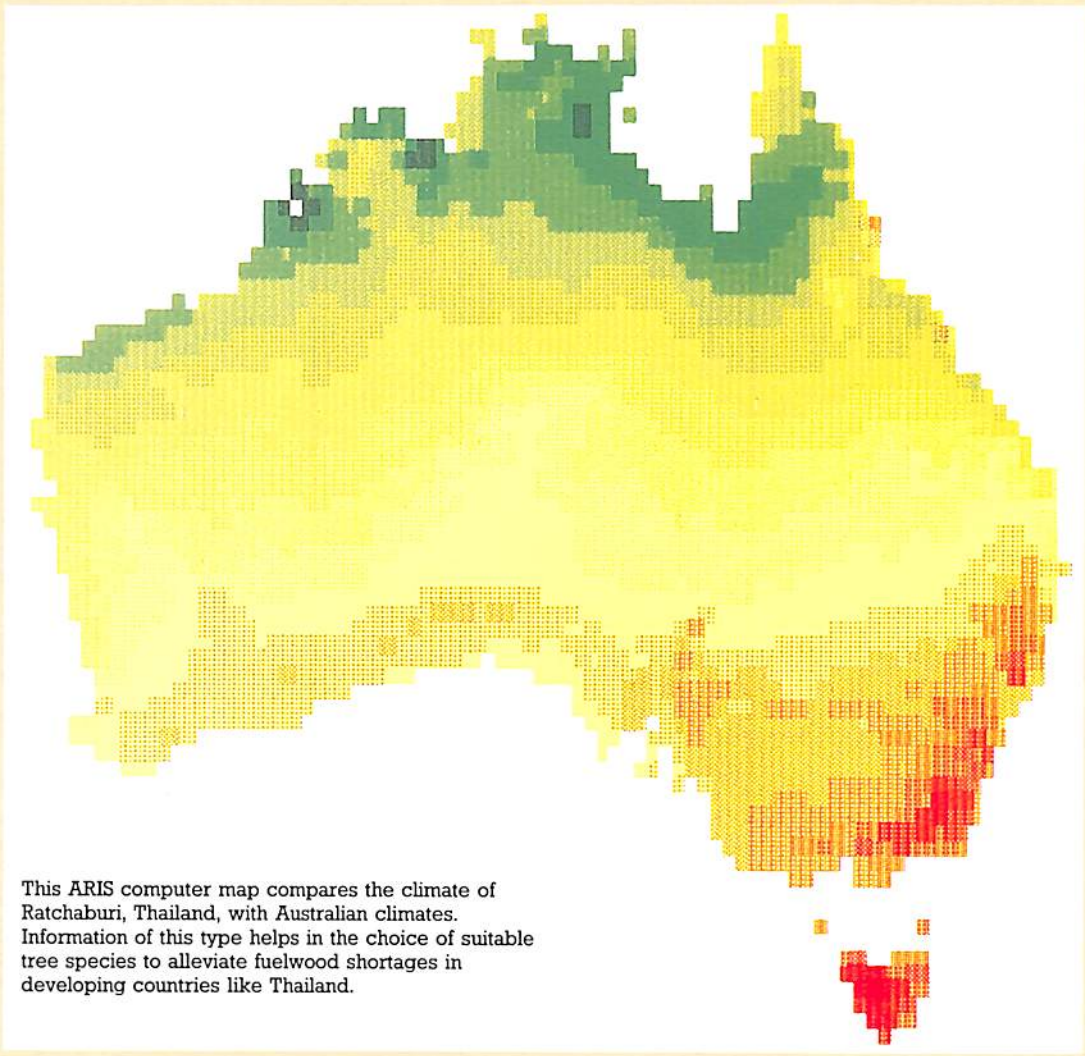
- Developing a hybrid image processing system featuring an optical analog processor, in combination with a digital computer. The analog processor can handle all the elements of a picture simultaneously and perform such processes as Fourier filtering quickly and easily. The system is suitable for operations such as texture discrimination and can, for example, locate structures oriented in particular directions and colour code them for easy identification (see figure).
- Developing a real-time hybrid processor. This involves studying various types of spatial light modulators that can be used in the optical analog processor at two locations: in the primary focal plane to input a video image, and in the Fourier plane as a programmable filter.

Division of Manufacturing Technology

- A vision-based control system for high-speed road marking.
- Automatic hand-written postal-code identification.
- General-purpose robot control software capable of supporting vision and force/torque sensors.
- A dynamic simulation package for robot task planning and validation.
- The application of expert systems to generate production planning strategies from part geometry descriptions.

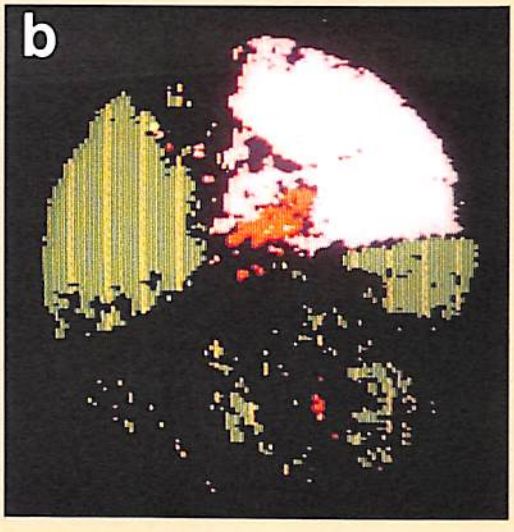
Division of Radiophysics

- Ongoing research into image construction and enhancement methods and applications, particularly in situations where sparse or inadequate data are available.
- Design of a VLSI fast Fourier transform chip for image and signal processing applications.
- Examination of a high-speed synthetic aperture radar processor for satellite remote-sensing applications.
- Development of various environmental control aids for handicapped people.
- Development and fabrication of gallium arsenide semiconductor devices (primarily integrated structures for use in low-noise microwave telecommunication systems) and of very-high-speed digital integrated circuits.



This ARIS computer map compares the climate of Ratchaburi, Thailand, with Australian climates. Information of this type helps in the choice of suitable tree species to alleviate fuelwood shortages in developing countries like Thailand.

A hybrid image processing system is being developed by the Division of Applied Physics. Figure (a) shows the original micrograph, and (b) the filtered output from the hybrid processor.



Space Technology

Space technology is central to the revolution now occurring in world communications; to the management of a nation's resources; and to the navigation systems of the future. It is therefore a core technology for a modern industrial state.

Australia has already spent more than $500 million to gain access to operational satellites. By 1995, it will be spending an estimated $350–500 million a year on space hardware. Some Australian firms have already realised the commercial potential of space technology and are manufacturing and marketing space-related equipment. CSIRO has been prominent in the genesis and development of much of this activity.

Some idea of the industrial potential of the space arena can be gained by looking at market projections for communications satellite microterminals, each of which currently costs about $20 000. Projections for the United States alone for the period 1986–90 vary between a low of 53 000 units in the most detailed study to date, to a high of 500 000 in a less rigorous assessment — which also concluded that as many as 250 000 terminals might already be on order.

For Australian industry to continue to penetrate the space technology market and gain an equitable share of expenditure on space applications, it must raise its competence and perceived capabilities in space technology. In this context CSIRO sees its roles in terms of devising applications of use to Australia and providing research and development support for innovative projects that will enhance Australian industry's capacity to compete effectively in international space technology markets.

The CSIRO Office of Space Science and Applications (COSSA) has developed a space research and development program involving some 15 Divisions in three of the Organization's Institutes. Some of the space research and development projects are outlined in this section.

Remote Sensing — Research, Development and Applications

The Division of Water and Land Resources, in collaboration with the Division of Wildlife and Rangelands Research and operating through SIROTECH Ltd, has established an agreement with Microprocessor Applications Pty Ltd (MPA) of Melbourne to market micro-BRIAN, a microcomputer-based version of the BRIAN system for image analysis developed at the Division of Water and Land Resources. Micro-BRIAN allows sophisticated interactive image processing of data from LANDSAT and other remote-sensing satellites to be undertaken on a personal computer without the need for a large, expensive, and centralised computer system.

The Division of Animal Production, with support from the Australian Wool Corporation and State agriculture departments, has continued its work on developing methods for using LANDSAT data to determine fertiliser application regimes that ensure stable livestock production on improved pastures.

Remote-sensing studies in the Division of Wildlife and Rangelands Research are directed to applying satellite data to the management of Australian rangelands. For example, LANDSAT data have been used to construct a model for forecasting large-scale patterns of soil erosion and deposition in arid grazing lands.

The Division is also organiser of a collaborative project with NASA personnel to process all archival (1979–1985) NOAA satellite data for the Australasian region with a view to extending studies on, among other things, continental-scale vegetation indexes.

The image processing group formerly with CSIRONET has been transferred to the Division of Information Technology to form part of an Image Processing and Graphics Program, based in Canberra. The Program will concentrate on developing generic image processing and graphics software to support applications of the technology. The group's image-processing packages can now be interfaced to different kinds of image display systems, including products from the Australian companies Quentron Optics Pty Ltd and the Dindima Group Pty Ltd. Installations of the software have increased to 13 in Australia and 2 in Finland.

The group is also involved, along with SIROTECH, in the COSSA-organised remote-sensing software market and technical surveys. COSSA has received support from the CSIRO Information Technology Grants Program to perform a market survey of remote-sensing image-processing system users, in tandem with a technical survey of these systems and their likely technological development over the next three years.

The objective of this work is to ensure effective, and commercially viable, technology transfer in the long term, both to the various users of remote sensing and to the industrial suppliers to those groups.

As part of its long-term interest in the Bowen Basin of central Queensland, the Division of Geomechanics has been using both LANDSAT MSS and NOAA-AVHRR imaging to determine

the nature and orientation of the structures in the coal-producing areas. The mining companies involved have supported and cooperated in this research. The remote-sensing instrument development activities of the Division are concentrated on radar research. The Division flew a test version of an airborne radar sounding instrument in December 1985, and has continued to provide an applications interface for an industrial consortium aimed at producing a commercial version of such an instrument.

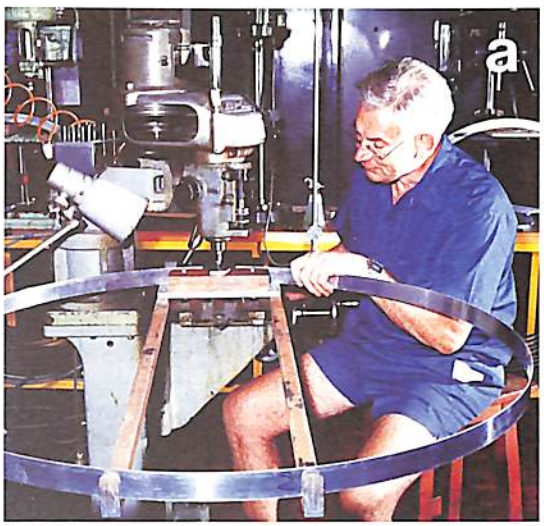
In a major project conceived and managed by the Division of Mineral Physics and Mineralogy, a consortium of seven Australian companies, eight Federal and State agencies, a university, and a British agency, together with NASA's Jet Propulsion Laboratory, conducted a month-long series of remote-sensing experiments in Australia in October 1985. CSIRO and the Bureau of Mineral Resources, Geology and Geophysics co-sponsored the project. Some 54 test sites were examined using CSIRO's F27 research aircraft and the NASA C-130 aircraft, which is equipped with state-of-the-art instrumentation. The prime objective of the project is to develop practical remote-sensing technologies for application in Australia in mapping, exploration, and monitoring and managing resources. The results of the project are expected to benefit users of the technologies and potential manufacturers of equipment.

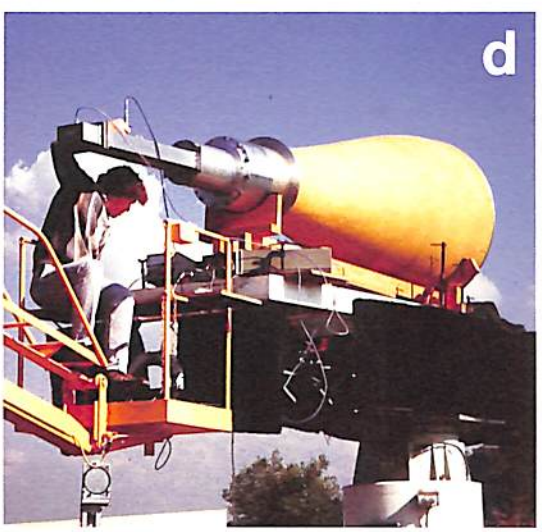
The Division of Oceanography and the Division of Mineral Physics and Mineralogy have each developed data acquisition platforms for use in remote locations on land or sea. They utilise the French ARGOS system on the NOAA satellites to retrieve the data. The technology incorporated in the platforms is available for commercialisation.

The Division of Groundwater Research, the Western Australian Institute of Technology, the Commonwealth Bureau of Meteorology, and the Western Australian Department of Lands and Surveys have established the Western Australian Satellite Technology and Applications Consortium. The Consortium covers research, development, applications, and education in remote sensing and will become the centre for remote-sensing activities in Western Australia. Its first objective was to acquire an operational, automated facility for receiving and achieving high-resolution picture transmission (HRPT) from the NOAA series of satellites.

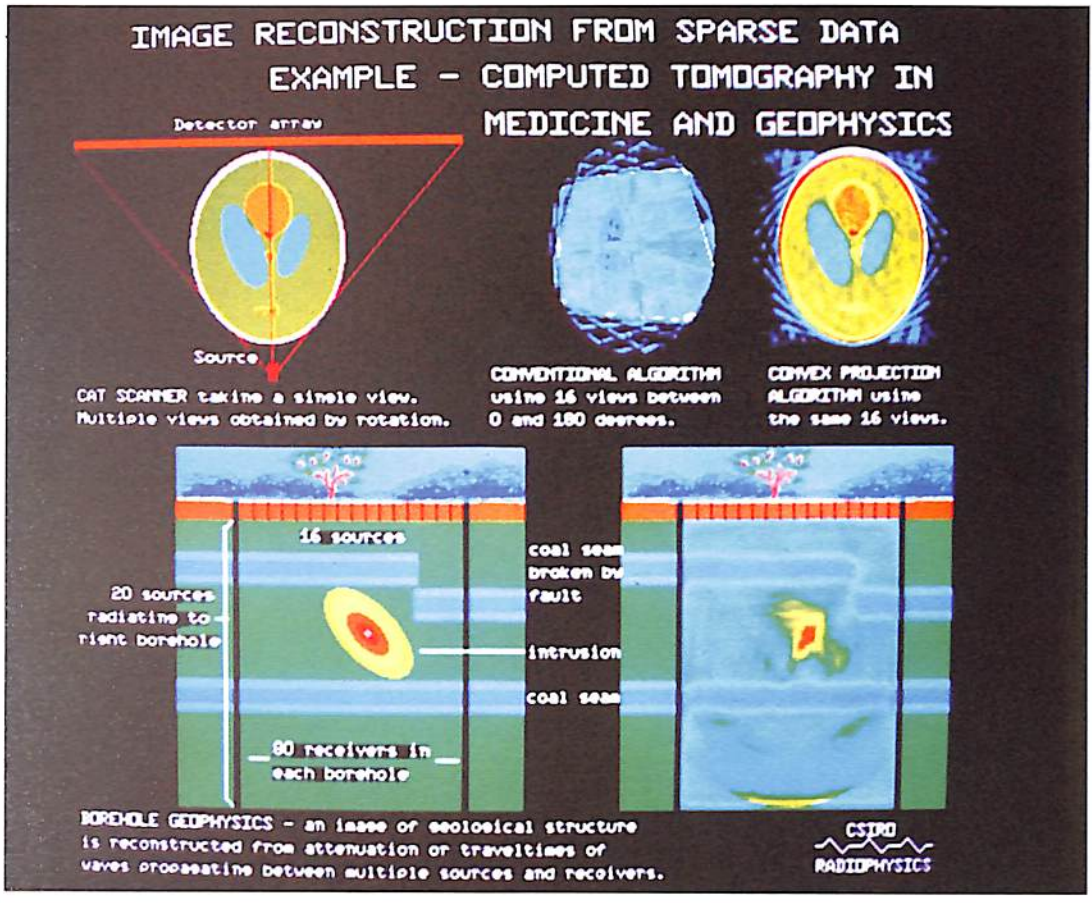
Three Divisions, Groundwater Research, Oceanography and Atmospheric Research, now have reception and processing systems to satisfy their research needs for data from NOAA environmental satellites. The Division of Oceanography can now also receive coastal zone colour scanner (CZCS) images from the Nimbus

A solar-powered data acquisition platform used in remote locations.





One of the new low-cost, lightweight Australia Telescope horns for L/S bands (1.25 to 2.5 GHz), 1 m wide at the aperture and 2 m long. Bands of aluminium (a) surrounding polystyrene foam discs are stacked to form the shape required (b). Sheets of fibreglass are bonded on (c) — by a professional boat builder — and with its finished coat of epoxy resin the horn is ready for testing (d).



An image produced on an image processor combines text with precomputed images and diagrams, created directly on the screen using a trackball.

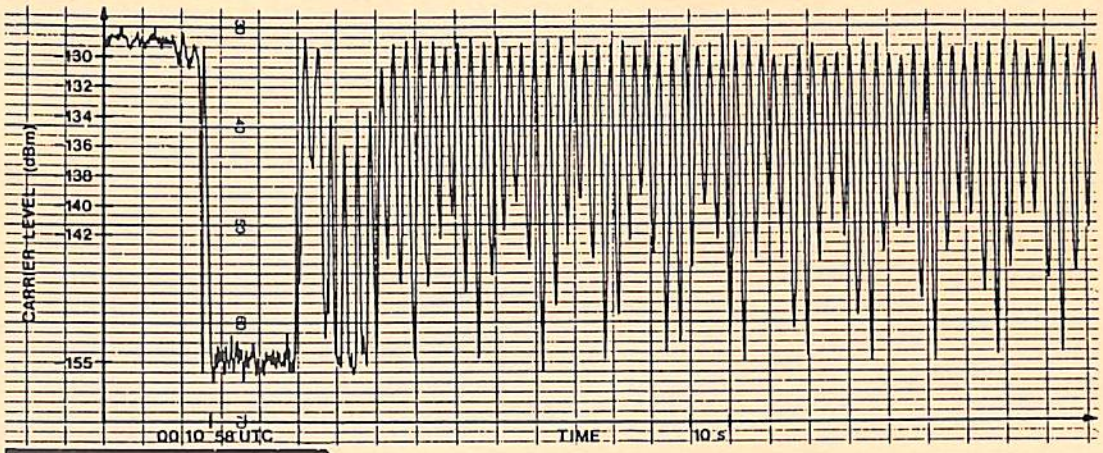
7 satellite. The hardware and software involved were developed within the Organization and have now been commercialised in collaboration with various Australian companies.

The satellite tracking antenna and associated data acquisition hardware for CSIDA (CSIRO System for Interactive Data Analysis) are being produced and marketed by PCM Electronics Pty Ltd under the name SAT-TRAC. In March 1986, PCM made its first sale — to the Bureau of Meteorology — after competing in open tender against various overseas companies. The image-processing component of CSIDA has been commercialised by the Dindima Group Pty Ltd, which has combined software development by CSIRONET and the Division of Atmospheric Research with state-of-the-art hardware to create a high-performance, stand-alone image-processing work station known as the Arlunya IW 1000.

Also during the year, the Victorian Country Fire Authority collaborated with the Division of Atmospheric Research on a research project investigating the use of satellite images in bushfire prevention. Using the Division's CSIDA facility, NOAA satellite images were analysed to provide a week-by-week vegetation index of Victoria. The images allowed the identification of areas of vigorous growth and subsequent drying off. The research is expected to lead to the use of satellite image processing as a routine tool for assessing bushfire risk.

Communication Satellite Facilities and Equipment

Radio astronomy research in the Division of Radiophysics has led to antenna design expertise that places it at the frontiers of satellite earth station technologies. Of special significance are the technologies developed for the Australia Telescope, due for completion in 1988.



A crucial role was played by CSIRO's 64-m radio telescope at Parkes, N.S.W., in Voyager's fly-by of the planet Uranus in January 1986, and the investigation of Halley's comet by the European Space Agency's Giotto spacecraft in March 1986.

For Voyager's encounter with Uranus, the Parkes telescope and NASA's telescope at Tidbinbilla, N.S.W., were linked to form one large telescope. Parkes' participation effectively doubled the amount of data received from Voyager.

In the Giotto Radio Science Experiment (GRE) the Parkes telescope was the primary receiving station for the mass impact data beamed back from Giotto via the Overseas Telecommunications Commission's satellite tracking station at Carnavon, W.A., to the European Space Operations Centre at Darmstadt, West Germany.

The fine quality of the Parkes recording provided unique information about the spacecraft's behaviour at encounter time. The above trace is the output from the Parkes receiver. The signal indicates that the spacecraft was hit several times before an impact that misdirected the high gain antenna, causing all on-board experiments to suffer at least some loss for 20 minutes. However, the Parkes record shows the GRE experiment suffered only a 20-second loss of signal.

In July 1985, the Minister for Science, the Hon. Barry O. Jones, and the Minister for Industry, Technology and Commerce, the Hon. John Button, announced the successful tenderers for key space technology contracts worth $20 million. A $15 million CSIRO contract went to Evans Deakin Industries Ltd for the construction of the Australia Telescope's seven 22-metre antennas. Six will be built at Culgoora, near Narrabri, N.S.W., to form a compact array and are due for completion in late 1987; the seventh will be situated at Siding Spring, near Coonabarabran, N.S.W., as part of the Long Baseline Array (LBA) linking Parkes and Culgoora.

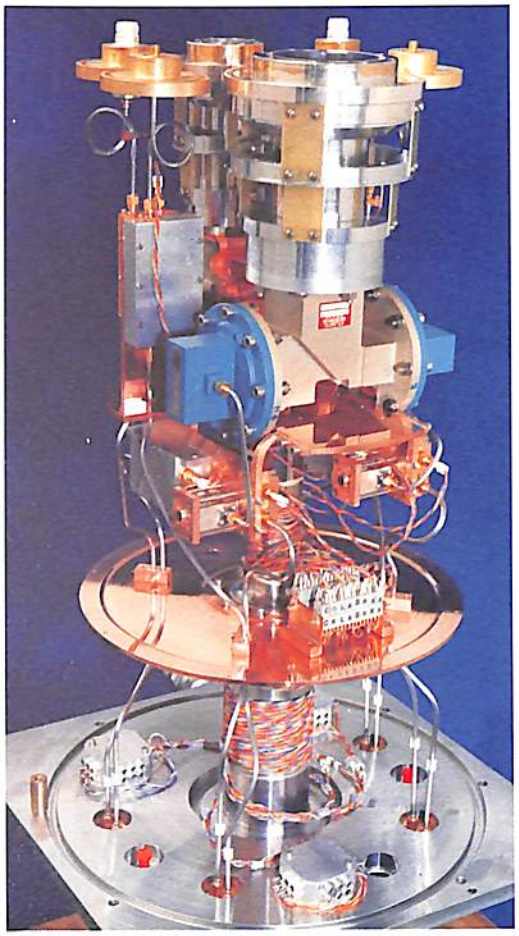
Another space technology contract, let by the Overseas Telecommunications Commission (OTC), concerned the design and construction of three 18-metre earth station antennas for the Intelsat network. The Division of Radiophysics will provide the specifications for the reflector optics and the feed system, including the design of the feed horn, advice about panel manufacture, and will participate in the antenna test program. It is collaborating in the contract with local firms, Macdonald Wagner and Johns Perry Ltd.

The Division also has a key role in the Intelsat Business Systems (IBS) project. This OTC development is being undertaken by a consortium comprising Codan, MITEC (University of Queensland), the University of Sydney, the South Australian Institute of Technology and CSIRO. The Division is developing the electromagnetic design for a 4.5-m-diameter antenna that requires high efficiency and low sidelobes to meet projected specifications. It is also developing the complete feed system, including horn and orthomode transducer, and is negotiating the manufacture of components by local industry. It will be responsible for developing and carrying out the earth station antenna test program. Part funding from OTC for this contract totals $295 000.

The Division has been contracted by AUSSAT Pty Ltd to develop multiple access antennas for the AUSSAT network.

Other Research Activity

- The Division of Chemical Physics, in collaboration with the University of Tasmania, has been exploring designs for spectrographs for the Lyman Space Observatory. The Division has also been involved in plans for an infrared imaging and sounding instrument for possible mounting on a second-generation AUSSAT satellite.
- The Division of Applied Physics has been collaborating with Johns Hopkins University in the U.S.A. in the construction of an imaging narrow-band spectrometer for remote-sensing and astronomical applications. It is expected to have considerable commercial potential, and Australian industrial involvement is being sought.
- Impending changes in the procedures used to transmit TV signals imply that the current widespread use of such signals to disseminate frequency standards will need to be altered. The Division of Applied Physics has been developing a new system that uses AUSSAT signals to disseminate frequency standards.
- In collaboration with a Canadian firm, the Division of Oceanography conducted an evaluation in Australian waters of the SARSAT search and rescue system during late 1985. Beacons were activated for extended periods at Jabiru in the Northern Territory and at Hobart, and were carried on two boats in the 1985 Sydney to Hobart yacht race.
- CSIRO has conducted a technical feasibility study for the reception of LANDSAT, SPOT, and ERS-1 data in Antarctica. The reception footprint of Casey, or Davis, together with the existing reception from Alice Springs, and from the station being established in New Zealand, would provide an exceptional ability to study atmospheric, oceanographic, and ice conditions at high southern latitudes. The facility would provide Australian industry with several unique opportunities to develop and commercialise the most up-to-date reception and image-processing technologies.
- The Divisions of Atmospheric Research and Oceanography and the Australian Bureau of Meteorology have put forward a joint proposal for the conduct of a feasibility study for a new remote-sensing instrument to be carried on future AUSSAT satellites. This instrument would provide two types of view: a full-disc view of the Earth, and a selected view of the Australasian region.
- WINDSAT is presently a conceptual design; it will measure the wind fields in the atmosphere using the light-scattering properties of atmospheric aerosols. As part of this project, the Division of Atmospheric Research and NASA conducted airborne and ground-based studies of southern hemisphere aerosol properties, using the CSIRO F27 research aircraft for the airborne studies.
- The Division of Radiophysics is participating in the QUASAT phase A studies, which began



in April 1986. QUASAT is an orbiting radiotelescope planned for launch in 1993. It will become an element in the world-wide system of synthesis telescopes. The Australia Telescope will be an important component of the total space/ground system. QUASAT should provide Australian industry with an important opportunity to participate in a state-of-the-art satellite involving a 15-m antenna in space (operating at frequencies of 1·6 GHz, 5 GHz, and 22 GHz), low-noise amplifiers, and extremely precise time and phase standardisation procedures. It is proposed that parts of the radio-frequency feed and part of the amplification system will be built by Australian manufacturers.

The Australia Telescope cryogenically cooled receiver to operate at 1.4, 2.3, 4.75 and 8.6 GHz at −250°C in a vacuum enclosure with thermal radiation shields, necessary to maintain inner temperature and to prevent ambient heat from entering.

12. International Aid

Despite its wealth and cultural links with the industrially rich countries of the northern hemisphere, Australia shares much with the world's poorer nations. A similar geographic position, geological history and an economy heavily dependent on primary production and mining provides a setting for Australia's research that is recognised by many Third World countries as being relevant to their own.

As a result Australian researchers are frequently sought to provide scientific advice to countries across a broad climatic and development spectrum. The importance of CSIRO's contribution was acknowledged in a review of the Organization's international activities in 1982, and the Executive decided that CSIRO should increase its involvement in development assistance programs. One of the initiatives implemented in response has been the registration of CSIRO as a consultant with the major development assistance banks and numerous United Nations affiliated organisations.

This initiative has been implemented not simply to generate a greater volume of international work for CSIRO — in fact some Divisions have now reached their limit for providing development assistance — but to increase the diversity of activities with which the Organization is associated.

Historically, because their work has relevance to the problems faced by developing countries, Divisions in the agricultural/biological areas and those concerned with the processing and utilisation of primary resources have always received a disproportionate number of requests for assistance. Raising awareness of the depth and breadth of CSIRO's skills and expertise will result in more opportunities for non-agricultural Divisions to participate in aid projects and for individual scientists to gain valuable overseas experience.

For those Divisions approaching their limit for providing development assistance, an increase in the total number of requests will improve the likelihood of finding a project compatible with the Organization's on-going research programs. Relevance to existing research is one of CSIRO's criteria when deciding on participation in aid programs.

Other criteria are the availability of appropriate staff and resources relative to existing commitments, cost recovery and the existing level of outside funding in relation to Divisional core programs. Research for application in developing countries normally represents an enhancement and extension of existing Divisional programs, but at all times the Organization strives to keep a balance between a Division's national and international priorities.

The CSIRO Centre for International Research Cooperation (CIRC) helps the Organization achieve this balance by assisting Divisions to appraise requests. CIRC is also responsible for briefing the Executive on policy and procedures for the Organization's participation in international activities and for coordinating the three major categories of its development assistance programs:

- participation in aid projects;
- training of scientists and technicians; and
- provision of scientific experts for short-term consultancies.

The Executive policy for recovering expenditure on development assistance was determined in 1982. The Executive considers that, while it is appropriate for CSIRO to participate in development assistance activities, it should not fund them. The Government has accepted as desirable a certain level of funding for this type of work, but does not aim to reach that goal through CSIRO's appropriation. The Australian Development Assistance Bureau (ADAB) and the Australian Centre for International Agricultural Research (ACIAR) are the specific funding agencies.

During 1985/86, in excess of $7 million were obtained from external sources for the Organization's involvement in aid-related programs. Most of this sum was for projects, but about $550 000 were earned by undertaking short-term consultancies and $300 000 for training activities.

Participation in Aid Projects

Despite an increase in the number of non-agricultural activities, agricultural research continues to dominate CSIRO's involvement in development assistance. With the establishment of ACIAR in 1982, the number of agricultural research projects has increased steadily each year. Currently, CSIRO has accepted responsibility for 34 ACIAR-funded projects, the first ones being initiated in 1982/83. Because they were planned with a time-frame of two to three years, the initial projects are now nearing completion. In future, the natural attrition of projects will probably match the numbers of CSIRO's new commitments.

The Organization undertakes both bilateral and multilateral projects, reflecting Australia's development assistance policy. CSIRO is undertaking bilateral projects in a number of

countries, including the following examples from Papua New Guinea, Indonesia and Kenya:

- CSIRO has a long tradition of scientific involvement with Papua New Guinea (PNG). In the 1950s and 1960s it conducted detailed surveys of soils, vegetation, landform and climate through some of the most remote river valleys and isolated highlands in the world.

  After independence, the previous emphasis on capital-intensive agriculture changed with the official recognition that subsistence agriculture and associated smallholder cash-crop production represented a most important sector of the PNG economy. In 1981, in the light of this recognition, the PNG Department of Primary Industry contracted the Division of Water and Land Resources to help with a fresh assessment of the large body of resource information available. The result: an information system based on cheap and simple microcomputer technology that can be used by operators with little or no previous computer experience.

  The techniques evolved in the project are applicable not only to other countries in the region, but to the humid equatorial tropics in general. The success of the approach has already been recognised by the Philippines Government who, in 1985, with financial assistance from ADAB, sent a group of 15 agricultural planners to a training course designed and run by the PNG project team in Canberra.

- CSIRO's largest and longest running bilateral development assistance project is the Project for Animal Research and Development (PARD) at Ciawi, near Bogor, Indonesia. Funded by ADAB, the Project began in 1974.

  The original objectives of PARD were the establishment of a new animal research laboratory, including construction of suitable buildings, training of local scientists, and development of a research program that would focus on solving animal production problems and demonstrate to Indonesian farmers ways in which they could increase the quantity and quality of their output.

Poultry research has been an important part of the Project for Animal Research and Development (PARD) in Indonesia.

Twelve years later, as the Australian input to the Project ends, the Indonesian Government's Research Institute boasts well equipped laboratories, an administrative block and extensive facilities for poultry and ruminant research.

Many young Indonesian scientists have gained valuable in-service training alongside experienced expatriate staff. More than 60 have undertaken formal technical and professional study, including about 40 who have obtained PhD or Masters' degrees in Australia.

- In its most recent bilateral project, CSIRO is using its knowledge of agriculture in the semi-arid tropics to assist agricultural scientists in Kenya to develop alternative, more stable, farming systems for the country's subsistence farmers. This project is funded by ACIAR and managed by the Division of Tropical Crops and Pastures, which has four of its project staff based in Kenya.

CSIRO's multilateral development assistance projects reflect the diversity of its activities and draw on its expertise in communication systems, primary industry, minerals and applied physics, as illustrated below:

- The Commonwealth Regional Renewable Energy Resources Information System (CRRERIS) is designed to facilitate the transfer of information on renewable energy resources among 18 Commonwealth countries in Asia and the Pacific. Liaison centres have been established in each of these countries and the Network Centre is at the Melbourne location of the Bureau of Information and Public Communication. CSIRO has established and is managing CRRERIS with funding by ADAB.
- The Seed Centre of the Division of Forest Research collects, tests, stores and dispatches seeds of Australian trees to developing countries under the provision of the Seeds of Australian Trees for Developing Countries project (SATDC), funded by ADAB. The supply of seeds is limited to small quantities for research purposes.
- Since 1981, another ADAB-funded project has been the supply of tropical pasture seeds and legume inocula for experimental trials to several countries in Asia, Africa and the South Pacific. In May 1986, this project was subsumed by the Forage Research and Development Program, which is funded jointly by ACIAR and ADAB. This Program, in addition to supplying pasture seeds, aims to strengthen research in pasture/forage production, to assist the publication, dissemination and application of research results, and to encourage closer scientific collaboration. The Program is located at the Division of Tropical Crops and Pastures.
- The aim of the project, On-stream Analysis and Control of Mineral Concentrators, is to provide training for mining engineers in the use of nucleonic systems for on-stream analysis of mineral slurries and in applying these systems to the control of mineral concentrators.

  This project, which is funded by ADAB and managed by the Division of Mineral Engineering, has involved two major training cycles: the first in 1983/84, the second in 1985/86. During this second cycle participants from eight countries of the Asia/Pacific region undertook training in Australia and the Philippines.

  The installation of the control equipment at a mine in the Philippines has resulted in a 3.6 wt% increase in copper/gold recovery, valued at $4 000 000 per year.
- Under the Regional Metrology Program the Division of Applied Physics, through its National Measurement Laboratory, is assisting nations in the Asia/Pacific region to establish or upgrade their national standards laboratories. This program is also funded by ADAB.

Training of Scientists and Technicians

In previous years ADAB acted as the principal funding agency for sponsored visits and training attachments to CSIRO. Although ADAB continues to provide this support, most training requests now emanate from United Nations agencies. This reflects an increased international awareness of Australia's capacity to provide these training opportunities, which usually involve an attachment to a CSIRO Division for a mutually agreed period.

In addition to a number of *ad hoc* training activities, CIRC has coordinated formal training programs with the help of several Divisions. Two of these programs originated as a result of recently stimulated collaboration between ASEAN scientific institutions and CSIRO, and developed under the aegis of the ASEAN-Australia Economic Cooperation Program (AAECP).

The first is a program on the use of biomass and low-grade coal resources for producing heat

ASEAN scientists at a CIRC research and development management training workshop.

and electrical power to develop and strengthen the research capability of ASEAN countries.

The various training programs are being conducted by the Divisions of Chemical and Wood Technology and Forest Research, Monash University, the Australian Mineral Development Laboratories and the Australian Coal Industry Research Laboratories Ltd.

During the first half of 1986, 20 trainees from various universities and research and development institutes completed programs on fluidised bed combustion, beneficiation and processing of low-grade coal, the standard method of testing cooking-stove performance, and the gasification of biomass.

The second formal training program relates to the management of research and development and began in 1985. The second phase of the four-year program was successfully completed in December of that year. Senior and middle-level research managers participated in seminars and workshops designed to increase knowledge and improve skills. ASEAN middle-level managers studied management practices in CSIRO Divisions and other Australian research institutions.

Short-Term Consultancies and other Activities

During 1985/86, CSIRO officers undertook over 50 consultancies in more than 30 countries.

Although CSIRO consultants usually need to travel overseas to provide their expert advice, two AAECP Joint Experts Meetings, coordinated by CIRC, were held recently in Melbourne. In August and September 1985, experts in biotechnology and materials processing from ASEAN countries and Australia discussed and reviewed project proposals and developed them for presentation to funding agencies.

CSIRO scientists serve on the policy, advisory and management committees of major Australian and international agencies, including ACIAR, the Consultative Group for International Agricultural Research, the Food and Agriculture Organisation and the World Health Organisation. The International Council for Control of Iodine Deficiency Disorders, which was formally inaugurated at Kathmandu in March 1986, now has its secretariat located at the Division of Human Nutrition. The Council will advise international agencies and countries, particularly in Africa and Asia, on control programs to prevent mental retardation arising from iodine deficiency.

In September 1985, Dr P.M. Room and his team at the Division of Entomology were awarded the prestigious UNESCO Science Prize for work on the successful biological control of the water weed salvinia, which had drastically disrupted the social and economic structure of Papua New Guinea's riverine communities.

Administration

13. Management

The management structure of CSIRO is expected to be changed soon by amendments to the *Science and Industry Research Act* 1949, following the ASTEC review (see chapter 1). The new structure will comprise a Board including a Chief Executive, a part-time Chairman and six to eight other part-time members. The Board will replace the present Executive, which comprises three full-time and five part-time members. Under present arrangements the Chairman is also Chief Executive.

The Executive is primarily concerned with:

- policies relating to the scientific and technical direction of the Organization and its internal management;
- definition of broad areas of research appropriate for CSIRO;
- designation of research areas for expansion, reduction and the taking of new initiatives;
- securing and distributing resources to major areas of activity;
- relationships with government, advisory bodies and major bodies representing industries and community interests;
- monitoring the effective performance of the Organization; and
- making senior appointments.

The research work of the Organization is carried out in five Institutes, each headed by a Director. Institutes are groupings of Divisions and Units with related research interests, headed by Chiefs and Officers-in-Charge, respectively. Divisions and Units are each responsible for a coherent set of research programs.

Institute Directors are responsible to the Executive for the management of their Institutes, with particular emphasis on priorities and objectives for research programs, resource distribution and organisational arrangements. Chiefs and Officers-in-Charge are responsible to their respective Directors for the management of their Divisions and Units, with particular emphasis on scientific leadership and the day-to-day allocation of resources to achieve agreed objectives and the implementation of the results of research. In addition, all Directors, Chiefs and Officers-in-Charge participate through committees and reviews in organisational decision-making beyond the confines of their immediate responsibilities.

Management Committee

The Executive is supported by a Management Committee comprising the three full-time members of the Executive, the five Institute Directors, other Directors, and the heads of the main elements of central administration.

The Management Committee provides advice to the Executive on corporate policies and strategies, and has authority to decide certain corporate management matters in its own right. These matters normally relate to the implementation of broad policies and strategies previously adopted by the Executive and affecting the Organization as a whole. The Management Committee deals with matters concerning the maintenance of scientific standards and the public standing of CSIRO. It also deals with certain matters that cross Institute boundaries.

Executive and Staff Changes

Executive Changes

Dr J.P. Wild, Chairman of CSIRO since 1978, retired on 24 September 1985. He was succeeeded by Dr N.K. Boardman, who was appointed as Chairman for an initial term of nine months and later for an additional term from 25 June to 31 December 1986.

The appointment of Mr Justice Kirby was extended to 31 December 1986, and the appointments of Professor A.E. Clarke, Dr K.J. Foley and Mr P.D.A. Wright were extended twice, first to 24 June and then to 31 December 1986. Mr G.G. Spurling's appointment was also extended twice, first to 8 June and then to 31 December 1986.

A vacancy for a full-time member existed on the Executive from 25 September 1985. Dr M.G. Pitman, Director of the Institute of Biological Resources, was appointed by the Executive to act as an associate member of the Executive during the vacancy.

Senior Staff Changes

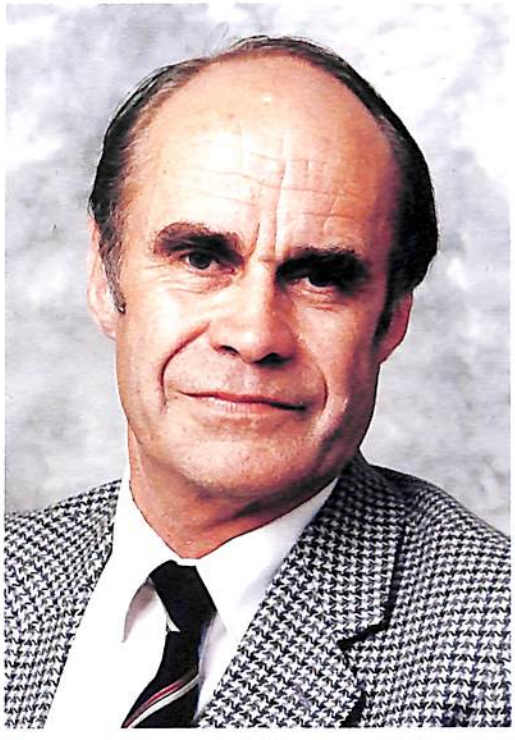
Dr K.A. Ferguson, Director of the Institute of Animal and Food Sciences, retired on 6 April 1986. Dr A.D. Donald, Chief of the Division of Animal Health, was appointed Acting Director for the period from 6 April to 30 June 1986.

Dr E.F. Henzell, Chief of the Division of Tropical Crops and Pastures, continued to serve as Acting Director of the Institute of Biological Resources until 30 June 1986.

Dr G.E. Thomas took up the appointment of Chief of the Division of Information Technology on 1 August 1985.

Dr P.J. Nestel commenced duty as Chief of the Division of Human Nutrition on 1 January 1986 for

Dr Alan Donald, Acting Director of the Institute of Animal and Food Sciences.



Dr 'Tommy' Thomas, Chief of the Division of Information Technology.

Dr Ted Henzell, Acting Director of the Institute of Biological Resources until 30 June 1986.

Dr Paul Nestel, Chief of the Division of Human Nutrition.

Professor Ming Leung, Chief of the Division of Fossil Fuels.

Dr Brian Embleton, Chief of the Division of Mineral Physics and Mineralogy.

a period of seven years. He succeeded Dr B.S. Hetzel, who retired on 31 December 1985.

Dr E.G. Bendit retired as Chief of the Division of Fossil Fuels on 27 June 1986. The appointment of Professor L.S. Leung of the University of Queensland has been approved for a period of seven years. He is expected to take up duty on 15 July 1986.

The appointment of Dr P.G. Alfredson as Chief of the Division of Energy Chemistry was extended for twelve months to 1 September 1987.

Dr B.J. Embleton was appointed Chief of the Division of Mineral Physics and Mineralogy for a term of seven years, to take effect from 10 April 1986.

Dr J.H.B. Christian's appointment as Chief of the Division of Food Research was extended to 31 December 1986.

Mr L.G. Wilson retired as Corporate Secretary on 5 July 1985. Dr N.J. Sullivan became Acting Corporate Secretary on 8 July 1985.

Administrative Review

Review of the Central Personnel Function

A committee to review the central personnel function was established in August 1985 in response to a proposal from the General Manager (Personnel). The Executive considered the recommendations of the committee in May 1986.

The Executive endorsed or agreed in principle to most of the recommendations of the review committee. In particular, it agreed that there was a need to encourage an active, forward-looking approach to personnel policy formulation, development and implementation. It also agreed that the Personnel Branch should continue to be recognised as the focus for issues of personnel policy and matters of general Organization-wide importance.

The Executive also supported recommendations for the Personnel Branch to become more involved in strategic planning where such planning could be applied to human resources in career planning, training and development, corporate succession analysis and performance counselling.

Other recommended measures supported by the Executive were the continued transfer of the operational aspects of personnnel work to Divisions and Units, and a program to foster participation by Divisions and Units in local industrial relations matters, including the provision of appropriate training for Divisional personnel. The Personnel Branch and Regional Personnel Officers will continue to concentrate on improving the cost-effectiveness of the delivery of personnel services at Divisional level. Improvements will be made in the timeliness of handling appeals and responses to requests for assistance from Divisions.

SIROTECH

SIROTECH Ltd has entered its second year of operation and by 30 June 1986 had a staff of 28, with expertise in marketing, law, industrial property, finance, and technology communication.

Joint ventures with an estimated total equity for CSIRO of more than $16 million negotiated by SIROTECH during 1985/86 included:

- An Australian-controlled joint venture formed between SIROTECH and Du Pont Australia. The new company, Dunlena Ltd, will enter the agricultural crop protection market by developing a range of CSIRO-invented pesticides. SIROTECH holds 51% of the shares on behalf of CSIRO. (Division: Applied Organic Chemistry.)
- Z-Tech Pty Ltd, a company formed by ICI Australia Operations Pty Ltd and SIROTECH to develop and manufacture zirconia products in Australia. (Division: Mineral Chemistry.)
- SIROCHEM, the result of a partnership between SIROTECH and the Australian Mineral Development Laboratories (AMDEL). It is a high-level chemical consultancy service specialising in advanced materials such as polymers, adhesives and pharmaceuticals, and will provide access to all AMDEL laboratories and the Division of Applied Organic Chemistry.

SIROTECH arranged over 20 major **collaborative**, **consultancy**, **licensing** and **royalty agreements** for CSIRO and provided advice on a further 200 agreements that CSIRO negotiated. Reference to many of the projects involved is made throughout this Report. Included was a joint venture between Elders IXL, Kumagai and TNT to undertake a pre-feasibility study on the proposed Sydney to Melbourne Very Fast Train.

A major initiative to encourage manufacturing industry and CSIRO to engage in mutually beneficial **collaborative research** is being managed by SIROTECH on behalf of CSIRO. The purpose of the CSIRO Manufacturing Industry Collaborative Research Program is to select projects that are of value to a number of companies or industry groups and to finance them from combined CSIRO and industry resources. Under the Program, comprehensive surveys of two industry sectors — automotive and automotive parts manufacture, and chemicals manufacture and plastics processing — have been conducted, with more to follow.

Examples of collaborative research under the Program are:

- the Division of Applied Organic Chemistry's research into the prediction of polymer properties and breakdown through the early detection of microscopic property changes. This project is of direct relevance to the chemicals and plastics industries, as well as to the motor industry; and
- the Division of Applied Physics' research into the use of rare-earth magnets in small electric motors, with support from local manufacturers in the automotive and robotics industries.

There has been a substantially increased level of provisional **patent** filings. In 1983/84, 43 provisional patents were filed; in 1984/85 and 1985/86, the number of filings were 73 and 71, respectively. The company expects this trend to continue. There has also been a rationalization of CSIRO's patent holdings, including the abandonment of 500 patent applications and patents. The rationalization allowed SIROTECH to reduce the level of expenditure in 1985/86 to $530 000. Revenue to CSIRO for the same period exceeded $900 000.

SIROMATH

Strenuous marketing efforts to widen SIROMATH Pty Ltd's client base and maintain a satisfactory level of consultancy work have continued. Over 75% of its work in 1985 came from the private sector. Collaborative research has continued between SIROMATH and the CSIRO Divisions of Mathematics and Statistics, Building Research, and Water and Land Resources.

SIROMATH again emphasised industrial statistics in its work. It helped to improve effectiveness and competitiveness in companies as diverse as IBM, Kodak and Australian Newsprint Mills. It assisted in setting up the Total Quality Management Institute, and has played a leading role in training courses and symposia in quality control.

The amount of work arising from surveys has increased substantially, with major projects being carried out for Telecom Market Research, the Federal Department of Health and the New South Wales Road Traffic Authority. Although this is a highly competitive area, SIROMATH has attracted projects because of its ability to carry out design and analysis as well as administration.

Other significant activities have included the sale of statistical software and the evaluation of computerised gaming devices for various regulatory authorities.

In 1985/86, the turnover for SIROMATH increased by some 20% to nearly $1.9 million, with a profit before audit of over $17 000.

Change in Shareholders

E.S. Knight and Co., one of the original shareholders, sold its shareholding in SIROMATH to AMDEL, which became a majority shareholder. It is proposed to introduce a staff shareholding scheme in 1987, but it is not intended that this will affect AMDEL's position as majority shareholder.

14. Personnel

A New Strategy

In September 1985, the Executive published a strategy for the Organization's development to 1990 and beyond. This strategy included the objective:

- to develop better management practices and more flexible staffing policies.

As the strategy paper states, the productivity and effectiveness of CSIRO depend heavily on the motivation of its staff and the management environment in which they work. Status and recognition are important contributing factors to this motivation, while the intellectual environment and research opportunities have enabled the Organization to employ innovative staff of world class. It is crucial that CSIRO continue to attract and retain staff of the highest quality.

But in these times of limited growth, or even diminishing resources, CSIRO needs greater flexibility in personnel management to give it the capacity to respond rapidly to changing national needs and to make more efficient use of staff. Historically, CSIRO's personnel policies have been tied to those of the Public Service. This has restricted CSIRO's ability to develop the personnel-management policies best suited to its objectives, role and funding arrangements.

ASTEC Review

CSIRO made a comprehensive submission on personnel issues to the ASTEC review of Public Investment in Research and Development. In calling for a new strategy on human resources, CSIRO argued that the frame of reference within which CSIRO personnel policies were made needed to focus more directly on CSIRO's management objectives. Policies which were simple derivations of those developed to meet Public Service needs were no longer acceptable. Areas identified in the submission as being in need of change included:

- the present incentives system (to render it more flexible);
- performance appraisal and staff counselling procedures (these needed to be pursued more systematically and tied directly to the incentives system);
- incentives to foster retraining, consulting and interaction with industry;
- policies which made for greater mobility between CSIRO and industry;
- superannuation matters and a scheme for the early separation of appropriate staff.

The ASTEC report, Future Directions for CSIRO, was published in November 1985. It gave substantial support to many of the personnel issues raised by CSIRO in the context of ASTEC's proposal for reshaping CSIRO to concentrate more on applications-oriented research coupled with the effective transfer of results to end-users.

ASTEC expressed concern about tendencies, especially in relation to negotiations over terms and conditions for research staff, that might be undermining the research environment. It stated that the costs in terms of efficiency and research quality of the imposition on research staff of cumbersome personnel-management procedures — designed for working conditions like those in the Commonwealth Public Service and apparently favoured by some staff associations — needed to be weighed carefully by CSIRO and by individual researchers, many of whom were members of those associations.

The report noted a tendency to apply certain conditions uniformly across all areas of public-sector employment, including CSIRO, without considering their impact on the research environment. ASTEC was particularly concerned about measures that limited mobility or weakened the principle of merit promotion for research staff. For example, it did not consider that preferential treatment for fixed-term appointees in selection for further appointment, or limitations on lateral recruitment in favour of internal promotion, were appropriate for scientific staff in CSIRO.

With respect to the Organization's statutory relationship with the Public Service Board, ASTEC supported the proposal that the relationship be ended, particularly if it helped to reduce pressures on CSIRO to introduce unsuitable conditions of employment.

The ASTEC report also emphasised the importance of CSIRO adopting staffing policies that enhanced flexibility and mobility while creating an environment conducive to higher-quality research. Some specified policies favoured in the report were that an increasing proportion of professional appointments should be on a fixed-term basis (including the suggestion that inexperienced research staff be given provisional fixed-term appointments), and that efforts to improve the Organization's staff appraisal system should be continued.

In response to CSIRO's submission, an early separation incentive scheme was recommended, its objective being to increase the Organization's flexibility by encouraging research workers to separate from CSIRO, thereby freeing resources that could be redeployed between programs. Such a scheme was also considered to be a means of reducing the proportion of staff on indefinite

appointment. The parameters of such an early separation incentive scheme are currently being examined by Government.

Enhancing Staff Creativity and Motivation

The Organization's submission to ASTEC and chapter 7 of the ASTEC report concentrated on personnel strategies designed to enhance the creativity and motivation of the Organization's staff. These included introducing new incentives for staff to perform well and making it easier for people to move between the Organization and other employers.

The incentives canvassed in the Organization's submission included the payment of bonuses, the sharing of property rights in inventions and the introduction of flexible classifications. ASTEC accepted that incentives represented a valuable way of motivating staff to work in appropriate areas of research. It recommended that in certain cases, property rights to, and income from, inventions should be divided between the inventors and CSIRO; bonuses were considered to be of considerable merit as a form of incentive to staff. ASTEC also called for regular performance appraisals to determine whether staff should remain at their existing levels or be reclassified upwards or downwards.

Mobility was considered to be an important way of improving the productivity of staff by providing a wide range of experience and diverse working environments. The Organization's view that current superannuation portability conditions inhibited mobility of research staff was shared by ASTEC, which recommended that suitable alternative arrangements be investigated. In addition, ASTEC recommended that short-term exchanges of staff with other organisations should be encouraged.

As a first step towards the implementation of the new strategy, CSIRO has begun studies of the areas mentioned above in the light of the ASTEC report and the Government's response. Changes in these areas will be considered in close consultation with the Organization's line managers, staff and staff associations.

Industrial Relations

In CSIRO, as in most areas of Australian government employment, most staff belong to a staff association or union. Relationships between these bodies and CSIRO are generally harmonious, despite the inevitable divergences of view over some issues.

Staff associations in CSIRO comprise two categories:

- 'in-house' staff associations whose members are drawn exclusively from the ranks of CSIRO officers; and
- associations whose members work for other employers as well as CSIRO.

Table 14.1 shows the distribution of CSIRO staff among the main staff associations as at 1 April 1986, in terms of potential and actual membership.

If CSIRO is to discharge its responsibilities to Australian industry and the community effectively it must have — in addition to the issues already mentioned — maximum flexibility to allocate work among the occupational categories engaged in research work.

The requirement for this flexibility relates to the impact of technological advances on work practices and to constantly shifting priorities in research programs. The ratios between different staff groups cannot be fixed: they will fluctuate according to the nature of the work to be done in individual projects at particular times. Recognition of the need for flexible staffing practices by staff and in-house associations has been a unique feature of CSIRO.

The three in-house associations (covering 78% of CSIRO staff) have historically contributed to a cooperative industrial climate, primarily because they appreciate, and identify with, the problems in research management. Because of their knowledge of the work and the work environment, these associations can also deliver a particularly useful service to their members.

Relations with non-CSIRO-based associations and unions reflect their very small memberships in CSIRO and their concern with issues affecting the vast majority of their membership, elsewhere in Commonwealth employment.

CSIRO has noted the support given in the Hancock Report to large and powerful unions. While rationalisation is a valid strategy in seeking to reduce demarcation disputes in particular industries, its impact on CSIRO seems likely to be disadvantageous if the expansion of certain unions leads to inappropriate coverage. The Executive is aware that aggressive external unions are seeking to press coverage of certain categories of CSIRO staff. In the event of their success, industrial disputation could well become a problem.

In the Executive's view, given the history of CSIRO's industrial relations, the promotion of in-house associations is in the best interests of research management and staff. The Executive is

seeking the establishment of a single CSIRO staff association with coverage of the majority of CSIRO staff, and has commenced negotiations to this end. While it will seek to promote a stronger in-house staff association, the Executive also believes that the membership of unions is a matter of personal choice.

One initiative in industrial relations during 1985/86 was the introduction of trials with industrial democracy (see chapter 15). The Executive also decided that greater emphasis should be placed on the resolution of industrial problems at the workface. These initiatives were designed to reduce dependence on the central resolution of issues that could be effectively dealt with between local management and the staff affected, in cooperation with the relevant staff association, and were in line with a general trend of devolution of responsibility to Divisions from the central administration.

Collaboration with Universities

The ASTEC report stressed the importance of increasing collaboration with Australian universities and other institutions conducting research. Such interaction is seen as particularly important in a country as large as Australia, where research centres exist in relative isolation from each other. This geographic dispersion contributes to fragmentation of the national research effort.

CSIRO and the Australian universities have long recognised the need for active collaboration in both research and the training of research workers. The *ad hoc* nature of many of the existing arrangements prompted the establishment in 1979 of a joint committee of representatives of CSIRO and the Australian Vice-Chancellors' Committee (AVCC) to examine mechanisms for formalising this cooperation. In March 1986, an Executive seminar on CSIRO/university interaction was held. The seminar program — developed jointly by CSIRO and the AVCC — addressed the following issues:

- developing a joint approach to meet national needs
- collaboration in training and research
- gaining public support
- the way ahead.

Participants concluded that CSIRO and the universities should maintain an overlap of interests in basic, strategic and applied research so that national needs could be identified and explored. Concern was expressed at the drift of PhD graduates overseas. It was felt that the adverse effects of this trend could be reduced by encouraging a greater exchange of post-doctoral research workers with overseas universities. Other initiatives considered worthy of further consideration were the formation of research networks and more Special Research Centres. Attention was given to systems for rewarding research workers and the commercialisation of research results.

Collaborative research funds: An important initiative of the joint CSIRO/AVCC committee was the establishment, in 1982, of the Collaborative Research Grants Scheme. Disbursements under the Scheme in 1985/86 amounted to $1.23 million, contributed equally by CSIRO and the 12 participating universities. The ASTEC report recommended that the Scheme be expanded to other universities and suitable higher-education institutions. Following the Executive seminar in March, the number of institutions participating has increased to 23, with disbursements under the scheme to total $1.83 million in 1986/87.

The Scheme aims to strengthen CSIRO and university research activities by encouraging greater interaction between relevant research groups, particularly where complementary strengths can be brought together. To this end, the funds are used to promote the development of new linkages between groups which have not previously collaborated, as well as strengthen existing linkages.

Training of research workers: The ASTEC report noted that '....CSIRO, the universities and other degree-granting institutions should cooperate more actively in making CSIRO's facilities and research staff available for training research workers at the doctoral and post-doctoral level'. The collaborative research projects have contributed to this goal by providing greater opportunities for students to spend a portion of their time in CSIRO's industry-oriented Divisions.

Apart from these collaborative projects, CSIRO plays an ongoing role in training research workers through its post-doctoral and post-graduate awards, and by providing joint supervision to PhD students on many other projects. CSIRO benefits from the stimulus brought to a project by able young researchers while, in turn, giving university students access to a broad range of research skills and facilities.

Two initiatives in 1985/86 should be noted. In October 1985, a scheme of vacation scholarships was expanded to accommodate all Divisions wishing to offer such scholarships to research students. The scheme gives promising under-graduates an opportunity to undertake a significant piece of research work under the

supervision of scientists in CSIRO laboratories. The research undertaken must be in a field of mutual interest to the Division and to the scholar.

Vacation scholarships are aimed primarily at currently enrolled undergraduates who have completed not less than three years of a full-time undergraduate course prior to continuing their studies towards an honours degree. The scholarships are offered for a period of at least eight weeks during the December-February vacation. Stipends may be paid within the range $150–200 per week, and Divisions may provide reasonable assistance with travel and accommodation. Sixty-nine students participated in the scheme in the 1985/86 university vacation.

The second initiative was finalised in June 1986. A scheme of volunteer fellowships will enable CSIRO Divisions to respond to requests from professionally qualified people wishing to gain research experience by working in the Organization's laboratories on a voluntary basis. The scheme will contribute to the performance of CSIRO's role in training research workers by providing practical experience which would not otherwise be available to the volunteers.

Equal Employment Opportunity

The 1983/84 Annual Report outlined an Executive decision to adopt a strategy for implementing full equal-employment opportunity (EEO) principles in CSIRO, following an inquiry into the status of women in CSIRO undertaken by a sub-committee of the Consultative Council. Although the main thrust of the strategy deals with problems facing women in CSIRO, it is equally concerned with removing both conscious and unwitting discrimination against other target groups (i.e., disabled people, Aboriginals and Torres Strait Islanders, and migrants). In essence, the strategy is designed to ensure that the people recruited as staff are of the highest quality and that, once recruited, equally qualified staff have equal opportunities to develop and progress within the Organization.

In March 1986, the Executive adopted a formal EEO management plan for CSIRO. The plan resulted from consultation with staff associations through the EEO sub-committee of the Consultative Council. The objectives of the plan are consistent with government policy and national objectives in matters of equity. The plan proposes strategies that make EEO a line-management responsibility; those responsible for managing and supervising staff at every level have obligations to assist in the successful implementation of the Organization's EEO policies and programs.

The only designated target group about which CSIRO has known data is women. An analysis of data for women reveals that the affirmative action program in CSIRO is producing positive results (see Table 14.2).

A study of the Organization's potential applicant pool in the occupational categories shown in Table 14.2 is being carried out with the aim of having recruitment figures reflect the available pool by about 1991.

During 1986 CSIRO decided to participate in an EEO census to be conducted in the Australian Public Service and other parts of the Commonwealth workforce. Participation should provide access to additional data on target groups that will assist in the design of effective affirmative action programs.

Throughout the year EEO seminars were conducted at most CSIRO locations in Australia. These seminars dealt with general EEO principles and also concentrated on their application to recruitment and selection practices. An effective communication network has been established through EEO contact officers to facilitate the achievement of the Executive's overall strategy and management plan.

Table 14.1 Union Membership

Staff association	Potential members	Actual members	Actual as % of potential
CSIRO Officers Association	2993	2520	84.2%
CSIRO Technical Association	2218	1405	63.3%
CSIRO Laboratory Craftsmen Association	407	290	71.3%
Administrative and Clerical Officers Association	507	281	55.4%
Australian Public Service Association (Fourth Division Officers)	915	171	18.7%

Table 14.2 Comparison of Percentage of Women in Selected Occupations 1983–1986

Category	June 1983 %	June 1986 %
Research staff	3.3	4.0
Experimental scientists	12.0	14.4
Technical staff	27.0	29.3
Administrative officers	10.6	24.4

15. Consultative Council

The CSIRO Consultative Council, a forum for consultation between senior management and staff associations, meets in April and October each year. A number of sub-committees meet more frequently to examine issues in detail. During 1985/86, sub-committees of the Consultative Council comprised: Equal Employment Opportunity, Industrial Democracy, Staffing Policy, Remote Localities, and Terms and Conditions of Service. The Council is chaired by Dr N.K. Boardman, the Chairman of CSIRO. The Deputy Chairman is Mr R.D. Bond, President of the CSIRO Officers Association.

The Consultative Council's regular meetings were held in Canberra in October 1985 and in Sydney in April 1986. A special meeting was held in Canberra in December 1985 to discuss the ASTEC report: Future Directions for CSIRO.

The most important matters discussed by Council included the continuing development of equal employment opportunity programs, industrial democracy, and the ASTEC report.

Equal Employment Opportunity

The Equal Employment Opportunity Sub-committee recommended a formal equal employment opportunity management plan, which was endorsed by Council and adopted by the Executive in March 1986.

Industrial Democracy

After examining consultative arrangements throughout the Organization, the Industrial Democracy Sub-committee decided that mechanisms for consultation between management and staff at the local level should be developed. As a first step the Sub-committee made arrangements to introduce a pilot trial of consultative committees at Divisional level. Three Divisions — Entomology, Tropical Animal Science and Soils — were chosen to participate as they provided a sample of the three types of local management structure most common in CSIRO.

The objectives of the pilot consultative committees are:

- to provide a forum in each Division and Unit to enable management and staff to consult and discuss openly matters affecting staff;
- to improve mutual understanding of problems experienced by Divisional management and staff and to help resolve them.

The pilot committees comprise staff association and management representatives, including the Chief of Division or Officer-in-Charge. They meet regularly. Staff are able to have matters raised with consultative committees through their representatives and the committees will develop mechanisms for informing staff of their work.

Other Matters

The Consultative Council discussed in detail the ASTEC reports: Future Directions for CSIRO, and Public Investment in Research and Development in Australia. In addition to the special meeting of December 1985, Council representatives met on three occasions to discuss the ASTEC review and to exchange documentation on submissions to the review. The meetings served as a useful exchange of ideas and information that could be drawn on by the staff associations and the Organization in responding to the reports.

Meeting of a pilot Divisional consultative committee held at the Division of Soils in Adelaide in May.

16. Finance and Works

Property Rationalisation Program

The rationalisation program involving the Organization's property portfolio continued during 1985/86. Nine individual properties were disposed of and a number of leases relinquished.

CSIRO concluded negotiations for the surrender of the Karumba and Kimberley Field Station crown leases, with compensation expected during 1986/87 for the improvements made by CSIRO.

No properties were acquired in 1985/86, but arrangements were made for the lease of accommodation in Sydney and Melbourne for the recently established Division of Information Technology. Various other leases, ranging from grazing rights to laboratory space, and licence agreements to partition the Falkiner Memorial Field Station at Deniliquin, N.S.W., into three discrete areas for conducting individual research were also arranged during the year.

The valuation of the CSIRO estate for accrual accounting purposes, which necessitates individual appraisal of all properties and buildings owned by the Organization, is well in hand and expected to be reflected in the 1986/87 Financial Statement.

Operation of National Facilities

Oceanographic Research Vessel

The 55-metre oceanographic Research Vessel *Franklin* — now in service for over 12 months — is being managed by McIlwraith McEachern Operations Pty Ltd and Associated Steamships Pty Ltd on behalf of CSIRO under a $10 million, 5-year contract signed during the year.

The Minister for Science, the Hon. Barry O. Jones, approved the appointment of an interim steering committee as the permanent National Facility Steering Committee under the chairmanship of Professor D.H. Green, of the University of Tasmania.

The operation of the *Franklin* as a national facility for use by the Australian marine-science community has proved most successful, with several research programs being undertaken during the year in north-eastern Australian waters. Some predictable teething troubles with equipment on the vessel have been experienced, but disruptions to research programs have been minimal.

Australia Telescope

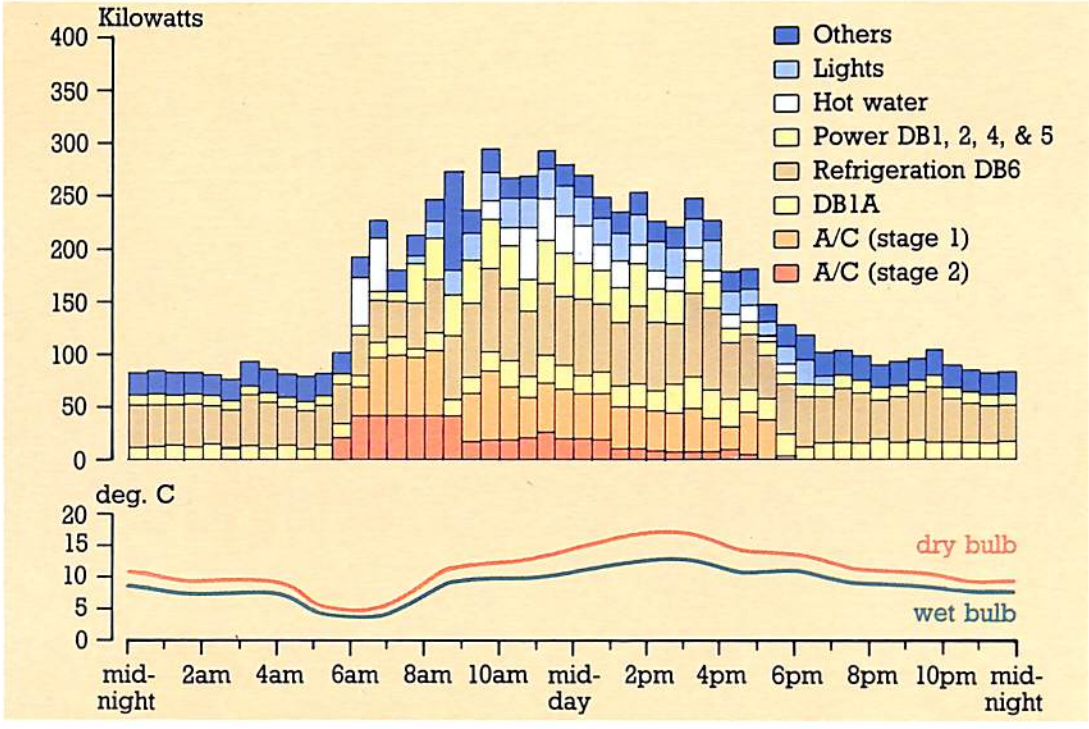
Contracts were negotiated with Roberts Construction Ltd for civil works, costing $3.57 million, at the Culgoora, N.S.W., site of the Australia Telescope, and with Evans Deakin Industries Pty Ltd for fabrication and construction of antenna elements, costing $15.2 million. The civil works contract is almost complete; progress with the antenna-elements contract remains on schedule.

Buildings

Clayton Laboratories

During the year, the Division of Materials Science laboratories at Clayton, Vic., were completed at a cost of $10.3 million. Occupation took place

The Research Vessel *Franklin* at Woolloomooloo Wharf, Sydney. (Photograph: Geoff Bagnall, Sydney Morning Herald.)



between August and December 1985.

Although CSIRO let a contract in July 1984 for the construction of the Division of Applied Organic Chemistry laboratories at Clayton, the project is behind schedule, with only 25% of the work having been completed — largely due to industrial disputes.

Floreat Park Laboratories

In August 1985, the Parliamentary Public Works Committee recommended that the existing CSIRO laboratories at Floreat Park, W.A., be upgraded and a new laboratory block built. Federal Parliament approved this recommendation in October 1985. A contract covering site works and refrigeration plant was let in March 1986. Tenders were called in June 1986 for the new laboratory block for the Laboratory for Rural Research. The current estimate of the project is approximately $9 million.

Capital Works and Property

The Division of Manufacturing Technology recently began its relocation from leased premises in Fitzroy, Vic., to a CSIRO-owned property — renovated at a cost of $1.5 million — in Preston, Vic.

Figure 3. Electrical demand profile — CSIRO Meat Research Laboratory (24.6.85).

The completion of a $1.3 million upgrade of the Katherine Field Station in the Northern Territory has allowed CSIRO to consolidate its agricultural research activities in northern Australia and to return the Kimberley Research Station at Kununurra to the Western Australian Government. Proceeds from the disposal of assets at Kununurra have been reinvested in development works at Katherine.

Work on an occupational health and safety project for the Division of Protein Chemistry is proceeding, the current estimate for the work being $1.8 million.

Completions at CSIRO's Black Mountain, A.C.T., site during the year were: the CSIRO Plant Molecular Biology Laboratory, costing $2.3 million, in March; and extensions to the value of $2 million to the laboratories of the Division of Environmental Mechanics in May.

Corporate Telecommunications Network

A corporate telecommunications network is being set up, through a contract with Telecom

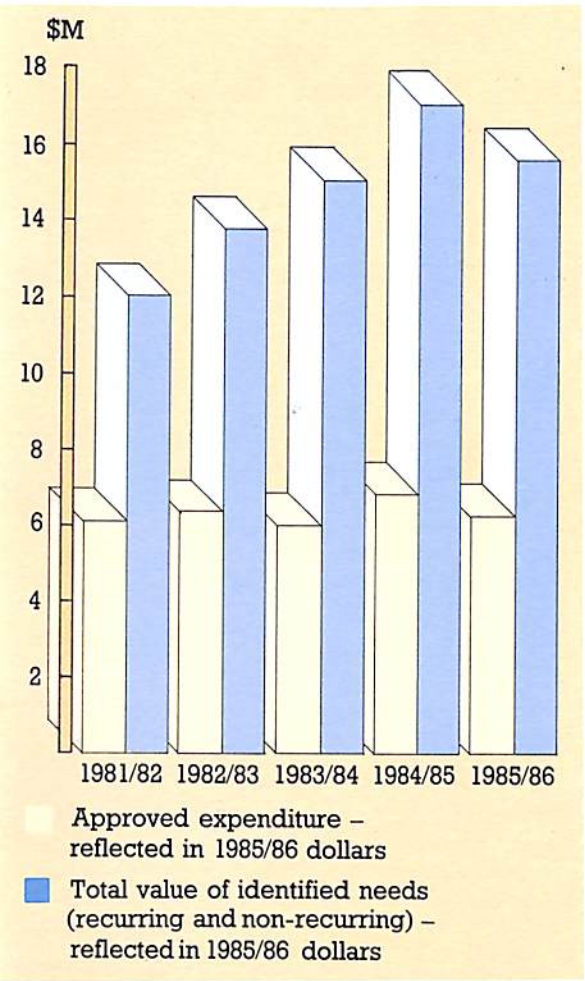


Figure 4. CSIRO repairs and maintenance expenditures 1981/82–1985/86.

Australia, to link major CSIRO sites in Canberra, Sydney, Melbourne and Brisbane, at a cost of $2.15 million. The network will result in significant savings on calls between the cities served and on local calls between CSIRO sites in each city.

The integration of data communications into the network, using modern digital PABX equipment, will lead to further cost savings and enhanced communications facilities for CSIRO.

Energy Management

The CSIRO Energy Management Unit, set up in December 1984, has implemented an energy management program progressively throughout the Organization during 1985/86.

The Unit organised introductory seminars on energy management in November 1985 for CSIRO employees in Brisbane, Sydney, Melbourne, Geelong, Hobart, Adelaide and Perth, followed by a conference for CSIRO Divisional engineers in May 1986 at which energy management was examined.

Energy audits are now being carried out at most CSIRO sites. At June 1986, estimated cumulative savings are in excess of $500 000. Sophisticated data acquisition and computing equipment provides a detailed analysis of energy consumption, as shown by the profile of electrical demand by the CSIRO Meat Research Laboratory in Figure 3.

The Commonwealth Department of Resources and Energy provided training aids and financial support for seminars conducted by the Unit.

Repairs and Maintenance

Since 1981/82, the level of financial resources provided by the Federal Government to CSIRO for repairs and maintenance has declined significantly in real terms. The impact on the Organization's building and plant assets has been:

- a steady deterioration in the quality of building fabrics and structures; and
- an increased level of breakdown and replacement of plant.

The deterioration in the level of repairs and maintenance funding is reflected in Figure 4.

The prospect of obtaining a greater level of funding remains unlikely in the present economic climate. CSIRO is examining the cost-effectiveness and efficiency of the present system for repairs and maintenance activities and is considering alternative methods of effecting repairs and maintenance with a view to achieving better value for the repair dollar.

Accrual Accounting

CSIRO agreed to accept the Guidelines for the Form and Standard of Financial Statements, issued by the Commonwealth Minister for Finance in 1983. The development of new financial systems is a major task, demanding considerable effort to identify financial information requirements, define accounting policy and determine methods to be employed in capturing and reporting the information in CSIRO.

The development of an on-line Fixed Assets System, managed by the Regional Administrative Offices, has allowed CSIRO to report the value of

the fixed asset holdings in its Annual Report for the first time this year.

Significant progress has been made in developing an enhanced Accounts Payable system, as well as in the introduction of a General Ledger package. These factors form part of the move by CSIRO towards sophisticated financial systems capable of producing more timely financial management information, in addition to accrual-based financial statements. Development of Accounts Payable and General Ledger systems was delayed during 1985/86 because of the limitations of available computer facilities.

Work began on a new automated Buildings and Property Register and a leave-accruals system during the year. Some accrual-based financial information is provided as an attachment to CSIRO's 1985/86 financial statements and full accrual-based financial statements will appear in the 1986/87 Annual Report.

Revised Administrative Arrangements

In June 1984, the Executive accepted in principle the recommendations of the committee reviewing CSIRO's administrative arrangements. As a result a plan was formulated for devolving to Divisions many of the administrative functions currently performed by the Regional Administrative Offices and CSIRO Headquarters in Canberra. These revised administrative arrangements were seen as providing better support for the devolved management strategy adopted by the Organization as an outcome of the Independent Inquiry into CSIRO in 1977.

The successful devolution of administrative functions depends on the development and implementation of modern computer systems. A time-frame of three to four years was envisaged by the review committee. Rapid initial progress was made in meeting the basic requirements for implementation — staff consultation; selection, acquisition and installation of computer terminals; and the establishment of a training capacity.

Stage I of the new payroll/personnel system was implemented in February 1985. Predictably, given the time allowed for the introduction of such a sophisticated on-line system, some teething problems were experienced. A major setback in mid-1985 was the inability of the CSIRONET Facom M190 to handle the new financial systems as well as the payroll. Although development and implementation of some of the smaller finance systems has continued, most effort has been directed to transferring the current finance systems from the Cyber 76 to the Cyber 840 and to securing these systems to complete the 1985/86 financial year.

While adequate security arrangements and testing procedures have now been introduced, shortcomings arising from the rapid implementation of the new systems prompted the Auditor General to criticise management planning for allowing the decommissioning of the Cyber 76 before fully tested and secure systems became operational on an alternative computer. A major effort is now being made to complete the new finance systems for operation on the CSIRONET Fujitsu M380 during 1986/87, with provision for 'front-end' financial inputting of transactions at the Divisions.

Implementation of the revised administrative arrangements has been complicated by the requirement for the concurrent introduction of accrual accounting. This has involved specifying and documenting new financial procedures and systems for the Organization.

Efforts are also being directed to introducing, as quickly as possible, some aspects of the revised administrative arrangements not dependent upon new computer systems, e.g. increased delegation to Chiefs and Officers-in-Charge in the purchasing/contracts area.

Impact of Devaluation on CSIRO's 1985/86 Budget

When the CSIRO budget for 1984/85 was established, $A1 would buy goods and services worth US$0.84. This value held fairly steadily until January 1985, when the buying power of the Australian dollar began a sharp decline. By the time the Organization's budget for 1985/86 was being set — some short time later — $A1 would buy goods and services worth only about US$0.65.

An analysis of CSIRO's expenditure in 1984/85 indicated that funds used, either directly or indirectly, to buy goods or services from overseas totalled $16.372 million. To maintain CSIRO's purchasing power at the same level would have required an increase of $4.94 million in the funds allocated for 1985/86. CSIRO sought some relief from this situation and was allocated an extra $905 000.

Expenditure

Expenditure from all funds under CSIRO's control amounted to more than $418.3 million in 1985/86. Of this amount, expenditure from funds directly appropriated by Parliament in 1985/86 accounted for 81% ($338.3 million). A further 12% ($49.6 million) was spent from funds provided by industry and other contributors. The remaining 7% ($30.4 million) of expenditure came from:

- revenue earned by the Organization
- unspent funds from 1984/85
- receipts from the Department of Primary Industry for its half-share of the operating expenses of AAHL.

This year's expenditure from appropriation and revenue funds for ongoing activities amounted to $336.7 million — representing an 8.3% increase over 1984/85, simply matching inflation.

Appropriation-funded capital costs during the year included expenditure on:

- redevelopment of the Floreat Park, W.A., laboratories
- continued construction of laboratories at Clayton, Vic.
- work on the Australia Telescope.

Expenditure funded by industry and other sources increased by 22% ($8.9 million).

Source of Funds and Expenditure

Source of funds	Salaries and general running expenses	Capital works and services and major items of equipment	Total
	$	$	$
Appropriation including revenue	336 655 257	32 035 157	368 690 414
NERDDC	1 017 899	–	1 017 899
Rural Credits Development Fund	446 861	–	446 861
Wool Research Trust Fund	13 518 868	415 363	13 934 231
Meat Research Trust Fund	4 657 462	849	4 658 311
Wheat Research Trust Account	952 901	–	952 901
Fishing Industry Research Trust Account	1 174 416	75 390	1 249 806
Other Rural Industry Research Funds	1 437 455	–	1 437 455
Contributions by private sector companies, public sector agencies, and others	25 789 611	159 894	25 949 505
Total	**385 650 730**	**32 686 653**	**418 337 383**

OFFICE OF THE
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G.P.O. Box 707
Canberra, A.C.T. 2601
Telephone 48 4711

F86/669

3 November 1986

The Honourable the Minister
for Science
Parliament House
CANBERRA ACT 2600

Dear Minister

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION
AUDIT REPORT ON FINANCIAL STATEMENTS

Pursuant to sub-section 57(3) of the Science and Industry Research Act 1949, the Commonwealth Scientific and Industrial Research Organization has submitted for audit report its financial statements for the year ended 30 June 1986. These comprise:

- Summary of Receipts and Payments
- Summary of Funds, and
- Notes to and forming part of the Accounts.

The statements have been prepared on a cash basis and in accordance with the policies outlined in Note 1 to the accounts and as such they do not comply fully with the Guidelines for the Form and Standard of Financial Statements of Commonwealth Undertakings approved by the Minister for Finance. The statements are in the form approved by the Minister for Finance pursuant to sub-section 57(3) of the Science and Industry Research Act 1949. A copy of the financial statements is enclosed for your information.

The statements have been audited in conformance with the Australian Audit Office Auditing Standards.

In accordance with sub-section 57(3) of the Act I now report that the statements are in agreement with the accounts and records of the Organization and, in my opinion:

- the statements are based on proper accounts and records, and
- the receipt, expenditure and investment of moneys, and the acquisition and disposal of assets, by the Organization during the year have been in accordance with the Act except as mentioned in Note 12.

In addition, the Organization provided Supplementary Accrual Accounting Information prepared in the form approved by the Minister for Finance pursuant to sub-section 57(3) of the Act. These comprise:

- Partial Statement of Assets and Liabilities
- Partial Statement of Activity, and
- Notes to and forming part of the Statements.

I have examined the supplementary information and in my opinion the statements are correct to the extent described in the related notes.

Yours sincerely
(Sgd.) J.V. Monaghan

J.V. Monaghan
Auditor-General

Commonwealth Scientific and Industrial Research Organization
Summary of Receipts and Payments for the year ended 30 June 1986

	Notes*	General Research Account	Specific Research Account	Other Moneys	Total
		$'000	$'000	$'000	$'000
Receipts					
Appropriations	2				
— Operational		312 405	–	–	312 405
— Capital		31 879	–	–	31 879
CSIRONET	3	9 149	–	–	9 149
Other receipts	4	12 424	50 612	4 601	67 637
Total receipts		**365 857**	**50 612**	**4 601**	**421 070**
Payments					
Headquarters	5	23 672	–	–	23 672
Research programs					
Institute of Animal and Food Sciences	6	57 223	16 717	–	73 940
Institute of Biological Resources	7	74 213	12 842	–	87 055
Institute of Energy and Earth Resources	8	42 432	6 774	–	49 206
Institute of Industrial Technology	9	38 310	9 710	–	48 020
Institute of Physical Sciences	10	52 933	1 516	–	54 449
National facilities	11	5 317	–	–	5 317
Bureau of Information and Public Communication	12	10 540	613	–	11 153
Repairs and maintenance	13	5 988	–	–	5 988
Capital works and services	14	32 035	651	–	32 686
Other	15	26 028	824	3 749	30 601
Total payments		**368 691**	**49 647**	**3 749**	**422 087**

* The accompanying notes form part of these statements.

Commonwealth Scientific and Industrial Research Organization
Summary of Funds for the year ended 30 June 1986

	Notes*	General Research Account	Specific Research Account	Other Moneys	Total
		$'000	$'000	$'000	$'000
Funds held 1 July 1985		9 454	11 531	731	21 716
Plus Receipts		365 858	50 612	4 601	421 071
Total funds available		**375 312**	**62 143**	**5 332**	**442 787**
Less Payments	17	368 691	49 647	3 749	422 087
Funds held 30 June 1986		**6 621**	**12 496**	**1 583**	**20 700**

* The accompanying notes form part of these statements.

Commonwealth Scientific and Industrial Research Organization
Notes to and forming part of the accounts for the year ended 30 June 1986

Note 1 — Statement of Accounting Policies

The financial statements have been prepared on a cash accounting basis in a form approved by the Minister for Finance under sub-section 57(1) of the *Science and Industry Research Act* 1949. This form does not accord with all requirements of 'The Guidelines for the Form and Standard of Financial Statements of Commonwealth Undertakings' issued by the Department of Finance. CSIRO has provided substantial accrual accounting information in the supplementary statements attached to the 1985/86 financial statements. Full accrual accounting financial statements in accordance with the Guidelines and Australian Accounting Standards are expected to be prepared in 1986/87.

Note 2 — Appropriations

1984/85 $		1985/86 $
291 494 000	Operational	312 405 300
33 228 000	Capital	31 879 000
324 722 000		**344 284 300**

Note 3 — Receipts, CSIRONET

1984/85 $		1985/86 $
8 300 555	Computing service charges	9 048 531
9 527	Receipts in respect of expenditure in former years	4 093
5 539	Miscellaneous receipts	96 740
8 315 621		**9 149 364**

Note 4 — Receipts, Other

1984/85 $		1985/86 $
	(i) General Research Account	
758 320	Sale of publications	775 018
3 248 481	Receipts in respect of expenditure in former years	663 099
569 216	Sale of produce, including livestock	497 330
452 056	Royalties from patents	914 249
503 070	Fees for tests and other services	536 125
1 163 938	Interest on investments	2 638 818
520 786	International consultancies	673 521
3 858 000	Department of Primary Industry's contribution to the cost of Australian Animal Health Laboratory	4 061 000
–	National facilities	21 600
–	Use of quantitative and scanning electron microscope	150 643
–	Disposal of fixed assets[a]	592 410
483 742	Miscellaneous receipts[b]	900 213
11 557 609		**12 424 026**
	(ii) Specific Research Account	
22 090 538	Rural Industry Research Trust Funds (Department of Primary Industry)	22 477 751
1 979 342	National Energy Research, Development and Demonstration Program (Department of Resources and Energy)	1 109 499
21 256 958	Other contributory funds	27 025 200
45 326 838		**50 612 450**
	(iii) Other Moneys	
	Funds made available by the Community Employment Program, Special Youth Employment Training Program, National Strategy for Aboriginals and other sources.[c]	
7 517 317		**4 600 899**

[a] In 1984/85, proceeds from the disposal of fixed assets were included with 'Receipts in respect of expenditure in former years'.

[b] Includes $190 000 that was appropriated in 1984/85 but not received until 1 July 1985.

[c] Includes interest from investments of $1 339 255, which will be allocated in 1986/87 between the Specific Research Account and Other Moneys.

Note 5 — Payments, Headquarters
(including Regional Administrative Offices)

1984/85 $		1985/86 $
	From General Research Account	
11 542 427	Salaries and allowances	13 899 796
557 154	Travelling and subsistence	919 934
702 248	Postage, telegrams and telephone	772 917
6 193 573	Other operating expenditure	7 540 586
389 350	Advisory Council	299 810
196 894	State Committees	239 419
19 581 646		23 672 462

Note 6 — Payments, Institute of Animal and Food Sciences

1984/85 $		1985/86 $
	(i) General Research Account	
628 340	Institute Headquarters	556 636
6 507 067	Animal Health	6 635 884
8 523 904	Animal Production	9 129 662
7 166 738	Australian Animal Health Laboratory	8 180 958
9 137 310	Fisheries Research	8 438 949
9 941 151	Food Research	10 423 425
3 558 190	Human Nutrition	3 963 358
3 055 613	Molecular Biology	3 177 946
6 085 617	Tropical Animal Science	6 083 285
604 098	Wheat Research	632 561
55 208 028		**57 222 664**
	(ii) Specific Research Account	
1 327 562	Animal Health	1 946 229
4 472 864	Animal Production	4 999 552
54 085	Australian Animal Health Laboratory	209 380
1 865 594	Fisheries Research	1 735 678
3 059 013	Food Research	3 734 549
210 725	Human Nutrition	279 985
317 277	Molecular Biology	587 000
1 317 419	Project for Animal Research and Development	965 359
1 006 709	Tropical Animal Science	1 790 721
501 314	Wheat Research	468 155
14 132 562		**16 716 608**
	(iii) Consolidated	
628 340	Institute Headquarters	556 636
7 834 629	Animal Health	8 582 113
12 996 768	Animal Production	14 129 214
7 220 823	Australian Animal Health Laboratory	8 390 338
11 002 904	Fisheries Research	10 174 627
13 000 164	Food Research	14 157 974
3 768 915	Human Nutrition	4 243 343
3 372 890	Molecular Biology	3 764 946
1 317 419	Project for Animal Research and Development	965 359
7 092 326	Tropical Animal Science	7 874 006
1 105 412	Wheat Research	1 100 716
69 340 590		**73 939 272**

Note 7 — Payments, Institute of Biological Resources

1984/85 $		1985/86 $
	(i) General Research Account	
530 140	Institute Headquarters	691 957
2 469 284	Centre for Irrigation Research	2 652 407
10 039 326	Entomology	10 567 451
8 679 147	Forest Research	8 509 817
2 825 108	Horticultural Research	3 068 366
–	National Bushfire Research Unit [a]	541 270
15 065 077	Plant Industry	15 865 189
8 009 381	Soils	8 477 822
9 386 616	Tropical Crops and Pastures	10 193 954
5 473 306	Water and Land Resources	5 718 589
7 471 913	Wildlife and Rangelands Research	7 925 963
69 949 298		**74 212 785**
	(ii) Specific Research Account	
240 227	Centre for Irrigation Research	315 900
3 586 389	Entomology	3 837 235
439 550	Forest Research	913 569
207 812	Horticultural Research	149 746
1 996 036	Plant Industry	2 854 904
323 624	Soils	462 481
1 292 391	Tropical Crops and Pastures	2 085 406
1 130 563	Water and Land Resources	1 404 365
692 582	Wildlife and Rangelands Research	817 949
9 909 174		**12 841 555**
	(iii) Consolidated	
530 140	Institute Headquarters	691 957
2 709 511	Centre for Irrigation Research	2 968 306
13 625 714	Entomology	14 404 686
9 118 696	Forest Research	9 423 386
3 032 920	Horticultural Research	3 218 113
–	National Bushfire Research Unit [a]	541 270
17 061 113	Plant Industry	18 720 093
8 333 006	Soils	8 940 303
10 679 008	Tropical Crops and Pastures	12 279 360
6 603 869	Water and Land Resources	7 122 954
8 164 495	Wildlife and Rangelands Research	8 743 912
79 858 472		**87 054 340**

[a] The National Bushfire Research Unit was created in 1985/86.

Note 8 — Payments, Institute of Energy and Earth Resources

1984/85 $		1985/86 $
	(i) General Research Account	
605 917	Institute Headquarters	702 950
5 170 450	Energy Chemistry	5 469 106
3 546 590	Energy Technology	3 707 318
5 654 539	Fossil Fuels	5 724 050
3 026 480	Geomechanics	3 320 428
2 904 705	Groundwater Research	3 111 328
5 278 893	Mineral Chemistry	5 092 361
4 248 563	Mineral Engineering	7 587 410
4 382 007	Minerals and Geochemistry	2 799 753
5 222 924	Mineral Physics and Mineralogy	4 917 126
40 041 068		**42 431 830**
	(ii) Specific Research Account	
237 054	Energy Chemistry	382 739
118 185	Energy Technology	49 547
713 245	Fossil Fuels	525 173
615 496	Geomechanics	1 382 915
126 395	Groundwater Research	271 302
693 570	Mineral Chemistry	524 375
929 180	Mineral Engineering	1 910 926
673 502	Minerals and Geochemistry	465 767
1 135 083	Mineral Physics and Mineralogy	1 261 186
5 241 710		**6 773 930**
	(iii) Consolidated	
605 917	Institute Headquarters	702 950
5 407 504	Energy Chemistry	5 851 845
3 664 775	Energy Technology	3 756 865
6 367 785	Fossil Fuels	6 249 223
3 641 976	Geomechanics	4 703 343
3 031 100	Groundwater Research	3 382 630
5 972 464	Mineral Chemistry	5 616 736
5 177 742	Mineral Engineering	9 498 336
5 055 509	Minerals and Geochemistry	3 265 520
6 358 006	Mineral Physics and Mineralogy	6 178 312
45 282 778		**49 205 760**

Note 9 — Payments, Institute of Industrial Technology

1984/85 $		1985/86 $
	(i) General Research Account	
257 870	Institute Headquarters	289 739
4 345 784	Applied Organic Chemistry	4 975 138
7 233 694	Building Research	7 511 101
7 375 691	Chemical and Wood Technology	7 866 645
4 885 492	Manufacturing Technology	5 694 068
5 519 625	Protein Chemistry	5 867 583
3 065 598	Textile Industry	3 126 968
2 810 185	Textile Physics	2 978 502
35 493 939		**38 309 744**
	(ii) Specific Research Account	
87 457	Applied Organic Chemistry	137 794
277 098	Building Research	373 262
703 964	Chemical and Wood Technology	841 520
98 361	Manufacturing Technology	259 675
214 712	Protein Chemistry	496 559
4 653 785	Textile Industry	5 132 575
1 958 663	Textile Physics	2 468 887
7 994 040		**9 710 272**
	(iii) Consolidated	
257 870	Institute Headquarters	289 739
4 433 241	Applied Organic Chemistry	5 112 932
7 510 792	Building Research	7 884 363
8 079 655	Chemical and Wood Technology	8 708 165
4 983 853	Manufacturing Technology	5 953 743
5 734 337	Protein Chemistry	6 364 142
7 719 383	Textile Industry	8 259 543
4 768 848	Textile Physics	5 447 389
43 487 979		**48 020 016**

Note 10 — Payments, Institute of Physical Sciences

1984/85 $		1985/86 $
	(i) General Research Account	
618 867	Institute Headquarters	1 002 706
15 160 026	Applied Physics	15 700 520
5 561 679	Atmospheric Research	5 639 598
315 276	Australian Numerical Meteorology Research Centre[a]	–
5 381 648	Chemical Physics	5 551 501
1 468 884	Environmental Mechanics	1 632 716
979 960	Information Technology	1 932 919
4 061 495	Materials Science	4 759 466
4 539 044	Mathematics and Statistics	4 568 423
4 512 787	Oceanography	3 936 249
7 233 628	Radiophysics	7 378 773
990 733	Research Aircraft Facility	829 927
50 824 027		**52 932 798**
	(ii) Specific Research Account	
234 441	Applied Physics	267 876
188 012	Atmospheric Research	203 949
21 209	Chemical Physics	–
34 414	Environmental Mechanics	67 920
15 183	Information Technology	9 271
310 347	Materials Science	368 047
1 093	Mathematics and Statistics	6 536
77 126	Oceanography	102 735
185 946	Radiophysics	489 808
1 067 771		**1 516 142**
	(iii) Consolidated	
618 867	Institute Headquarters	1 002 706
15 394 467	Applied Physics	15 968 396
5 749 691	Atmospheric Research	5 843 547
315 276	Australian Numerical Meteorology Research Centre[a]	–
5 402 857	Chemical Physics	5 551 501
1 503 298	Environmental Mechanics	1 700 636
995 143	Information Technology	1 942 190
4 371 842	Materials Science	5 127 513
4 540 137	Mathematics and Statistics	4 574 959
4 589 913	Oceanography	4 038 984
7 419 574	Radiophysics	7 868 581
990 733	Research Aircraft Facility	829 927
51 891 798		**54 448 940**

[a] Ceased to exist as a Unit in 1985/86.

Note 11 — Payments, National Facilities

1984/85 $		1985/86 $
	(i) General Research Account	
1 323 445	Australia Telescope	1 578 462
617 467	Research Vessel	3 738 837
1 940 912		5 317 299

Note 12 — Payments, Bureau of Information and Public Communication[a]

1984/85 $		1985/86 $
	(i) General Research Account	
299 490	Bureau Headquarters	334 163
6 093 548	Central Information, Library and Editorial Section	7 092 321
1 805 022	Science Communication Unit	2 198 296
856 839	CSIRO/University Research	915 000
9 054 899		10 539 780[b]
	(ii) Specific Research Account	
432 288	Central Information, Library and Editorial Section	462 563
86 272	Science Communication Unit	150 235
518 560		612 798
	(iii) Consolidated	
299 490	Bureau Headquarters	334 163
6 525 836	Central Information, Library and Editorial Section	7 554 884
1 891 294	Science Communication Unit	2 348 531
856 839	CSIRO/University Research	915 000
9 573 459		11 152 578

[a] Known in 1984/85 as the Bureau of Scientific Services.

[b] Sub-section 49(2) of the *Science and Industry Research Act* 1949 requires that the moneys of the Organization shall not be expended otherwise than in accordance with estimates of expenditure approved by the Minister. As at 30 June 1986, the Bureau of Information and Public Communication had exceeded the approved estimate by an amount of $173 080.

Note 13 — Payments, Repairs and Maintenance

1984/85 $		1985/86 $
	(i) General Research Account	
6 442 074	Repairs and maintenance	5 987 999

Note 14 — Payments, Capital Works and Services

1984/85 $		1985/86 $
	(i) General Research Account	
1 812 251	Acquisitions of sites and buildings	620 000
	Buildings, works, plant and development expenditure	
5 113 178	— Australian Animal Health Laboratory	361 982
11 480 832	— Other	13 193 579
	Major items of laboratory equipment	
479 240	— Australian Animal Health Laboratory	427 525
3 874 800	— Other	6 921 984
2 848 676	Construction of Research Vessel	570 597
3 220 556	Australia Telescope	8 934 821
–	Telecommunications network[a]	1 004 669
28 829 533		32 035 157
	(ii) Specific Research Account	
167 642	Buildings, works, plant and development expenditure	54 708
978 490	Major items of laboratory equipment	596 788
1 146 132		651 496
	(iii) Consolidated	
1 812 251	Acquisitions of sites and buildings	620 000
	Buildings, works, plant and development expenditure	
5 113 178	— Australian Animal Health Laboratory	361 982
11 648 474	— Other	13 248 286
	Major items of laboratory equipment	
479 240	— Australian Animal Health Laboratory	427 525
4 853 290	— Other	7 518 773
2 848 676	Construction of Research Vessel	570 597
3 220 556	Australia Telescope	8 934 821
–	Telecommunications network[a]	1 004 669
29 975 665		32 686 653

[a] Project created in 1985/86.

Note 15 — Payments, Other

1984/85 $		1985/86 $
	(i) General Research Account	
9 485 372	CSIRONET[a]	12 646 143
2 010 300	SIROTECH	2 456 825
160 934	CSIRO Office for Space Science and Applications	800 560
951 819	Centre for International Research Cooperation	1 121 455
872 326	Contributions	748 104
8 847 860	Miscellaneous (includes Auditor's Remuneration — see Note 20)	8 254 809
22 328 611		**26 027 896**
	(ii) Specific Research Account	
507 971	CSIRONET[a]	349 323
229 541	Centre for International Research Cooperation	474 845
185	Miscellaneous	–
737 697		**824 168**
	(iii) Other Moneys	
	From funds made available by the Community Employment Program, Special Youth Employment Training Program, National Strategy for Aboriginals and other sources.	
7 883 532		**3 749 135**
	(iv) Consolidated	
9 993 343	CSIRONET[a]	12 995 466
2 010 300	SIROTECH	2 456 825
160 934	CSIRO Office for Space Science and Applications	800 560
1 181 360	Centre for International Research Cooperation	1 596 300
872 326	Contributions	748 104
8 848 045	Miscellaneous	8 254 809
7 883 532	Employment schemes and other	3 749 135
30 949 840		**30 601 199**

[a] Expenditure for CSIRONET excludes the value of CSIRONET services provided to CSIRO users. See Note 18.

Note 16 — Funds Held at 30 June 1986

1984/85 $		1985/86 $
4 204 628	Cash at bank[a]	5 442 651
17 500 000	Deposits[b]	15 250 000
11 174	Advances	7 674
21 715 802		**20 700 325[c]**

[a] Does not include cash held at 30 June 1986 in Divisional Imprest Advances that were expensed in the year of formation.

[b] Deposits — represented by Interest Bearing Deposits with the Reserve Bank of Australia. See Note 21.

[c] Of the $6 621 488 funds held in the General Research Account, $6 133 886 (1984/85 $4 742 167) represents funds that had been appropriated to CSIRO but were not expended in 1985/86.

Note 17 — Payments

1984/85 $		1985/86 $
247 860 596	Salaries[d]	260 768 537
11 290 462	Travel	13 766 469
20 647 297	Assets	23 154 800
81 747 474	Other operating	96 755 029
26 779 384	Capital	27 641 683
388 325 213		**422 086 518**

[d] The Organization has entered into an arrangement with the Minister for Finance in accordance with section 159(2) of the *Superannuation Act* 1976 and has met all payments sought from it in accordance with that arrangement. The total salary expenditure includes expenditure of $35 870 661 (1984/85 $34 565 679) on the employer's share of superannuation.

Note 18 — CSIRONET Computer Services

1984/85 $		1985/86 $
	Receipts and payments relating to the provision of CSIRONET Computer Services are as follows:	
	Receipts	
4 600 000	CSIRO users	5 043 538
8 300 555	Other users	9 048 531
9 527	Receipts in respect of expenditure in former years	4 093
5 539	Miscellaneous	96 740
12 915 621		**14 192 902**
	Payments	
13 685 372	Operational expenditure	17 812 261
110 766	Capital expenditure	138 331
13 796 138		**17 950 592**

Note 19 — Moneys Held in Trust

1984/85 $		1985/86 $
	(i) Summary of receipts and payments for the year ended 30 June 1986	
566 566	Funds on hand 1 July 1985	791 015
284 442	Add Receipts	856 203
851 008		1 647 218
59 993	Less Payments	24 982
791 015	**Funds on hand 30 June 1986**	**1 622 236**
	(ii) Trust funds are represented by the following investments at cost and cash at bank:	
	Investments	
50 000	Commonwealth Inscribed Stock	50 000
12 200	State Electricity Commission of Victoria	12 200
96 000	Primary Industry Bank of Australia	96 000
584 622	Civic Advance Bank	1 091 000
742 822	Total investments	1 249 200
48 193	Cash at bank	373 036
791 015	**Total funds held 30 June 1986**	**1 622 236**
	(iii) The components of trust funds are as follows:	
100 000	William McIlraith Trust Fund	100 000
58 200	David Rivett Memorial Lecture Fund	63 507
602 615	F.D. McMaster Bequest[a]	1 384 700
27 700	Sir Ian McLennan Achievement for Industry Award	69 295
2 500	Other	4 734
791 015		**1 622 236**

[a] The F.D. McMaster Bequest consists of $1 050 000, of which $1 029 178 has been received, with the balance to be received as a final instalment.

Note 20 — Auditor's Remuneration

The total amount paid to the Auditor-General for the audit of CSIRO amounted to $175 700 (1984/85 $145 200). No other benefits were received by the Auditor-General.

Note 21 — Investments and Deposits — at cost

1984/85 $		1985/86 $
	Shares	
5 373	Griffith Producers Co-operative Co. Ltd	5 373
40	Griffith Co-operative Society Ltd	40
133	Primac Holdings Ltd	–
100 001	SIROMATH Pty Ltd[a]	150 001
82	Bioquip Ltd	82
–	Z-Tech Pty Ltd	15
–	Dunlena Pty Ltd[b]	350 001
156 585	Austek Microsystems Pty Ltd[c]	156 585
262 214		662 097
	Unsecured Notes	
380	CSBP and Farmers Ltd	380
	Interest Bearing Deposits	
17 500 000	Reserve Bank of Australia	15 250 000
17 762 594		**15 912 477**

[a] SIROMATH Pty Ltd. CSIRO holds a 37·5% equity shareholding in SIROMATH Pty Ltd, a private company established to provide high-level mathematical consultancy services, primarily to Australian industry. As at 30 June 1986, CSIRO had subscribed a total of $150 001 to the share capital of SIROMATH Pty Ltd.

[b] Dunlena Pty Ltd. As at 30 June 1986, CSIRO had subscribed a total of 350 000 shares at $1.00 par value. As part of the Agreement with the company, the shares were exchanged for patent rights at an estimated value of $10 million and an expenditure commitment of $5 million towards research.

[c] Austek Microsystems Pty Ltd. As at 30 June 1986, CSIRO holds 130 000 shares in Austek Microsystems Pty Ltd, which cost $156 585. In addition, CSIRO was allotted 250 000 shares for the assignment of licence rights and the value of these shares have not been included in the above values.

Note 22 — SIROTECH Ltd

SIROTECH Ltd is a non-profit company, limited by guarantee and governed by a board comprising nominees of CSIRO and its partners. The company was incorporated on 15 November 1984. SIROTECH's finances come mainly from an annual service fee negotiated with and paid by CSIRO to cover day-to-day commercial and intellectual property advice. During 1985/86, payments made by CSIRO to or on behalf of SIROTECH were $2 456 825 (1984/85 $1 484 784).

Note 23 — Executive Members' Emoluments

Emoluments or other benefits received or due and receivable directly or indirectly by full-time and other members of the Executive were as follows:

	1984/85 $	1985/86 $
Full-time members[a]	223 267	352 379
Part-time members	35 083	37 145
	258 350	389 524

These rates are in accordance with determinations of the Remuneration Tribunal.

[a] Includes $86 556, which relates to payment in 1985/86 of accrued entitlements upon retirement.

Certification of Statements

In my opinion the Statements of Receipts and Payments and Summary of Funds, together with the accompanying notes, provide a fair record of the financial operations of the Commonwealth Scientific and Industrial Research Organization for the year ended 30 June 1986.

N.K. Boardman
(Chairman)

G.I. Batchelor
(Manager, Management Services)

Attachments to Cash-based Financial Statements
Supplementary Accrual Accounting Information

The Supplementary Accrual Accounting Information consists of the following:

- Partial Statement of Assets and Liabilities
- Partial Statement of Activity
- Notes to and forming part of the Statements.

Commonwealth Scientific and Industrial Research Organization
Partial Statement of Assets and Liabilities as at 30 June 1986

	Notes	1985/86 $'000
Non-current Assets		
Fixed assets		
Land and buildings	2	554 281
Other fixed assets	3	83 174
Investments	4	662
Total Non-current Assets		**638 117**
Current Assets		
Cash on hand and at bank		6 083
Advances		21
Consumable stores	1.4	4 427
Debtors	5	3 212
Interest bearing deposits		15 250
Prepayments		3 162
Total Current Assets		**32 155**
Current Liabilities		
Accrued expenses		3 055
Creditors		9 885
Grants received in advance		16 148
Total Current Liabilities		**29 088**

The accompanying notes form part of these Statements.

Commonwealth Scientific and Industrial Research Organization
Partial Statement of Activity for the year ended 30 June 1986

	1985/86 $'000
Revenue	
Appropriations	
— Operational	312 405
— Capital	31 879
General operating revenue	12 424
Grants, contributions and donations	55 213
CSIRONET Operations	9 149
Total Revenue	**421 070**
Less Capital appropriation	31 879
Net Revenue	**389 191**
Expenditure	
Salaries	260 779
Travel allowances	13 768
Other operating	96 744
Total Expenditure	**371 291**
Excess of Revenue over Expenditure	**17 900**
Less Unfunded charge depreciation	9 127
Surplus/(Deficit) for 1985/86	**8 773**

This statement contains cash revenue and expenditure transactions for the year and 1985/86 depreciation charges.

The accompanying notes form part of these Statements.

Commonwealth Scientific and Industrial Research Organization
Notes to and Forming Part of the Statements for the year ended 30 June 1986

1. Statement of Accounting Policies

1.1 General

In accordance with the 'Guidelines for the Form and Standard of Financial Statements of Commonwealth Undertakings' issued by the Minister for Finance, it is necessary for CSIRO to prepare financial statements based on accrual accounting principles. As CSIRO was not in a position to immediately comply with the requirements of the Guidelines, a phased implementation period of two years was approved. Under this arrangement, CSIRO is expected to provide full accrual accounting statements in 1986/87. To indicate CSIRO's progress towards full accrual accounting, a partial statement of assets and liabilities and a partial statement of activity have been prepared and presented, with figures being rounded to the nearest thousand dollars. The partial statements are based on the best information available from the existing financial recording systems.

The financial statements do not contain the following information or Statements:

- Statement of Capital Accumulation
- Statement of Sources and Applications of Funds
- Provisions for long-service leave and annual leave
- Progress payments on construction contracts and capital equipment
- Capital commitments and contingent liabilities
- Accounting for finance leases.

1.2 Valuation of Fixed Assets

- Fixed assets, other than land and buildings, are valued at cost. Assets costing less than the threshold limit of $1000 are expensed during the year of purchase.
- Land and commercial, residential and rural properties have been valued by CSIRO's registered valuer as at 30 June 1986.
- Buildings have been valued by the Department of Housing and Construction and CSIRO officers as at 30 June 1986. The value of plant and fittings have not been separated from the value of buildings.
- Computer software, scientific glassware, experimental prototype equipment, and library monographs and serials are not capitalised as fixed assets due to either their uncertain useful lives or the uncertainty of benefits to be derived from their development.

1.3 Depreciation

Depreciation on fixed assets except land is calculated on a straight line basis, so as to write off the assets progressively over their estimated useful lives.

1.4 Consumable stores

Consumable stores are valued at cost.

2. **Land and Buildings** (see Note 1.2)

	1985/86 $'000
Land	68 105
Commercial, residential and rural property	15 291
Buildings	470 885
	554 281

Land ($17 100 000) and rural properties ($150 000) that are in Commonwealth titles and vested with CSIRO have been included in the above values, respectively.

3. **Other Fixed Assets** (see Note 1.2)

	At cost	Accumulated depreciation	Written-down value
	$'000	$'000	$'000
Transport equipment	8 783	957	7 826
Agricultural equipment	2 397	872	1 525
Computing equipment	38 750	21 261	17 489
Workshop equipment	6 969	3 055	3 914
Office equipment	6 459	2 383	4 076
General scientific equipment	88 339	40 128	48 211
Furniture	245	112	133
Total	**151 942**	**68 768**	**83 174**

(a) Fixed assets, comprising the research vessel (cost — $13.3 million) and Australia Telescope (progress cost — $8.6 million), which are classified as 'National Facilities', have been excluded from fixed assets.

(b) CSIRO have not been able to determine the value of fixed assets held by CSIRONET. Consequently these assets have been excluded from the total fixed asset values. Their asset values will need to be determined and brought to account in 1986/87.

4. Investments — at cost

	1985/86 $'000
Shares	
Griffith Producers Co-operative Co. Ltd	5
SIROMATH Pty Ltd	150
Dunlena Pty Ltd [a]	350
Austek Microsystems Pty Ltd [b]	157
	662

[a] Dunlena Pty Ltd. As at 30 June 1986, CSIRO had subscribed a total of 350 000 shares at $1.00 par value. As part of the Agreement with the company, the shares were exchanged for patent rights at an estimated value of $10 million and an expenditure commitment of $5 million towards research.

[b] Austek Microsystems Pty Ltd. As at 30 June 1986, CSIRO holds 130 000 shares in Austek Microsystems Pty Ltd, which cost $156 585. In addition, CSIRO was allotted 250 000 shares for the assignment of licence rights and the value of these shares have not been included in the above values.

5. Debtors

	1985/86 $'000
Specific research debtors	2 597
Accrued incomes	494
Sundry debtors	293
	3 384
Less Provision for doubtful debts	172
	3 212

The trade debtors of CSIRONET have not been determined as at 30 June 1986. Consequently these debtors have been excluded from the above debtors.

6. Resources Provided Free of Charge

Resources used but not owned by CSIRO as at 30 June 1986 include:

	1985/86 $'000
Land and rural property in CSIRO titles — at valuation by CSIRO's registered valuer as at 30 June 1986 [a]	10 009
Other fixed assets — at cost [a]	21 260
Land, property and buildings in non-CSIRO titles — at valuation by CSIRO's registered valuer as at 30 June 1986	13 974
	45 243

[a] These assets are purchased out of specific grants and in CSIRO titles. In accordance with the Grants Agreements, any sales proceeds from disposal of these assets shall be refunded to the grantor.

Advisory Council and State and Territory Committees

17. Advisory Council and State and Territory Committees — Advice and Activities

ADVISORY COUNCIL

The Advisory Council was established under the *Science and Industry Research Act* 1949. The function of the Council is to furnish advice to the Executive in connection with the following matters:

- the objectives that should be pursued by the Organization and the priorities to be followed to achieve those objectives;
- industrial or economic matters that may be of importance in formulating those objectives;
- the identification of the interests of the Australian community that may be furthered by the Organization; and
- any other matter that is referred to it by the Executive for advice.

During the year Council met three times and three meetings of the Chairpersons of State and Territory Committees and Standing Committees were held to discuss specific issues of Council's program.

Council received activity reports and advice from the Chairpersons of its five Standing Committees:

- Dr S.C. Bambrick, Mineral, Energy, Water Resources and Soils Standing Committee
- Dr V.A. Brown, Information and Social Impact Standing Committee
- Mr J.H.S. Heussler, Rural Industries Standing Committee
- Mr J.E. Kolm, Manufacturing Industries Standing Committee
- Professor P. Scott, Natural Environment, Renewable Natural Resources Standing Committee.

Changes in Membership

During the year Mr L.P. Duthie, former Secretary of the Department of Primary Industry, was appointed Australia's Special Trade Representative to Europe. Mr G.L. Miller succeeded Mr Duthie on Council from April 1986.

Mr D. Hartley, former Chairman, Hartley Computers Australia Pty Ltd, resigned from Council because of increased commitments to his business interests.

There were no additional appointments to Council's membership. Full lists of members appear in the next chapter.

Council Advice

During the year Council continued to interact closely with CSIRO in an informal manner by discussing research directions and results with Institute Directors at Standing Committee meetings. Although no formal advice was given to the Executive requiring response in terms of sections 34 and 57 of the *Science and Industry Research Act* 1949, Council expressed views in extensive correspondence between the Chairman of Council and the Chairman of CSIRO on the following important issues.

A Strategy for CSIRO 1985–1990

Council had especially welcomed the earlier initiative of the CSIRO Executive and Dr J.P. Wild's personal efforts to assess and document changes in the Organization's research directions over the previous five years and particularly to take stock of trends for the future.

During the past 18 months, Council gave its strong support for the Executive Discussion Paper 'A Strategy for CSIRO 1985–1990' and pressed for a determined emphasis on the completion and implementation of the Strategy. In extensive correspondence Council stressed a number of aspects, described below, that it continues to regard as critical.

The balance and concentration of CSIRO's research effort across the different industry sectors flow from program activity and often cannot be predetermined by any systematic means. There are, nevertheless, likely to be national indicators of the need for change, for example where new technologies, problems or opportunities emerge. Council continues to support the systematic application of selection criteria in determining research priorities and stresses that the potential of an industry to generate wealth and employment is a criterion for selection of areas of CSIRO research growth that needs emphasis over other criteria in the Strategy. Similarly, Council urges more positive statements of CSIRO's initiatives and efforts to interact with industry, while noting that the formation of SIROTECH Ltd was a major initiative to bring knowledge of industry's needs to CSIRO.

Council strongly endorsed the Executive's reference to the benefits of collaboration

between CSIRO and tertiary education institutions in terms of obtaining the best use of human resources and overall flexibility of employment.

Council reiterated its earlier stated view that the establishment of a Corporate Planning Unit was central to the implementation of the CSIRO Strategy and that the proposed Unit should be headed by a senior member of CSIRO management, reporting to the Chief Executive Officer.

CSIRO'S External Communication Activities

The State and Territory Committees and Council, through its Information and Social Impact Standing Committee, chaired by Dr V.A. Brown, have given considerable attention to the CSIRO review of this key subject. Dr Brown was also a member of the review committee established by the Executive in 1984 to report on CSIRO's external communication activities. On 2 August 1985, Sir Peter Derham wrote to Dr N.K. Boardman indicating Council's strong support for the overall thrust of the review committee's report and its emphasis on the need for a much stronger and more direct public communication role for CSIRO. Council stressed the need for the development of CSIRO's corporate image, with special emphasis on achievements. Council also saw a need for attention to the staffing implications of reorienting CSIRO's objectives towards closer integration with industry and the community generally, including if necessary some reallocation of current funding as a first step in the direction of improved external communication.

Growth Areas 1986/87 and Beyond

In December 1985, Council was asked by the Executive to comment on proposals from CSIRO Institute Directors for future research growth areas, including new policy proposals. Council was concerned about the relatively short time available for a proper examination of Institute proposals and decided to arrange a special committee meeting in February 1986 to enable Directors to explain their proposals.

As a result of that meeting, Council put forward views to the Executive on:

- the value of a more systematic approach in CSIRO to the identification and support of growth areas, and recognition that concentration of resources on research growth areas required an effective mechanism to protect other worthwhile and on-going programs as a necessary part of this approach;
- support for the use of the assessment criteria developed during the Strategy planning referred to earlier in this chapter;
- the need for 5-year targets to be stated clearly; and
- the value of outlining in an open and sensitive way the mechanism for freeing resources from lower-priority programs.

Future Directions for CSIRO — Report to the Prime Minister by the Australian Science and Technology Council (ASTEC)

As reported last year, Council prepared a substantial submission incorporating its views and those of the State and Territory Committees for the ASTEC review; unfortunately the ASTEC Working Party did not hold discussions with Council.

As the ASTEC report is currently under consideration it would be inappropriate to comment further, other than to record the considerable interest in, and support for, the Advisory Council's and the State and Territory Committees' work that has become apparent in the public arena.

Other Informal Advice and Comments

During the year Council has continued its role of providing comments on CSIRO Divisional reviews and sector reviews. Under its new guidelines the Executive has also drawn on Council and the State and Territory Committees for membership of review committees, with names put forward by Council's Chairman. It is pleasing to record that already two such reviews have been chaired by State Committee members.

Council's Rural Industries Standing Committee (RISC) made a major contribution to the conclusions and decisions of the reviews of CSIRO's plant research Divisions, particularly emphasising the need for more external consultation about research needs and expanded collaboration among CSIRO Divisions on research programs in progress. RISC underlined the need for continuing attention to the balance between tropical and temperate plant research.

The Mineral, Energy, Water Resources and Soils Standing Committee (MEWRS) held discussions with Institute Directors and the Convenor of a CSIRO working party on CSIRO's water resources research. These discussions, an Executive Discussion Paper on the subject and on-going reviews of Divisions involved in water

The Sir Ian McLennan Achievement for Industry Awards — a medal for the inventor of COALSCAN, Dr Brian Sowerby, and a plaque for the Division of Mineral Engineering — were presented at a ceremony in Sydney in December. Left to right are: Sir Ian McLennan, Dr Sowerby, Sir Peter Derham, Dr W.J. Howarth, Managing Director of Mineral Control Instrumentation Pty Ltd — the company that developed COALSCAN commercially — and Sir Bruce Watson, Chairman of MIM Holdings Ltd, a major user of COALSCAN.

research and related work are a major consideration of MEWRS at this time. Council believes that the direction of CSIRO's water resources research should be determined after an integrated program of consultation with the water and agricultural industries.

The Manufacturing Industries Standing Committee has continued to provide CSIRO with valuable comments on individual matters of research planning and on reviews with relevance to industry's needs.

Work of the Information and Social Impact Standing Committee has centred on the previously mentioned review of CSIRO's external communication activities, particularly in regard to the implementation of the review committee's conclusions.

The Natural Environment, Renewable Natural Resources Standing Committee has been examining ways of assessing CSIRO's environmentally associated research programs that flow across much of the Organization's work in all regions of Australia.

All of Council's Standing Committees have assisted CSIRO Institute Directors with comments on sectoral research papers that Directors prepared for the ASTEC review and in connection with CSIRO's Strategy for 1985–1990.

Sir Ian McLennan Achievement for Industry Award

In last year's Annual Report, the establishment of the Award was announced. Through the efforts of the Chairman, members of Council and State and Territory Committees and the generosity of the Founders and initial contributors, a substantial fund has been raised. Trustees have been appointed to manage the Award.

Applications for the inaugural Sir Ian McLennan Achievement for Industry Award were called for in July 1985 and the nominations received were of a very high standard. The medal and prize were presented in December 1985 to Dr B.D. Sowerby of the CSIRO Division of Mineral Engineering's Lucas Heights Laboratory for the highly successful transfer to industry of the technology underlying an innovative coal analysis system. The COALSCAN pair production instrument measures the dirt or ash content of coal during the washing and grading processes to ensure minimum wastage and a product of consistent known quality.

Given the interest in the inaugural Award, Council expects that it will be much sought after in the coming years and will serve as a significant incentive to CSIRO scientists to develop their research beyond the laboratory stage.

STATE AND TERRITORY COMMITTEES

New South Wales

The Committee met on five occasions during the year and continued to be heavily involved in promoting an awareness in industry of CSIRO's research activities. The Manufacturing Industry Sub-committee commenced a program to contact the chief executives and senior executives of selected companies to discuss the potential for collaborative projects with CSIRO. Several senior executives from the bread- and flour-making industry joined the Committee on a visit to the

CSIRO Wheat Research Unit and the Bread Research Institute.

During the year the Committee strengthened links with the New South Wales Science and Technology Council. The Executive Officer of the Council became a coopted member of the Committee, which has greatly facilitated the Committee's interactions with the New South Wales Government. Support from the Science and Technology Council has resulted in that Government reviewing previous decisions and agreeing to provide a teacher for a CSIRO Science Education Centre in Sydney. The Centre should be in operation by early 1987.

The Committee visited Newcastle and the Hunter Valley with senior CSIRO research staff. Visits were made to several industries, as well as to the Newcastle coal-loading facility and the N.S.W. Electricity Commission's Eraring power station. Flowing from these visits and previous activities involving the Hunter Development Board, the CSIRO Division of Textile Physics has begun collaborative research with National Textiles Limited.

Submissions were presented to the committees reviewing the Divisions of Applied Physics and Manufacturing Technology and to the CSIRO working party on pasture research in the temperate/mediterranean regions of Australia. In addition, the Committee commented on proposals for CSIRO growth areas for 1986/87, and several members held a discussion with the ASTEC Working Party on Future Directions for CSIRO.

The Committee was involved with CSIRO staff in developing a proposal for a CSIRO shop front in Sydney. It also undertook a negotiating role leading to CSIRO's involvement as the major guest exhibitor in the new Westpac Banking Museum currently being developed in The Rocks area of Sydney.

Northern Territory

The Committee met on three occasions during the year, twice in Alice Springs and once in Darwin. The Committee received presentations on the rangelands research work being conducted by staff at the Central Australian Laboratory and from the Director of the Division of Wildlife and Rangelands Research on current and future proposals for research effort by the Division.

A major Committee initiative during the year was the sponsorship of a workshop to consider future directions and priorities for tropical research within CSIRO. This evolved from the Committee's concern that CSIRO was directing insufficient research effort to Australia's tropical zone in relation to its area and resources.

The workshop, held at Mandorah, N.T., involved nine participants — three members of the Northern Territory Advisory Committee, three local CSIRO scientists, the Northern Territory Advisory Committee Secretary/ Technical Information and Liaison Officer, Dr O. Stanley, an economist at the New South Wales Institute of Technology, and Dr I.R. Noble of the Australian National University.

A report of proceedings and recommendations of the workshop was prepared and distributed widely within CSIRO for comment and consideration. The Chairman formally presented the report at a meeting with Institute of Biological Resources Chiefs during their visit to Darwin in September. Their response to the report's recommendations was extremely positive.

Queensland

During the year four meetings were held, as well as an informal meeting to discuss aspects of the ASTEC review. A meeting and seminar at Cairns in February reviewed current and proposed CSIRO research activity in far north Queensland. Three Chairpersons of the Advisory Council's Standing Committees attended and six CSIRO Divisions were represented. The Committee took the opportunity to view agricultural, fisheries and mining activities of some government and private organisations in the region: these included the Burdekin River dam project, gold mining at Kidston, and tropical fruit growing on the Atherton Tableland.

The Committee strongly supported a study project, Refuse Disposal in Small and Medium-sized Local Government Areas, funded jointly by the Division of Building Research, the Local Government Association of Queensland and the Department of Local Government and Administrative Services. The study began in July 1985. In April 1986, the study team demonstrated the preliminary computer-based refuse disposal optimising model to about 50 potential users at a seminar organised by the Committee in conjunction with the Caboolture Shire Council. After completion of the study the software will be marketed following a public launch and a user training seminar planned for October 1986.

Committee members contributed to several CSIRO reviews and participated on Advisory Council Standing Committees. Activities included discussions about growth areas in CSIRO's research, water resources research and environmental research.

South Australia

The Committee held six formal meetings and several *ad hoc* and sub-committee meetings during the year.

The Committee was actively involved in CSIRO-community interaction in several industry sectors. Members continued to support the Executive decision to relocate the Rangelands Research Laboratory to South Australia, and made considerable efforts liaising with CSIRO, the State Government, relevant departments and Technology Park, Adelaide, to expedite the move.

Another initiative pursued by the Committee concerned the development of the ornamental horticulture industry in Australia. The industry is growing rapidly but requires Australia-wide coordination and multidisciplinary and marketing research for healthy development. Its current environment of poor organisational support and industry structure presents a unique opportunity for CSIRO involvement. While discussion with the Division of Horticultural Research highlighted CSIRO's financial constraints for strong participation, the Committee suggested further action, including discussion at Federal and State level and a national industry workshop. This advice has been passed to the Advisory Council.

Two public sector/industry seminars were organised by the Committee. The first involved technical advisory services in secondary industry and examined the present and future levels of interaction between State, Federal and CSIRO services in South Australia. At the second seminar, Mr K.C. Richardson, from the Division of Food Research in New South Wales, addressed people involved in the food-processing industry in South Australia.

Other Committee activities included:

- a meeting with the consultant engaged to study the feasibility of setting up a Science and Technology Centre in South Australia; the consultant was also presented with information on CSIRO's research activities in the State;
- sponsorship of a further two CSIRO speakers from interstate to contribute to high-level discussions. One addressed a government-department-convened policy workshop; the other discussed interactions between the micro-electronics industry, Technology Park, Adelaide, and CSIRO;
- visits to, and discussions on the work of, Divisions in South Australia;
- provision of advice and input to the Advisory Council on matters such as the ASTEC review, the CSIRO Strategy, the Sir Ian McLennan Achievement for Industry Award and research growth areas.

The Committee has continued to work hard to maintain its relevance and direction for the benefit of the whole Organization. A feature of the future activities of the South Australian State Committee will be its close liaison with the Divisional advisory groups that have been established following the review of CSIRO's strategic research planning activities.

Tasmania

The Committee held three formal meetings during the year and sub-committees met as required. Among matters considered were submissions on the ASTEC inquiry, research growth areas, pasture research in CSIRO, water resources research and reviews of the Divisions of Mineral Chemistry and Manufacturing Technology.

In September, several members met Dr G.H. Taylor, Member of the Executive, and Mr B.J. Woodruff, of the Science Communication Unit, during their visit to Tasmania to explain CSIRO's future approach to public communication. The Managing Director of SIROTECH was invited to meet industry leaders and address the March meeting of the State Committee.

Committee members maintained an interest in the setting up of a Science Education Centre in Tasmania and early in 1986 a teacher was seconded to CSIRO from the Education Department to establish a Centre in time for the 1987 school year.

The Committee's major activity for the year was the public seminar held on 24 April, when four speakers, two from CSIRO, lectured on space science and its applications. The large audience comprised scientists from CSIRO and the University of Tasmania, members of technologically oriented government agencies, representatives of industry and secondary science students. The seminar was opened by the Premier of Tasmania, Mr Robin Gray. That evening, the State Committee hosted a dinner for prominent members of the Tasmanian community.

Victoria

The Committee held four meetings during the year and visited the Division of Building Research and the Dairy Research Laboratory of the Division of Food Research, accompanied by invited guests whose interests were related to the research of the respective Divisions. This enabled contact to be established with senior representatives of manufacturing and rural industry and government and semi-government authorities, and community leaders.

The meetings included special presentations on SIROTECH, the CSIRO proposal for a fast train between Sydney, Canberra and Melbourne, and CSIDA, a system for interactive data analysis developed by the Division of Atmospheric Research. Among the major issues considered during the year were the future role of the Advisory Council and State Committees and the proposals from the CSIRO Executive concerning the Organization's growth areas.

Members of the Committee have been active in Divisional reviews. Mr D.J. Constable was Chairman of the committee reviewing the Division of Groundwater Research, Mr R.D.E. Parry-Okeden, Chairman of the committee reviewing the Division of Manufacturing Technology, and Mr E.F. Sandbach, a member of the committee reviewing the Division of Applied Physics.

Committee members continued to seek support from industry for the Sir Ian McLennan Achievement for Industry Award.

On 13 November 1985, the Chairman of the Committee, Mr J.E. Kolm, addressed the annual conference of the Australian Industrial Research Group in Melbourne on ways to encourage closer contact between CSIRO and the Group.

Western Australia

The Committee met formally on six occasions and held a special meeting with Dr N.K. Boardman, Chairman of CSIRO.

Chiefs of the Divisions within the Institute of Biological Resources visited Perth in two groups during the year, meeting State Government, tertiary and industry groups and examining areas of possible collaboration.

The 1986 Brodie-Hall Address, 'Bringing Biology to Industry: CSIRO's Role', was presented in the Perth Cultural Centre by Dr M.G. Pitman.

While in Perth, Dr Boardman met the Minister representing the Premier and visited tertiary institutions, and attended a meeting of the State Committee.

Mr P.J. Dunstan (Director, Bureau of Information and Public Communication, CSIRO) reviewed the Community Leaders Program conducted at the Floreat Park laboratories and met government, media and business groups.

Other visitors who met the Committee and addressed specially convened meetings were: Dr G.E. Thomas (Chief, Division of Information Technology), Dr J.P. Wild (former Chairman of CSIRO), Dr G.H. Taylor (Member of the Executive) and Dr K.A. Ferguson (Director, Institute of Animal and Food Sciences).

Divisional representation in Perth was discussed during meetings with the Chief of the Division of Information Technology.

Representation was made for transferring a major segment of the Division of Geomechanics to Western Australia.

Current State Committee proposals include:

- a Science Education Centre for Western Australia
- appointment of a fishing industry liaison officer.

Submissions were made to review committees and working parties concerned with the following:

- Division of Groundwater Research
- Division of Manufacturing Technology
- Division of Mineral Chemistry
- pasture research in the temperate/ mediterranean regions of Australia
- water resources research in CSIRO.

A submission was also made, and the Chairman presented evidence, to the Parliamentary Works Committee regarding the proposed major laboratory complex at Floreat Park. The resultant approval for the complex greatly satisfied the Committee.

The Committee met two members of the ASTEC Working Party on Future Directions for CSIRO and subsequently the ASTEC Deputy Chairman. The Committee expressed concern about the ASTEC recommendations relating to the future of the advisory system.

The State Committee welcomed the appointment of three Committee members to Divisional advisory committees for the Divisions of Animal Health, Applied Physics, and Minerals and Geochemistry.

18. Advisory Council and State and Territory Committee Members

ADVISORY COUNCIL

Chairman

Sir Peter Derham, BSc, FAIM, LPIA, FInstD, former Managing Director, Nylex Corporation Ltd

Chairmen of State/Northern Territory Committees

G.I. Alexander, AO, BVSc, MSc, PhD, FACVSc, Director-General, Queensland Department of Primary Industries (*Queensland*)

R.A. Footner, AM, former Chairman and Joint Managing Director, Bridgestone Australia Pty Ltd (*South Australia*)

G.J. Hunt, BArch, Principal, Hunt, Giles and Partners, and Principal, Gary Hunt and Associates (*Northern Territory*)

J.E. Kolm, AO, FTS, IngChemEng, Consultant and Company Director (*Victoria*)

J.R. de Laeter, PhD, FTS, Associate Director, Division of Engineering and Science, W.A. Institute of Technology (*Western Australia*)

K. Satchwell, BSc, MSc, former Managing Director, AFL Holdings Ltd (*New South Wales*)

Professor P. Scott, OBE, PhD, LLD, former Pro-Vice-Chancellor, University of Tasmania (*Tasmania*)

Other Members

S.C. Bambrick, OBE, BEcon, PhD, Dean of Students, Australian National University

V.A. Brown, MSc, PhD, Director, Health Advancement Branch, A.C.T. Health Authority

L.P. Duthie, BCom, Secretary, Department of Primary Industry (until March 1986)

Professor P.T. Fink, CB, CBE, BE, FTS, Chief Defence Scientist, Department of Defence

A.M. Godfrey, BEcon, Deputy Secretary, Department of Industry, Technology and Commerce

D. Hartley, BE, former Chairman, Hartley Computers Australia Pty Ltd (until July 1985)

J.H.S. Heussler, Grazier

D.J. Ives, BSc, BEc, Deputy Secretary, Department of Resources and Energy

R.J. Kirby, AO, BE, Managing Director, James N. Kirby Holdings Pty Ltd

The Hon. M.J.R. MacKellar, BScAgr, MA (Oxon), MP, Member for Warringah

G.L. Miller, BAgrEc, MA, Secretary, Department of Primary Industry (from April 1986)

M.S. Shanahan, Farmer, Member of Australian Wheat Board

P.R. Staples, BApplSc, MP, Member for Jagajaga

W.J. McG. Tegart, PhD, FTS, Secretary, Department of Science

Observers

I. Castles, OBE, BCom, Secretary, Department of Finance (until April 1986)

Professor R.O. Slatyer, AO, FAA, FRS, Chairman, Australian Science and Technology Council

J.P. Wild, CBE, ScD, FTS, FAA, FRS, Chairman, CSIRO (until September 1985)

N.K. Boardman, ScD, FAA, FRS, Chairman, CSIRO (from September 1985)

Secretariat

E.N. Cain, BSc, PhD, Secretary
I.D. Gordon, Assistant Secretary
B. Magi, Administrative Officer

STATE AND NORTHERN TERRITORY COMMITTEES

New South Wales

K. Satchwell, BSc, MSc (*Chairman*), former Managing Director, AFL Holdings Ltd

C.S. Barnes, PhD, FTS, Research Manager, Biotechnology Australia Pty Ltd

C.G. Coulter, BE, ME, FIE, Manager, Development, New South Wales Electricity Commission

D.R. Dunk, Assistant Secretary, Health and Research Employees' Association

S.C. Hayes, BA, PhD, Senior Lecturer, Department of Behavioural Sciences, University of Sydney

W.J. Hucker, OBE, Chairman, Air Programs International Pty Ltd

D.J. McGarry, AM, BSc, Director, Australian Oil and Gas Corporation

D.R.H. MacIntyre, Grazier

K.P. Sheridan, BAgrSc, MSc, PhD, Member, New South Wales Public Service Board

D.A.J. Swinkels, PhD, Minerals Process Research Manager, BHP Central Research Laboratories

Professor A.R. Toakley, PhD, Professor of Building and Head of School of Building, University of New South Wales

R.A. Williams, BSc, Cotton Farmer

T.C. Clark, AASA, ACIS (*Secretary*), Regional Administrative Officer, CSIRO, Sydney

Northern Territory

G.J. Hunt, BArch (*Chairman*), Principal, Hunt, Giles and Partners, and Principal, Gary Hunt and Associates

P.L. Garton, Insurance Loss Adjuster

B.K. James, BA, Research Officer

G.A. Letts, CBE, DVSc, former Director, Conservation Commission of the Northern Territory

R.M. Morrison, DipArch, FRAIA, ARIBA, Architect

B.R. Reid, MB, BS, Medical Practitioner

S.P. Saville, OBE, BScAgr, DipEd, Secretary, Department of Primary Production

V.F. Stanton, Community Welfare Worker

J.W. Suiter, BSc, MSc, PhD, FRMIT, Vice-Principal, Darwin Institute of Technology (until September 1985)

R.J. Tormey, BEc, AASA, Manager, Secondary Industry, Northern Territory Development Corporation

W.J. Waudby, Pastoralist

S.M. Taylor, BEc, MEnvSc (*Secretary*), CILES Technical Information and Liaison Officer, CSIRO Darwin Laboratories

Queensland

G.I. Alexander, AO, BVSc, MSc, PhD, FACVSc (*Chairman*), Director-General, Queensland Department of Primary Industries

V.B. Aldrich, BSc, former Regional Manager, Queensland, CSR Limited

A.J. Allingham, Grazier

G.L. Baker, MSc, Assistant Director (Industry), Department of Industrial Development, Queensland

D.W. Beattie, BE, FIE, Commissioner of Water Resources, Queensland

J.M. Hudson, Grazier

B.J. Meynink, BSc, Lecturer

M.A. Sargent, BE, PhD, Chief Engineer, South East Queeensland Electricity Board

J. Sheridan, Family Day Care Co-ordinator for Queensland

D.M. Traves, OBE, BSc, Consultant, Peat, Marwick and Mitchell

Professor D.H. Trollope, PhD, DEng, Deputy Vice-Chancellor, James Cook University of North Queensland

C.D. Williams, MAIMM, Research Manager, MIM Holdings Limited

K.J. Turner, BCom (*Acting Secretary*), Senior Finance Officer, CSIRO, Brisbane (July 1985)

P.V. Batson (*Acting Secretary*), Acting Regional Administrative Officer, CSIRO, Brisbane (August-December 1985)

I.D. Sutherland, BRurSc (*Secretary*), CILES Technical Information and Liaison Officer, CSIRO, Brisbane

South Australia

R.A. Footner, AM (*Chairman*), former Chairman and Joint Managing Director, Bridgestone Australia Pty Ltd

F.E. Acton, General Manager, South Australian Co-operative Bulk Handling Ltd

D. Andary, OBE, FAIM, Chairman of Directors, DWN Distributors Pty Ltd

J.C. Killick, BE, ME, Manager, Water Resources, South Australian Department of Engineering and Water Supply

I.J. Kowalick, BSc, BEc, Executive Officer, SAMIC Limited

J.K. Lesses, Secretary, United Trades and Labor Council of South Australia

J. Levendis, Small Farms Adviser, South Australian Department of Agriculture

S.D. Meek, BSc, MSc, PhD, Senior Project Officer, Biotechnology, Department of State Development

Professor J.P. Quirk, AO, DSc, FTS, FAA, Director, Waite Agricultural Research Institute

G.K. Wilkinson, BSc, MSc, Senior Dietician, Modbury Hospital

V.W. Westwood, BAgrSc (*Secretary*), CILES Technical Information and Liaison Officer, CSIRO Division of Manufacturing Technology, Adelaide Laboratory

Tasmania

Professor P. Scott, OBE, PhD, LLD (*Chairman*), former Pro-Vice-Chancellor, University of Tasmania

E.C. Best, BSc, BE, Manufacturing Manager, Cadbury Schweppes Ltd

J.S.S. Burns, Editor, *The Mercury*

T.M. Cunningham, BSc, BFor, PhD, former Commissioner (Management), Tasmanian Forestry Commission

A.T. Dunbabin, BAgrSc, Grazier

B.F. Gibson, BScF, BA, Managing Director, Australian Newsprint Mills Ltd

Professor F.P. Larkins, BSc, DipEd, MSc, PhD (Oxon), Department of Chemistry, University of Tasmania

H. Murchie, BSc, DRTC Director of Mines

J. Simmonds, BA, Secretary, Hospital Employees' Federation

G.R. Stackhouse, President, Tasmanian Branch, Australian Fishing Industry Council

G.B. Laffer, BSc, MSc, BA (*Secretary*), CILES Technical Information and Liaison Officer, CSIRO Marine Laboratories

Victoria

J.E. Kolm, AO, FTS, IngChemEng (*Chairman*), Consultant and Company Director

J.D. Brookes, MC, MSc, former Director of Conservation, Ministry of Conservation, Victoria

I.W. Cameron, BMechE, former Group Managing Director, Repco Corporation Ltd

H. Campbell, BSc, DipEd, BA, Marketing Services Manager, Plastics Group, ICI Australia Operations Pty Ltd

D.J. Constable, BE(Civil), General Manager, Rural Water Commission

Professor J.D.C. Crisp, AM, FTS, BE, ME, Professor of Engineering, Monash University

A.J. Farnworth, MBE, PhD, former Chief General Manager, Australian Wool Corporation

D.E. Hore, BVSc, PhD, Deputy Director-General, Department of Agriculture, Victoria

H.M. Mitchell, OBE, Vice-President, Victorian Farmers' and Graziers' Association

R.D.E. Parry-Okeden, BE, former Managing Director, Vickers Ruwolt

E.F. Sandbach, AM, FTS, BA, BSc, former Director Research, Telecom Australia

E.J.L. Turnbull, AO, Executive Director, The Herald & Weekly Times Ltd

C.D. Kimpton, BAgrSc (*Secretary*), CILES Technical Information and Liaison Officer, CSIRO, Melbourne

Western Australia

J.R. de Laeter, PhD, FTS (*Chairman*), Associate Director, Division of Engineering and Science, W.A. Institute of Technology

D.S. Balfour, BSc, DipEd, Science Lecturer

N.J. Halse, MAgrSc, FAIAS, Director, Western Australian Department of Agriculture

R.M. Hillman, BEng, Chairman, Water Authority of Western Australia

D.R. Hull, BCom, PhD, Director, Western Australian Government Technology Directorate

P.V. Hurse, OBE, MB, BS, Medical Practitioner

S.L.G. Morgan, BE, Managing Director, Westintech Innovation Corporation Ltd

J.R.H. Ross, BSc, PhD, Manager, Diamonds Exploration, Western Mining Corporation

D.W. Saunders, BE, BEc, Assistant Commissioner (Operations), State Energy Commission

S.R. Shea, BSc, MSc, PhD, Executive Director, Department of Conservation and Land Management, Western Australia

J. Shepherd, BSc, Farmer and Agricultural Scientist

Professor R. Street, DSc, FAA, former Vice-Chancellor, University of Western Australia

J.P. Brophy, MBE (*Secretary*), Regional Administrative Officer, CSIRO, Perth

Appendices

Appendix I Science and Industry Endowment Fund

The *Science and Industry Endowment Act* 1926 allocated $200 000 to the Fund to be used for grants to assist in the training of research workers or with actual research. The principal was put to low-risk investments, which currently return about $30 000 p.a.

This reporting year was the first during which the availability of Science and Industry Endowment Fund (SIEF) grants was advertised and awards made on an annual competitive basis.

The Trustees initially received 36 applications, three of which were withdrawn. Six *ad hoc* applications were made. The criteria for selection included the objectives of the research, the possibility of publication, the dedication of the applicant, the realism of projected expense, the recognition of the project's value by outside bodies, and evidence that funding could not be obtained elsewhere.

Ten grants totalling $14 407 were made. The successful applicants are listed in the table. Two additional grants were made early in 1986. These were:

- $500 to the National Science Summer School for the sponsorship of international visitors;
- $250 to the organisers of the Australian Science in Schools Week to assist with the production of a resource book.

Changes in the administration of SIEF appear not to have altered the nature of the projects funded. The policies of the Trustees, outlined in the 1982/83 Annual Report, remain in place.

At 30 June 1985, the Fund retained $13 126 cash in hand. When combined with income from investment, the total available for distribution in 1985/86 was $33 578. A total of $15 157 was spent on grants, leaving $18 421 cash in hand.

Table. Grant Disbursements — 1985/86

Applicant	Project	Amount $
Dr I. Howells	Assistance with travel costs related to work on transport processes in solutions and suspensions.	1 500
Prof. H. Messel	Contribution to costs of conducting 1985 International Science School for secondary students.	1 000
Mrs P. Olsen	Purchase of boat and motor for use in study of peregrine falcons in the Canberra region.	3 000
Dr I. Jarrett	Fares to attend annual meeting of American Gastroenterology Association and discuss his work with peers.	2 300
Dr A. Hargraves	Fares overseas to enable this applicant to study instantaneous gas outbursts in underground salt mines in various regions.	2 500
Prof. V.D. Hopper	Travel expenses within Australia for study of meteorite disintegration.	600

Table. Grant Disbursements — 1985/86 (cont.)

Applicant	Project	Amount $
Dr T. Frankel	Purchase of consumables for study of metabolism of essential fatty acids in pouch young of the Tamar wallaby.	1 750
Dr A.T. Pugsley	Travel to consult with CSIRO and the W.A. Department of Agriculture on work on the genetics and physiology of wheat.	233
Mr M Morrison	Air fare to allow discussion of his work on ruminant nutrition with CSIRO and other colleagues in Melbourne, Brisbane and Armidale.	824
Mr W. Willgoss and Mr R. Mallard	Cost of production of dictionary of marine technical terms.	700
Sub-total		**14 407**
Ad hoc grants:		
National Science Summer School		500
Australian Science in Schools Week		250
Total		**15 157**

Appendix II CSIRO Submissions to Parliamentary and Official Inquiries

CSIRO made formal submissions to the following Parliamentary, Government and official inquiries during 1985/86. Continuing input was provided to some of the inquiries listed in the 1983/84 and 1984/85 Annual Reports, particularly to the Animal Welfare Inquiry.

Inquiry into Army Land Acquisition in New South Wales

The Senate Standing Committee on Foreign Affairs and Defence invited CSIRO to make a submission to its Inquiry into Army Land Acquisition in New South Wales. The CSIRO Division of Water and Land Resources has maintained a long-term association with the Department of Defence as a consultant and research body advising on land selection, planning and management. CSIRO's submission summarised its role in the selection and management of Army training areas, provided details of the formal Memorandum of Understanding between CSIRO and the Department of Defence, outlined current and completed research activities and described, as an example, the rehabilitation of the Army's training area at Puckapunyal, in Victoria.

ASTEC Review of Public Investment in Research and Development

CSIRO provided the ASTEC Review of Public Investment in Research and Development with a three-volume submission. Volumes 2 and 3 provided factual information about the major issues facing CSIRO and reports about CSIRO's research activities for the various industry and community sectors.

The first volume presented the Executive's views on research and development (R&D) in Australia. It commented on the role of Government in R&D, the organisation of Government research, and the role, funding and management of CSIRO. In essence, CSIRO suggested that research and development had a major role to play in Australia's exploitation of new technologies, the Government had a role in stimulating a private-sector increase in research and development, and that CSIRO's primary role should remain the conduct of strategic research for Australian industry or the Australian community.

ASTEC Review of Higher Education Research Funding

CSIRO made a formal submission to the ASTEC Review of Higher Education Research Funding in May 1986. The Organization's submission supported continuation of the traditional freedom of universities to pursue uncommitted fundamental research. The level of research infrastructure funding should be maintained and additional funding provided for replacing obsolete equipment and facilities. The importance of research grant funding arrangements such as those of the Australian Research Grants Scheme and the Commonwealth Tertiary Education Commission was noted and comments made on ways that might improve their effectiveness. Suggestions were also made on the need for specialised courses to be concentrated at selected universities, for the acquisition of expensive facilities to be rationalised, for research students to be encouraged to change universities for their higher degrees, and for a significant post-doctoral corps to be formed in university science and engineering departments.

While most of CSIRO's submission related to universities, mention was also made of the special research and training roles of the institutes of technology and colleges of advanced education. CSIRO believed that these institutions should receive adequate recognition and the funding necessary to fulfil their special roles.

ASTEC Review of the Defence Science and Technology Organisation

CSIRO made a formal submission to the review by ASTEC of the Defence Science and Technology Organisation (DSTO). The submission supported the need for a single organisation within the Defence portfolio dedicated to carrying out defence R&D. However, much more defence-related R&D should be undertaken in Australian industry, tertiary educational institutions, and Government research institutions other than DSTO. This would ensure that R&D performed within the Department of Defence would be much more closely linked with R&D effort in other sectors, and so contribute more broadly and effectively to Australian industry and the Australian

community. Conversely, a defence R&D organisation, such as DSTO, should not be restricted to performing only defence-related work or assisting only the Australian defence industries. Rather, work performed in DSTO to maintain its technological base should, as far as possible, be optimised to meet broad national needs. There should be some strengthening of the role of DSTO in Australian industry in general, and an increase in the proportion of effort devoted to the transfer to Australian industry of the results of work carried out by DSTO. Mechanisms ensuring substantial and effective interaction between scientists and engineers in DSTO, other organisations performing R&D and industry were essential to this technology-transfer process.

IAC Inquiry into the Measuring, Professional and Scientific Equipment Industry

A submission was made by CSIRO to the inquiry by the Industries Assistance Commission (IAC) into the Measuring, Professional and Scientific Equipment Industry. The Organization argued that Australia's measuring, professional and scientific equipment industry was fragmented, consisting as it did of a diverse range of generally small firms. As long as current research policies and financial support for them prevailed, CSIRO would continue to have an extensive pool of developments in instrumentation available for possible commercialisation. However, many of the companies in the industry had neither the capital nor the human resources to further develop, manufacture and market innovations produced by CSIRO and others. In particular, many manufacturers had a limited technical capability, which complicated the transfer of technology. If the industry continued to be dominated by small firms, each with its own specialised skills, then the translation of research developments into products with significant market potential would be made more difficult. Pooling of technical, capital and marketing resources through the formation of industry consortia could help to overcome the problem.

The submission emphasised the importance of industry organisations, such as the Australian Scientific Industry Association and the Medical Engineering Research Association — CSIRO has representatives on these bodies and assists with their activities. Continuity of the wide range of Government assistance measures already in force was seen as being essential to the stability and growth of this industry sector in Australia. The key to successful commercialisation was export sales, which in turn depended upon the selection and appointment of reliable and efficient overseas sales and service representatives.

Other Inquiries

An offer of assistance was made to the Senate Standing Committee on Science, Technology and the Environment in relation to its Inquiry into the Need for a National Technology Assessment System. CSIRO is also participating in one of the working parties established by the New South Wales Science and Technology Council as part of its review of R&D in New South Wales.

At the end of the reporting year submissions were being finalised for the Inquiry into the Potential of the Kakadu National Park Region by the Senate Standing Committee on National Resources, the Infrastructures inquiry by the House of Representatives Standing Committee on Expenditure and the Inquiry into the Australian Atomic Energy Commission/Australian Nuclear Science and Technology Organisation by a committee commissioned by the Minister for Resources and Energy.

Appendix III Reporting Requirements

Statutory Reporting Requirements

Section 57 of the *Science and Industry Research Act* 1949 requires each annual report to include particular matters as well as a general account of the operations of the Organization. These matters are listed below in the order in which they appear in section 57, together with responses or cross-references to other parts of the report.

Financial statements in respect of that year in such form as the Minister for Finance approves.	See chapter 16.
Copies of all determinations of the Minister made under sub-paragraph 9(a)(iv).	No determination was made.
Copies of all directions of the Minister given under section 13.	No direction was given.
All advice furnished by the Advisory Council under section 34 during that year.	See chapter 17.
A statement of the policies of the Organization in relation to the carrying out of the scientific research of the Organization that were current at the beginning of the relevant year, together with a description of any developments in those policies that occurred during that year.	The response developed by the Organization to meet this requirement has two main components. These are: • a comprehensive statement each year of the research objectives being pursued by the Organization and the level of resources devoted to each objective; and • an initial statement of general policies relating to specific areas of research, as these policies are developed. The statement of research objectives and resources is presented in chapter 2. The initial statement of general policies relating to research appeared in the CSIRO Annual Report 1978/79. Policies relating to specific areas of research appear in chapters 2, 3, and 5-12.
Comments of the Executive on advice furnished to it by the Advisory Council during that year.	No advice requiring specific comment was received during the reporting year.
Auditor-General's report.	See chapter 16.

Additional Reporting Requirements

In November 1982 the Government announced decisions on general information to be provided to Parliament in the annual reports of statutory authorities (see Senate Hansard pages 2258–2261). These items are listed below in the order in which they appear in the Government's announcement, together with responses or with cross-references to other parts of the report.

Enabling legislation	*Science and Industry Research Act* 1949.
Responsible Minister	Minister for Science.
Powers, functions and objects	See page 2.

Membership and staff

Names of Executive members and senior staff are shown on the Organization chart. Staff are employed under section 32 of the *Science and Industry Research Act* 1949. At 30 June 1986 CSIRO had a total staff of 7321.

Terms of office of Executive members are as follows:

Chairman and Chief Executive

N.K. Boardman, ScD, FAA, FRS
25.9.85-24.6.86
25.6.86-31.12.86

J.P. Wild, AC, CBE, ScD, FTS, FAA, FRS
14.12.78-24.9.85

Full-time Members

N.K. Boardman, ScD, FAA, FRS
14.12.78-24.9.85
G.H. Taylor, DSc, DrRerNat, FTS
1.5.82-30.4.89

Part-time Members

A.E. Clarke, BSc, PhD
23.6.85-22.3.86
23.3.86-24.6.86
25.6.86-31.12.86
K.J. Foley, MCom, PhD
23.6.85-22.3.86
23.3.86-24.6.86
25.6.86-31.12.86
M.D. Kirby, CMG, BA, LLM, BEc
11.8.83-10.8.86
11.8.86-31.12.86
G.G. Spurling, BTech, MAE, ED
9.9.82-8.9.85
9.9.85-8.6.86
9.6.86-31.12.86
P.D.A. Wright
1.12.79-30.11.82
4.2.83-3.2.86
4.2.86-24.6.86
25.6.86-31.12.86

Inquiries

Information about CSIRO may be obtained from the sources listed below:

Scientific and technical inquiries:

CSIRO's National Information Network maintains a nation-wide scientific and technical inquiry and referral service to industry and the community. This service can be accessed through:

The Librarian, CSIRO
PO Box 225, Dickson, ACT 2602
Tel. (062) 48 4228

Regional Information Manager, CSIRO
PO Box 218, Lindfield, NSW 2070
Tel. (02) 467 6211

Regional Information Manager, CSIRO
Private Bag No. 44, Winnellie, NT 5789
Tel. (089) 84 3611

Regional Information Manager, CSIRO
PO Box 4, Woodville, SA 5011
Tel. (08) 268 0116

Regional Information Manager, CSIRO
GPO Box 1538, Hobart, Tas. 7001
Tel. (002) 20 6222

Regional Information Manager, CSIRO
PO Box 378, Spring Hill, Qld 4000
Tel. (07) 839 7363

Regional Information Manager, CSIRO
PO Box 89, East Melbourne, Vic. 3002
Tel. (03) 418 7333

Regional Information Manager, CSIRO
PO Box 374, West Perth, WA 6005
Tel. (09) 322 2111

Freedom of Information inquiries:

Freedom of Information Unit, CSIRO
PO Box 225, Dickson, ACT 2602
Tel. (062) 48 4123

Media inquiries:

Media Office, CSIRO
PO Box 225, Dickson, ACT 2602
Tel. (062) 48 4484

Financial statements

See chapter 16.

Activities and reports

See chapters 1–16. CSIRO maintains relations with a wide range of Commonwealth, State and local government organisations concerned with science and technology matters and relevant national and international bodies.

CSIRO publications

CSIRO produces about 2000 publications annually. Information on these can be obtained from:

Publication Sales, CSIRO
PO Box 89, East Melbourne, Vic. 3002
Tel. (03) 418 7333

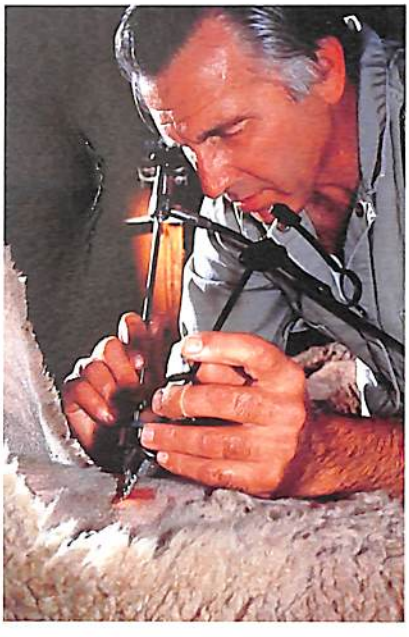
Operational problems

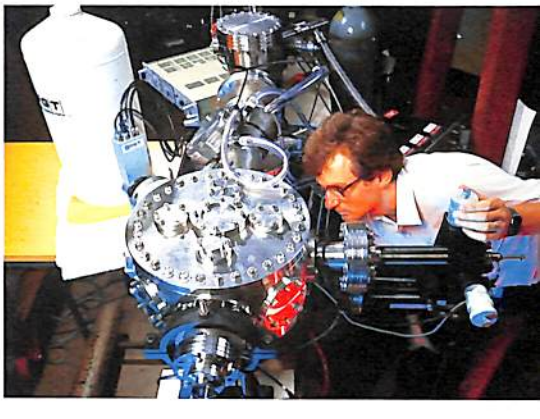
See chapters 1–16.

Subsidiaries

See chapter 13.

CSIRO Australia Annual Report 1985/86





Commonwealth Scientific and Industrial Research Organization, Australi