CSIRO
Annual Report
1984/85

The CSIRO oceanographic research vessel *Franklin* off the coast of Cairns, Qld., during sea trials in March 1985. Photo courtesy of Yon Ivanovic, Studio One, Cairns.

CSIRO
Annual Report 1984/85

Commonwealth Scientific and Industrial Research Organization, Australia

The Role, Organization 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:

- finding better ways of producing and processing Australia's agricultural and mineral products;
- developing manufacturing technologies which lead to new and improved products and processes;
- 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.

Organization

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.

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. 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. 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 utilization 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 recognize, 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.

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Commonwealth Scientific and Industrial Research Organization, Australia

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

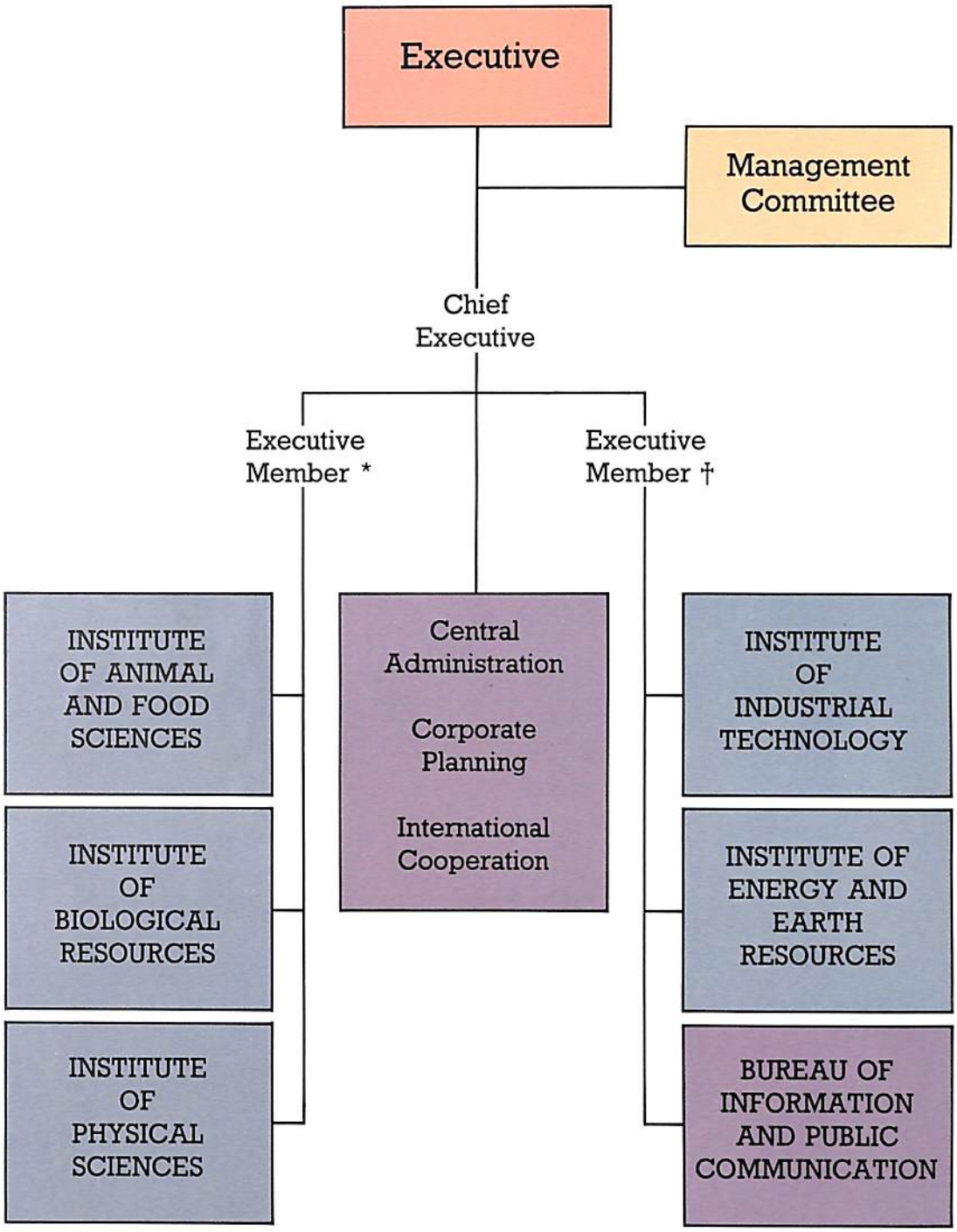
The Executive of CSIRO has pleasure in submitting to you, for presentation to Parliament, its thirty-seventh annual report, which covers the period 1 July 1984 to 30 June 1985. The report is submitted in accordance with section 57 of the Science and Industry Research Act 1949.

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

September 1985

Organization Chart

The chart shows the structure of CSIRO as at 1 July 1985.



Executive
Chairman
and Chief Executive
Dr J.P. Wild
Full-time Members
Dr N.K. Boardman *
Dr G.H. Taylor †
Part-time Members
Dr A.E. Clarke
Dr K.J. Foley
Hon. Justice M.D. Kirby
Mr G.G. Spurling
Mr P.D.A. Wright

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

INSTITUTE OF ANIMAL AND FOOD SCIENCES
Director
Dr K.A. Ferguson

Divisions and Chiefs
Animal Health
Dr A.D. Donald
Animal Production
Dr T.W. Scott
Australian National Animal Health Laboratory
Mr W.A. Snowdon
Fisheries Research
Dr F.R. Harden Jones
Food Research
Dr J.H.B. Christian
Human Nutrition
Dr B.S. Hetzel
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 M.G. Pitman

Divisions and Chiefs
Entomology
Dr M.J. Whitten
Forest Research
Dr J.J. Landsberg
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 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
(Chief Designate)
Materials Science
Dr J.R. Anderson
Mathematics and Statistics
Dr T.P. Speed
Oceanography
Dr A.D. McEwan
Radiophysics
Dr R.H. Frater

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
Dr E.G. Bendit
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 *(Acting)*
Minerals and Geochemistry
Dr D.F.A. Koch

Central Administration
Office of the Chairman
Corporate Secretary
Mr L.G. Wilson
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

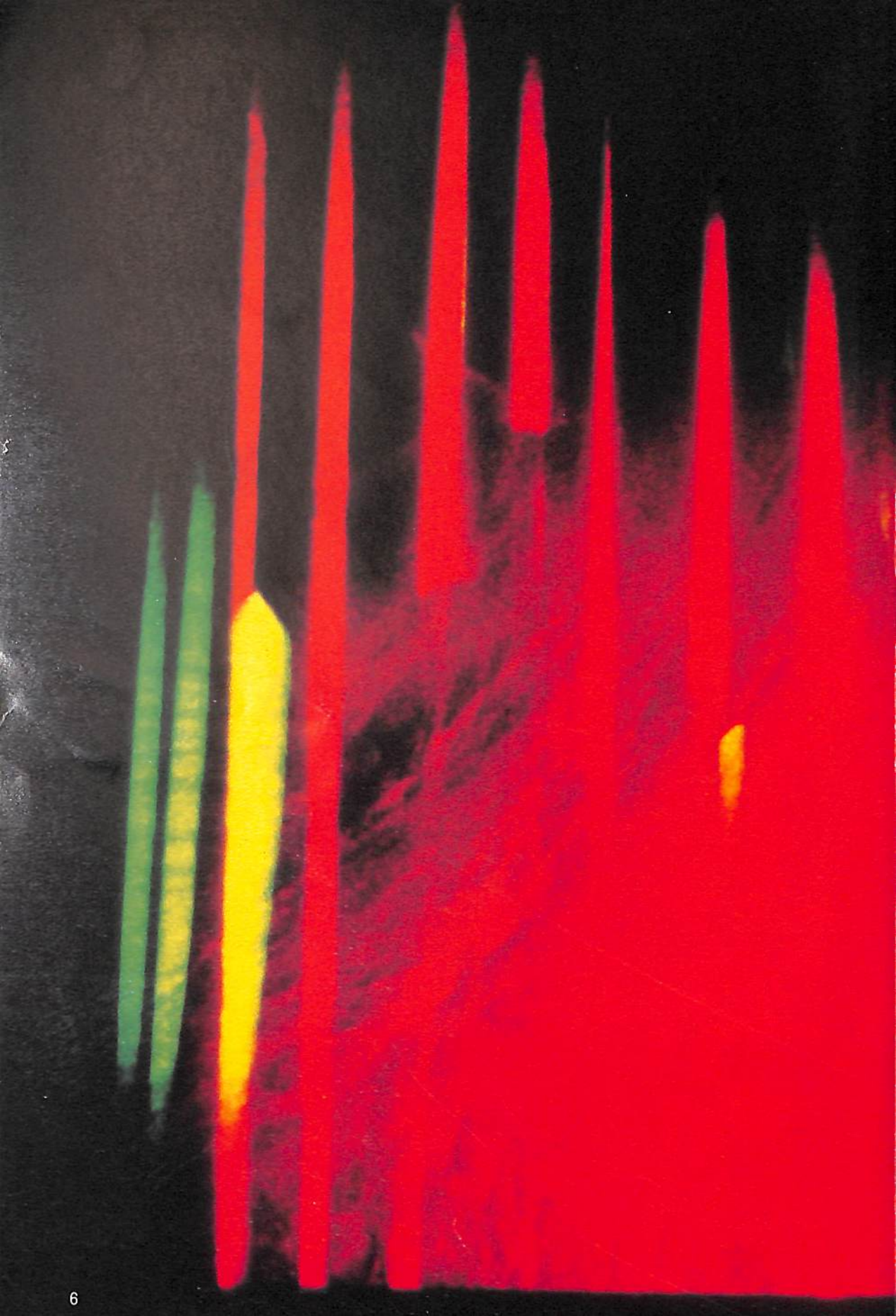
CSIRO Office of Space Science and Applications (COSSA)
Director
Dr K.G. McCracken

CSIRONET
Chairman
Mr D. McCullough
Chief Executive
Dr P.J. Claringbold

Bureau of Information and Public Communication

Related Companies

SIROTECH Ltd
SIROMATH Pty Ltd



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Chairman's Review

The period since the Birch Inquiry in 1977-78 has been marked by change. I believe that period has now reached its zenith, and that 1985 will be seen as a turning point in the history of CSIRO, the year which has seen the Organization transformed more fundamentally than at any time since it was reconstituted from the old CSIR in 1949.

In the year we have seen:

- the introduction of a corporate planning system to decentralize research planning and define anew the planning responsibilities of the Executive, Directors, Chiefs and senior administrators
- the launching of CSIRO's technology transfer and commercial assessment company, Sirotech, which has already scored some notable successes
- the establishment of a CSIRO Office of Space Science and Applications (COSSA) to coordinate and expand our research in this area
- the creation of a Division of Information Technology and an organization-wide collaborative program to strengthen CSIRO's work in computer-based information technologies
- the implementation of new review procedures to give a greater say to users of CSIRO research
- the appointment of a Director, Information and Public Communication, the issuing of new staff guidelines on public comment, the launching of a 21-volume work 'CSIRO Research for Australia' and other initiatives to improve communication with industry and the Australian community
- the setting up of a manufacturing industry collaborative research scheme to promote research carried out with manufacturing companies; the scheme begins this year with $0.75 million, increasing to $3 million in 1987.

These initiatives have built on earlier ones; for example, changes to guidelines for the promotion of research staff, which give greater recognition to contributions to industry and the community, are now being reflected in staff promotions.

The culmination of the year's policy activities has been the development of a strategy for CSIRO over the next five years. The strategy was derived from five Executive working parties set up in late 1984 and has the following goals:

- to develop systematic procedures for identifying growth areas and assessing the balance of research across economic sectors
- to concentrate CSIRO's research effort into fewer research programs focused on significant national objectives

- to introduce more systematic evaluation of research
- to improve the two-way communication of results and information between the Organization and its user groups
- to develop better management practices and more flexible staffing policies.

The strategy for 1985-1990, and its elaboration through corporate planning, will give CSIRO a clearer voice. Parliament, the government, industry and the community will be provided with regularly updated statements of our objectives and priorities, and the reasons for them. This we hope will help overcome one of the great bugbears of life in the public sector, the limited time horizon of the annual budget cycle, which militates against long-term initiatives.

Other changes to CSIRO will flow from the review by the Australian Science and Technology Council of public investment in research and development, commissioned by the Prime Minister in May. I do not know, at the time of writing, what the outcome of that review will be. But I am confident that

its recommendations will help ensure, as the chairman of ASTEC, Professor Ralph Slatyer, has said, 'that the CSIRO of the future is better equipped to deal with the problems that are going to be encountered'.

For much of the post-war period government and the community largely left to scientists the business of deciding what research to do. That period has now finished and its demise can be traced to several causes. First, the early 1970s saw a growing public disenchantment with science due to a swing of the pendulum away from the over-expectations of the years of Sputnik, Apollo and the double helix. More recently, two other developments further demolished the laissez-faire attitude, ironically one of them the result of scientific success: the technological revolutions wrought by computers, robots, space technology and genetic engineering, with all the significance these held for industrial competitiveness; and the global recession of the late 1970s and early 1980s. All over the world, industrialized nations looked for ways of improving the science-industry connection in order to gain a competitive edge and promote economic growth.

In Australia, we also experienced a local change in perspective. The worst drought on record, declining world prices for primary commodities, and the country's accelerating economic slide down through the ranks of industrial countries, all served to sharpen the focus on how much we spend on research, who spends it, for whom, for what purpose, and to what effect. A change in government further stimulated the questioning.

I believe CSIRO has responded rapidly to the changed climate for research. Many of the recent initiatives have their origins before CSIRO's research became an 'issue' for political and public debate. This is not to deny the value of the debate. It has given CSIRO a new zest, a clearer sense of purpose, a greater capacity for self-criticism, and a greater self-confidence. Even with the best of intentions, no organization can be as responsive to the community as it should be if it is left purely to its own devices.

But public debate can harm the best interests of the country when it is ill-informed and excessively partisan. I think this danger has existed in the debate about Australian science and technology, but I am pleased to sense that the debate has now reached a better-informed and more constructive stage.

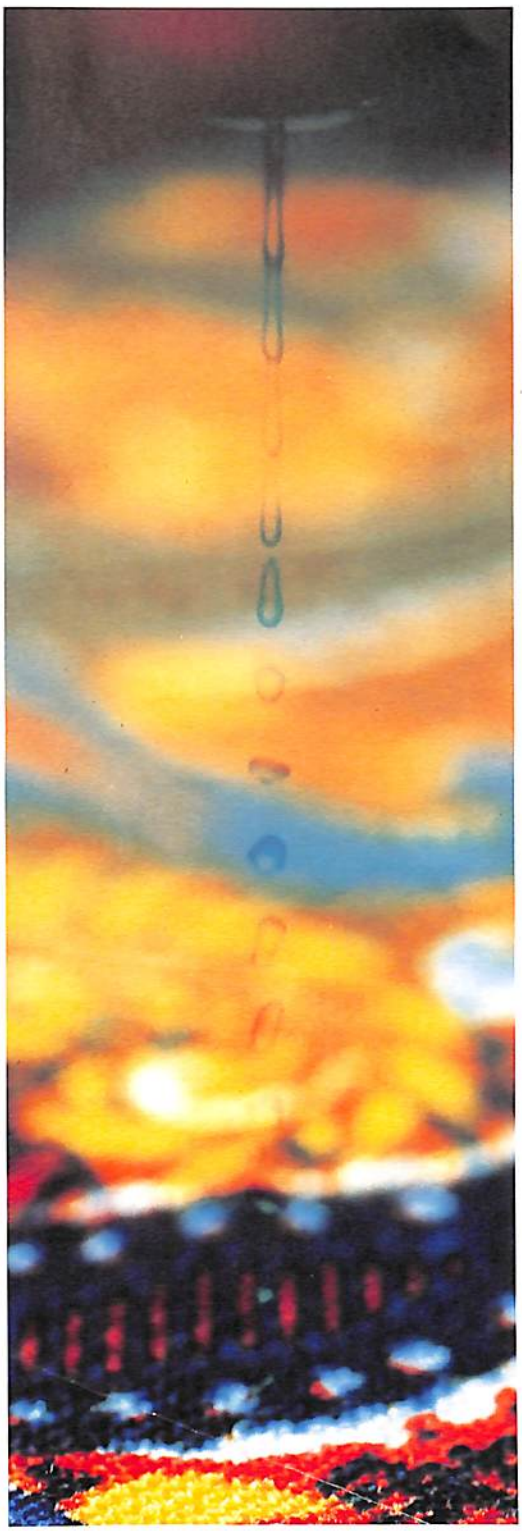
The past year or so has seen some memorable openings of national research facilities which will shape the future of scientific endeavour in several fields. In late 1984 there was the commemoration of the start of construction of the Australia Telescope, followed this year by the launch of our oceanographic research ship, *Franklin*, and the openings of the Australian National Animal Health Laboratory at Geelong and the Marine Laboratories at Hobart. These and highlights of the year's research achievements are summarized in the next section of this report.

1985 has been a full and exciting year for CSIRO, and a good year for me to bow out. The seven years I have been Chairman have been probably the most turbulent in CSIRO's history. They have been eventful and challenging years which I have relished. The road we have travelled has been mainly uphill and the hope for my successor is that the gradient may now ease — for what the Organization needs is a period of consolidation, stability and untroubled creativity.

I am more than pleased that Keith Boardman, my close colleague and comrade-in-arms for seven years, will be the next Chairman of CSIRO. While in his hands, the future of the Organization is assured.

Finally, I give my thanks to that very special body of people, the staff of CSIRO, for their unfailing spirit, support and loyalty.

Highlights



Research

Counter Current Extractor

Three commercial counter current extractors used for extracting soluble materials have been installed in industry. The Division of Food Research developed the extractors in conjunction with BIOQUIP Australia Pty Ltd.

Jet Printing

A new computer-controlled technique for making printed woollen fabrics reduces the preparation time for new print designs from two months to two hours, greatly expanding the market for such fabrics. The Division of Textile Physics devised the technique, which is to be developed commercially by Wilcom Pty Ltd, an Australian company.

Diecasting

METLFLOW, die design software for diecasting, was launched commercially during the year. Originating from diecasting research at the Division of Manufacturing Technology, it is being marketed world-wide by Moldflow Pty Ltd.

Reconstituted Timber — Scrimber

A process using timber from young trees, bound together with polymers, has entered commercial production. The new material, Scrimber, originated from the Divison of Chemical and Wood Technology and was developed in conjunction with Repco Research Pty Ltd.

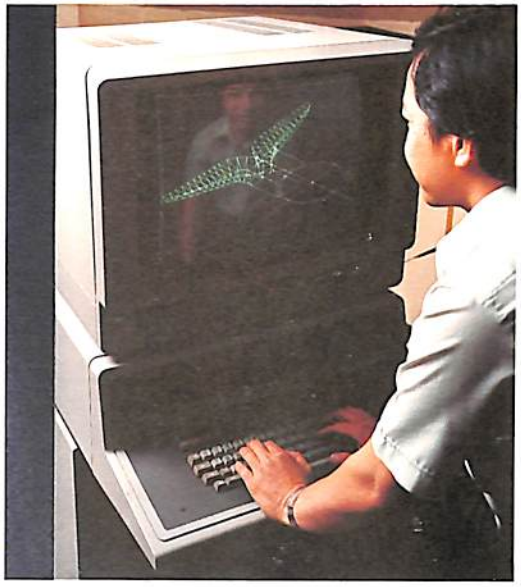
High-yield Cheddar Cheese

The technology for producing a cheese-base equivalent to cheddar cheese for manufacture, incorporating all the proteins from milk and increasing the yield of cheese solids, has been proven and is now available to Australian manufacturers. The Division of Food Research collaborated with Schrieber Foods Inc., Wisconsin, to commission a full-scale plant in the USA.

Sirostrain

Sirostrain, a software package for metal forming strain analysis, is being marketed by Kodiak Pty Ltd of Adelaide, following its development by the Division of Manufacturing Technology.

The new 'jet printing' technique, developed by the Division of Textile Physics, will reduce the preparation time for new print designs from two months to two hours.



CSIRO scientist, Mr Ho Siauw, demonstrating METLFLOW with an isometric view of a runner system. The software also includes programs for numerically-controlled machining of runners and for analyzing heat flow.

Vision Processing

A vision processor which measures and processes objects in milliseconds, much faster than other commercially-available equipment, has been developed by the Division of Manufacturing Technology and Vision Systems Pty Ltd, in collaboration with a management investment company, Western Pacific Pty Ltd.

Low-temperature Oxygen Sensor

The Division of Materials Science developed a low-temperature oxygen sensor to assist with industrial process control where temperatures of 300°–600°C are experienced. Conventional sensors work only above 600°C. The sensor is being produced commercially.

Soil Tests — Wheat Nematodes

A soil test procedure to guide decisions on applying sprays against wheat nematodes — based on research by the Division of Soils — has attracted widespread use in South Australia and Victoria.

Leucaena Utilization

Rumen micro-organisms, able to break down a toxic chemical in the foliage of the otherwise highly nutritious shrub *Leucaena*, have been identified and introduced from overseas by the Division of Tropical Crops and Pastures. Without the micro-organisms, which spread naturally in cattle herds in the field, cattle grazing *Leucaena* can be poisoned by the toxin. Dr Ray Jones of the Division received the 1984 Urrbrae Award for his work on *Leucaena*.

Cattle Tick Vaccine

Research by the Division of Tropical Animal Science has led to the successful immunization of cattle against the cattle tick *Boophilus microplus*. Commercial vaccine production, using recombinant DNA technology, is being investigated in a collaborative project with Biotechnology Australia Pty Ltd.

Oriental Fruit Moth Pheromone

An Australian company, Biocontrol Ltd, has developed and marketed a system for controlling oriental fruit moth using a synthetic version of the natural pheromone blend, based on research by the Division of Entomology.

Genetically-altered Blowflies

The Division of Entomology has released genetically-altered sheep blowflies in a major field trial to test their ability to control wild flies. The altered flies introduce genes for sterility and other genetic defects, such as blindness in females, into the field populations.

Shale Oil Recovery

A new process for extracting oil from Julia Creek shale, which will reduce production costs by $4 a barrel compared with the cost of existing technology, has been patented jointly by the Division of Mineral Engineering and CSR Ltd. The process is completely heat self-sufficient, removing the need for burning part of the oil shale to produce heat.

Barrier Reef Image Analysis System (BRIAN)

BRIAN, a remote sensing system being used in the management of the Great Barrier Reef, was developed by the Division of Water and Land Resources in collaboration with the Great Barrier Reef Marine Park Authority.

CSIDA Facility

The Division of Atmospheric Research completed the development phase of the CSIRO System of Interactive Data Analysis (CSIDA). The system gathers information from geostationary and polar

The Prime Minister, the Hon. R J L Hawke, congratulates the Chief of the Division of Building Research, Dr F A Blakey, on his Division's input to the GMI Council's 5–Star Design Rating project for Australian housing.

Small wall sections mounted in a test rig are subjected to simulated rain and wind pressures as part of the 5–Star Design Rating project. Filling the cavity between internal and external skins of walls could improve the energy efficiency of buildings; it could also increase the potential for water to penetrate the walls.

orbiting meteorological satellites. It will provide a powerful tool for atmospheric and oceanographic studies and is able to obtain the highest-resolution weather satellite data.

Five-star Design Rating

The Division of Building Research contributed to the Five-star Design Rating for Australian housing which is now awarded by State Governments. The rating takes into account such factors as glass areas, thermal mass, insulation, overall shape and internal layout, and their relationship to local climatic conditions.

Events

Research Vessel

The new CSIRO vessel *Franklin*, Australia's most advanced oceanographic research vessel, was launched by Her Excellency Lady Stephen in January. The 1100-tonne, 55-metre vessel will be operated as a national facility by the Division of Oceanography out of Hobart. It will serve physical, chemical and biological oceanography. Built at a cost of $13.3 million, the *Franklin* has a complement of 25 scientists and crew.

Animal Health Laboratory

The $160 million Australian National Animal Health Laboratory operated by CSIRO was opened in April. The $8 million a year operating costs of the Laboratory will be shared with the Department of Primary Industry.

CSIRONET/National Library Link

Australia's information technology took an important step forward through the linking of CSIRO's computing facility, CSIRONET, with the National Library's Bibliographic Network (ABN). The Division of Computing Research and a private company, Office Automation Pty Ltd of Canberra, developed the new computer micronode which is a vital component in the link.

Cyber 205 Supercomputer

A new $8 million super computer — a Control Data Cyber 205 — began operations in Canberra in August. Regarded as the most powerful computer in the world, the Cyber 205 has a 16-million byte memory and performs 400 million calculations a second at peak operating speed. It enables researchers to tackle a diverse range of industrial and scientific problems.

Australia Telescope

Construction of the Australia Telescope at Culgoora, NSW, was commenced in September. The $43 million project will incorporate the Parkes Radio Telescope, a new antenna at Siding Spring and a six km array of six new antennas at Culgoora. Together they will operate as a giant 300 km diameter radio telescope.

COSSA

A CSIRO Office of Space Science and Applications (COSSA) was set up to coordinate and expand space research and development. The Office will concentrate on areas which will assist Australian industry to participate in international space business, especially in communications, meteorology and remote sensing.

Animal Ethics Committee

CSIRO has established a committee to advise it on the ethical and social issues involved in the care and use of research animals. Representatives of animal welfare, livestock industries and academia are included on the committee.

McMaster Fellowships

The setting up of the Sir Frederick McMaster Fellowships will enable eminent overseas animal and plant scientists to visit CSIRO.

SIROTECH Launch

SIROTECH Ltd, the Organization's technology transfer company, was launched in March by Senator the Hon. John Button, Minister for Industry, Technology and Commerce. The company will market CSIRO research and technology, provide business advice and manage CSIRO's industrial property portfolio.

Program for ASEAN

A CSIRO-managed program to help member nations of ASEAN upgrade the management of their research and development started in March. Seminars and workshops will be organized through national scientific institutions in the six ASEAN countries.

New Division

CSIRO's new Division of Information Technology was set up. Dr G E Thomas, Director of the Edinburgh Regional Computing Centre, was appointed Foundation Chief and will take up his position in August 1985.

The Vice-President of Academia Sinica, Prof. Yan Dong Sheng and Dr Paul Wild, Chairman of CSIRO, sign the first major scientific cooperation agreement between the two organisations.

ASTEC Review

In May the Prime Minister, the Hon. R J L Hawke, announced a major review of Government-funded research and development, focusing initially on CSIRO. The review is being undertaken by the Australian Science and Technology Council (ASTEC).

New Chairman

Dr Keith Boardman was named as the next Chairman of CSIRO following Dr Paul Wild's retirement in September 1985. Dr Boardman has been a full-time member of the CSIRO Executive for eight years.

Marine Laboratories

The $13 million CSIRO Marine Laboratories in Hobart were opened by the Hon. Barry O Jones, Minister for Science, in May. The five-building complex will accommodate the Divisions of Fisheries Research and Oceanography, formerly housed at Cronulla, NSW.

Research for Australia

Two volumes in the 'Research for Australia' series were launched in June. Titled 'Advanced Materials' and 'Energy' they are the first of a series of 21 simple and comprehensive guides to CSIRO research. The rest will be released progressively over the next 12 months.

China Science Agreement

An agreement between CSIRO and Academia Sinica, China's largest scientific research organization, was signed by Dr Paul Wild and the Vice-President of Academia Sinica, Professor Yan Dong Sheng, in Canberra in April. The agreement enables up to 10 Australian scientists to visit China and the same number of Chinese scientists to visit Australia each year.

Corporate Policies

Research Management

The Executive has introduced new measures to improve decision-making within CSIRO.

Corporate Planning

A corporate planning system has been introduced. Each cycle will start with planning guidelines from top management, giving managers at all levels an indication of the broad directions they should follow in formulating plans. Plans will be formulated at Division, Institute and corporate levels. Research users will be involved in the development of plans and the evaluation of progress.

Strategy for CSIRO 1985-1990

Executive working parties were set up in 1984 to consider: balance of research effort; concentration of research effort; assessment of benefits from research; interaction with industry; and human resources. A strategy for CSIRO covering each of these areas has been determined.

Divisional Reviews

The Executive has formalised and updated the Divisional review system. Components include: external chairmanship of review committees; membership to include representatives from staff associations and the CSIRO Advisory Council; regular program reviews; and a more open and consultative review process.

Distribution of Research Effort

CSIRO's research classificaton scheme has been amended to include new sectors, Multi-sectoral Technologies, comprising biotechnology, information technology and space technology, and International Aid.

Growth areas nominated for 1984/85 and 1985/86 are:

	1984/85	1985/86
Biotechnology	Yes	Yes
Advanced materials	Yes	No
Generic (broadly applicable) manufacturing industries	Yes	Yes
Information technology	Yes	Yes
Water and soils	Yes	Yes
Plant diseases	Yes	Yes*
Oceanography	Yes	No
Space technology	No	Yes
Raw materials processing	No	Yes*
Human nutrition	No	Yes*

* Second priority growth areas.

Oceanography research has been expanded substantially since 1979. The status of advanced materials will be reconsidered later in 1985/86.

Resources to undertake expanded activity in the Executive's designated growth areas come mainly from redeployment of existing resources. In 1984/85, fewer resources were available for redeployment because costs associated with Government-directed repairs, maintenance and an occupational safety and health program had to be absorbed.

CSIRO's Commercial Policies

The main aim in conducting research for Australian industry is to maximise national benefit through contributions to commercially-viable innovations. A subsidiary aim is to maximise CSIRO's revenue from its commercial transactions. SIROTECH Ltd provides a business-oriented approach to commercializing CSIRO-generated technology.

Prospective partners are involved as early as possible in industrially-oriented research projects. Where appropriate, exclusive licences are negotiated with individual Australian firms. Where an arrangement with an overseas-based firm offers the best avenue for obtaining maximum benefits for Australia, the potential for future involvement of Australian firms is reserved.

Research Reviews

Reviews were completed of the: Divisions of Mineralogy and Mineral Physics; Division of Horticultural Research; Division of Plant Industry; Division of Tropical Crops and Pastures; interactions between the plant Divisions; and calibration services provided by the Division of Applied Physics.

Work continued on a subject review of materials science and technology, and commenced on reviews of the Divisions of Food Research and Environmental Mechanics. The Divisions of Groundwater Research, Applied Physics and Chemical Physics will be reviewed in 1985/86.

Sectoral Reports

Manufacturing Industries

Detailed policies for research in support of Australia's manufacturing industries were given in the 1980/81 and 1983/84 Annual Reports.

Steps to implement these policies include: redeployment of resources into generic manufacturing technologies (robotics, sensors, flexible manufacturing systems, CAD/CAM) and other areas such as advanced materials, biologically-active chemicals, processing of raw materials, energy saving devices and metal fabrication processes; building up resources in eight research topics designated by the Executive as having highest priority; upgrading consultative mechanisms with industry to assist in program selection; participation in specific industry councils forming parts of the Australian Manufacturing Council; and initiation of an Industry Collaborative Research Program to give industry the opportunity to set objectives for a certain amount of CSIRO research.

Rural Industries

The major areas within the rural industries sector are agriculture, forestry and fisheries. Executive policies on these areas were described in the 1981/82, the 1980/81 and 1979/80 Annual Reports respectively.

Areas in which research was strengthened or new initiatives undertaken included: selection of pasture species for nutritional value; manipulation of rumen micro-organisms; delivery of supplementary mineral nutrients to sheep and cattle; computerised management of grazing animals (GRAZPLAN); immunization to improve productivity; rangelands research; increased

collaboration with State departments on plant pathology research; and establishment of the National Bushfire Research Unit.

Mineral, Energy and Water Resources

Minerals — Remote Sensing

There has been a rapid evolution in the geological applications of remote sensing with potential for identification of minerals. Research includes: instrument development; information on land topography from radar images; evaluation of the data from the NOAA satellites; and rapid transmission techniques.

Energy — Oil Shale Research

Work is aimed at reducing the costs of extracting oil from shale, including research into the structure and behaviour of the components of oil shale, techniques to hydrotreat shale oil to produce gasoline directly, avoiding a refining stage, and the possible environmental effects of an oil shale industry.

Water — Crop Irrigation

Work is aimed at achieving savings in irrigation agriculture (accounting for 74% of the water used in Australia) and at increasing the yield of irrigated row crops. Research includes computer management (SIRAGCROP), plant root zone investigations and monitoring of soil salinity.

Conservation and the Natural Environment

Research topics include:

- Soil Resources, Conservation and Management: the mapping of Australian soil and soil conservation (soil inventories, stability, nutrients, infiltration and run-off of water).
- Land Use: conserving the values of land — productivity, water yield, nature conservation, living environment — and the understanding of interrelationships.
- Ecology and Environment: processes by which fire, grazing and nutrient levels affect natural plant communities; biological control and fauna conservation; and water quality and supply, and the biology, ecology and dynamics of marine plant and animal populations.
- Flora and Fauna: endangered plant species, plant toxicology and identification of resource stocks, exploitation and conservation of germplasm, systematic biology of Australian insect fauna, and the physiology and habitat requirements of vertebrates.
- Oceans: physical oceanography, chemical oceanography, air-sea interactions and remote sensing of sea surface temperature.
- Atmosphere: atmospheric processes, including weather, climate and atmospheric pollution.
- Astronomy: the Australia Telescope, due for completion in 1988.
- Environmental Protection: the treatment and disposal of wastes, the effects of contaminants, global atmospheric pollution and the protection of the human environment from insect pests.

Service Industries

Urban and Civil Engineering

Work is aimed at fostering innovation for the building and construction industry and includes research on aggregate stability, the use of slab-on-ground for domestic construction and the development of computer systems for use by local government.

Health

CSIRO's medical research policy was reported in the 1983/84 Annual Report. Research areas include associations between diet and human health, food safety and medical technology.

Physical Standards of Measurement

CSIRO fulfils statutory obligations relating to standards. Research includes microwave calibrations at higher frequencies, electromagnetic distance measurement, measurement of low temperatures and collaboration with Australian industry through an Applied Physics Industrial Program.

Multi-sectoral Technologies

Biotechnology

CSIRO's program embraces the development of useful products and processes from micro-organisms and mammalian cells and genetic modification of plants and animals to improve productivity. Major research areas include the production of new vaccines, the development of diagnostic probes and the use of genetic surgery for improved plants and animals.

Information Technology

A Division of Information Technology was established and a CSIRO Information Technology Program was set up to allocate grants to external researchers to support collaborative projects between CSIRO Divisions and industrial or academic partners on a 50/50 basis.

Space Technology

Work is aimed at devising applications which will be used in Australia and fostering innovative projects which enhance Australian industry's capability to compete effectively in international space technology. It is coordinated by the CSIRO Office of Space Science and Applications (COSSA). Research includes space-based communications, remote sensing and meteorology spacecraft systems.

International Aid

Participation in aid programs is based on criteria such as relevance to existing research programs, availability of appropriate expertise, staff and resources, cost recovery, and the existing level of external funding in relation to Divisional core programs. Development assistance includes participation in aid projects, provision of scientific experts for short-term consultancies and training of scientists and technicians at CSIRO laboratories. Requests for assistance are increasing.

Administration

Management

Administrative Reviews

Reviews of: the Bureau of Scientific Services; the Library and Information Services; strategic research planning; Divisional reviews; and the Office of the Executive were completed. The committee reviewing the Organization's external communications activities reported to the Executive and a review of the central personnel function was established. COSSA was established following consideration of the recommendations of a Space Science and Technology Study Group.

CSIRONET

CSIRONET was established in January 1985 from the computing science and associated developmental activities of the former Division of Computing Research. It is managed by a Board of Management on a cost-recovery basis, and aims to increase its commercial role. The financial feasibility of restructuring CSIRONET as a separate commercial entity outside CSIRO is being investigated.

SIROMATH Pty Ltd

This joint venture works in mathematical and statistical areas where commercial demand outstrips CSIRO's capacity or is outside normal CSIRO skills. SIROMINES, a joint venture between SIROMATH and the French School of Mines, doubled its turnover in 1984/85.

Personnel

Areas of particular importance were: staff development and training, including retraining and staff counselling; the personal counselling service; and monitoring the effect of the revised research scientist classification guidelines.

Consultative Council

Matters considered included: industrial democracy; technological change; probation and grievance procedures; staffing; internal communications; training opportunities in remote areas; implementation of equal employment opportunities; and staff development and training.

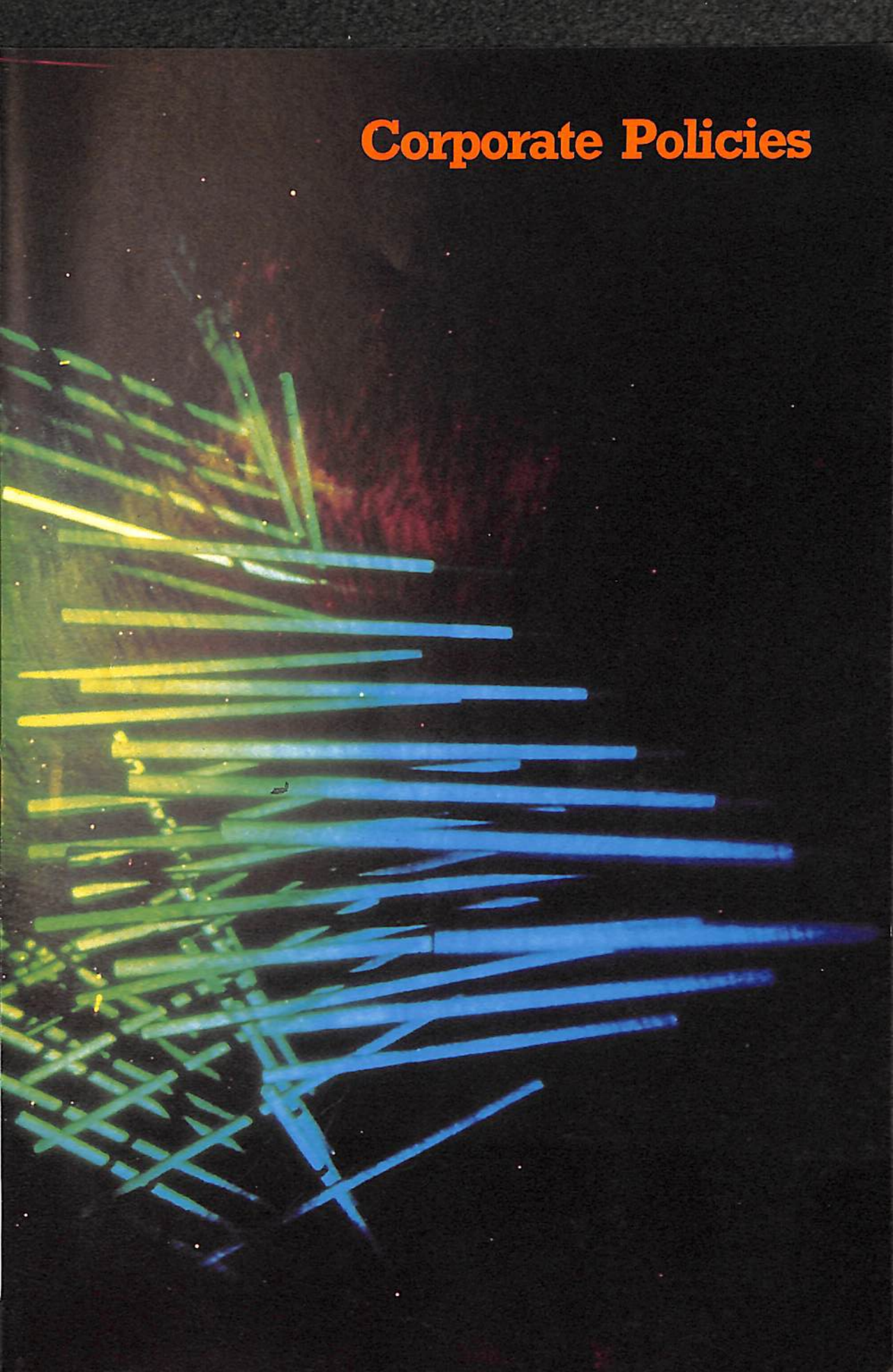
Finance and Works

Major developments and activities were: the CSIRO/Department of Finance Joint Working Party; funding arrangements for the operation of national facilities; the launch of *Franklin*; the start of construction of the Australia Telescope; and the openings of ANAHL and the Marine Laboratories.

Advisory Council and State and Territory Committees

Topics considered by the Advisory Council at its three meetings and by the Standing Committees included: CSIRO's budget appropriation 1984/85; CSIRO's growth areas; the reviews of CSIRO's strategic research planning activities and CSIRO's external communication activities; science education centres; CSIRO's reviews and review committees; and the establishment of the Sir Ian McLennan Achievement for Industry Award.

Corporate Policies



The holograms introducing the major sections of this report were produced at the Division of Applied Physics by Alexander, an internationally known sculptor, and Dr P Hariharan, a CSIRO scientist, under a program sponsored by CSIRO and the the Australia Council.

They can be illuminated by a simple spot lamp; a new processing technique gives an image bright enough to be viewed under normal room illumination.

One of these holograms is featured along with some of Alexander's sculptures in the exhibition 'Les Immateriaux' currently being held at the Centre Georges Pompidou in Paris.

Another set of five holograms is on display at the Australian Pavilion at the World Fair, Expo 85, at Tsukuba, Japan.

1. Research Management

The Executive has introduced new measures to improve decision-making within CSIRO. These are:

- a corporate planning system;
- a strategy for the period 1985-1990; and
- a revision of the system for reviewing the work of Divisions.

Together, the changes are intended to provide:

- clearer aims for CSIRO;
- better avenues for users of research to influence objectives and priorities;
- greater responsiveness to changing national needs and opportunities;
- improved staff participation in the setting of objectives and priorities;
- clearer personal targets for research staff;
- more systematic evaluation of research;
- improved interaction with industry; and
- more flexible management of staff.

Corporate Planning

'Corporate planning' describes management systems built around the cyclic formulation, implementation and review of linked plans at all levels within an organization. Managers are asked each year to specify, concisely and simply, their principal objectives for the planning period. Plans for each level of management are brought together and used as the basis for plans at the next higher level, and these are aggregated upwards until a plan for the organization as a whole is formed. At each level of upward aggregation, plans are added to or modified to reflect objectives and priorities appropriate to that level.

Each cycle starts with a statement of planning guidelines from top management, which gives managers at all levels an indication of the broad directions they should pursue in formulating plans.

Features of the CSIRO system include:

- a flow of guidance on broad objectives and priorities downwards from the Executive to Institutes and Divisions;
- a flow of ideas and specific planning proposals upwards from Divisions to Institutes to the Executive; and
- formation of groups of research users associated with each Division, to advise the Chief on new plans and on outcomes of current plans.

The system will relate primarily to objectives and priorities for research but will also include plans relating to administration, capital works and personnel management.

Planning for research will concentrate on defining objectives in terms that permit assessment of progress. Chiefs will be asked to prepare plans for existing areas of research, and for new ones falling within broad areas of public interest assigned to the Division. Within these areas the object will be to ensure that programs having the highest national priority are given precedence for resources, and that lower priority programs are terminated to free resources for redeployment to higher priority programs.

Plans will include statements of long-term objectives, which may have to look many years ahead depending on the nature of the research, but their principal focus will be on action to be taken over the following five years. Plans will be updated annually. Work has begun on plans for the years 1986/1991. In the first planning cycle the main priority will be to ensure clear definition of objectives and timescales for programs, ways of indicating concrete progress towards the achievement of stated objectives, measures to concentrate effort into nominated growth areas, and timescales for terminating work of lower priority.

A principal feature of the planning system is the formation of mechanisms at Divisional level to involve users of research in planning and the assessment of progress towards meeting objectives. Divisions are now forming advisory groups, based where possible on existing bodies related to the research interests of the Division. These groups will be invited to participate in formulating plans, contributing a perspective from users of the research results. A part of this involvement will be to review with the Chief the Division's success in meeting the objectives of the preceding plan.

Strategy for CSIRO 1985-1990

Issues and Goals

Five Executive working parties were set up in 1984 to consider the following questions:

Balance of research: What are the most effective ways of determining the allocation of the Organization's resources, e.g. across economic sectors, research areas and technologies?

Concentration of effort: How can we achieve the most effective degree of concentration within the Organization in its research programs and projects?

Assessment of benefits from research: What processes can be established to make the most systematic evaluation of the benefits of CSIRO contributions to the community and industry of Australia?

Interaction with industry: What are the most effective means of transferring the benefits of CSIRO research to industry and the community, and making known research needs to the Organization?

Human resources: What are the conditions of employment, management practices and training opportunities which will lead to the most effective use of the Organization's human resources and give greater flexibility to meet changing needs?

From these were identified the following goals:

- to develop more systematic procedures for identifying growth areas and assessing the balance of research across economic sectors;
- to concentrate CSIRO's research effort into fewer research programs focused on fewer national objectives;
- to introduce more systematic evaluation of research;
- to improve the two-way communications of results and information between the Organization and its user groups;
- to develop better management practices and more flexible staffing policies.

Divisional Reviews

Each Division of CSIRO is reviewed regularly to provide an independent check on its progress and the continuing appropriateness of its objectives. The system for conducting these reviews has evolved over the years and the Executive has now formalized and updated it.

The main features of the new system are

- the introduction on a formal basis of 'Chiefs' Program Reviews' to be conducted regularly to assist Chiefs in their management of Divisions and to provide an input to Divisional Review Committees;
- chairing of Review Committees, in general, by an external member of the Review Committee;
- Review Committee membership to include representatives of staff associations and the CSIRO Advisory Council; and
- a more open and consultative review process and consequential elimination of the current post-review consultation phase.

Strategy for CSIRO 1985-1990

Balance of research effort

As Australia's main strategic research organization, CSIRO has major research programs in support of key broad sectors of the Australian economy or community interest. CSIRO is required to make judgments on the extent to which it undertakes research in support of each of these broad sectors.

In recent years, alterations in the sectoral balance of CSIRO's research have resulted largely from the identification of areas for growth based on a number of social, economic and scientific criteria, and the concentration of additional resources into these areas. We will continue to identify areas for growth. The resources for increased effort will come either from redeployment of existing resources or from additional funding from Government or industry.

We will introduce more systematic procedures for selecting growth areas and assessing the balance of research across sectors with emphasis being given to more effective consultation with user groups.

Currently our designated growth areas are:

First priority —

- developing and encouraging the application of computer-based information technologies in all sectors of industry and the community;
- developing technologies that are widely applicable in manufacturing industry;
- contributing to the management of Australia's precious resources, its soils and water, currently being seriously degraded;
- encouraging the development of an Australian space industry;
- developing and applying biotechnological techniques to improve Australian agriculture and create new manufacturing opportunities.

Second Priority —

- controlling plant diseases, which exact an enormous cost from Australia's agricultural industries;
- increasing the value to Australia from primary products through further local processing;
- improving the health of the Australian people through nutrition research.

Other topics may also receive increased resource allocation as a consequence of Divisional or Institute priorities, or through increased contributions from users.

Criteria to be used in determining growth areas and for assessing sectoral balance have been developed (see inset). It is not possible to weight

Criteria for assessing research areas

National Benefits

(1) Wealth generation
Does the area have high potential for making a sustained contribution to the generation of national wealth through exports or in the domestic economy?

(2) Employment generation
Is the area capable of contributing substantially to the level and quality of employment in Australia?

(3) Quality of life
Can the area make an important contribution to upgrading the health, welfare or social amenity of Australians?

Scientific Prospects

(4) Fertility of field
Is the problem amenable to solution through research and does the field of science or technology involved show promise of major developments in Australia on a reasonable time-scale?

(5) Future requirements
Are there potential benefits for Australia in developing expertise in a new field?

Quality of Staff

(6) Availability
Does CSIRO have high-quality staff in the area, or can it recruit new staff or redeploy existing staff after suitable training within a reasonable time?

Funding Requirements

(7) Internal resources
Are the resources required for effective prosecution of the work commensurate with the likely benefits and are they within CSIRO's ability to provide?

(8) External funding
Are there sound prospects of attracting external funds to assist in mounting a viable research effort?

Appropriateness for CSIRO

(9) CSIRO's role and charter
Are the nature and objectives of the research required consistent with CSIRO's role and prescribed functions?

(10) Other research bodies
Are there other bodies that are more appropriate to undertake the work?

(11) Collaboration and contracting-out
Should the work be undertaken in collaboration with other research bodies or contracted-out where appropriate external skills are available?

Utilization of Research Results

(12) Technology transfer
Are there existing or potential customers for the work and sound prospects for effective transfer and, where appropriate, commercialization of research results?

External Commitments

(13) Political or commercial commitments
Are there political or commercial considerations attached to initiation or continuation of work in a particular area?

(14) External relations
Are there special concerns or obligations to national bodies or interest groups that should influence the initiation or continuation of research in a particular area?

these criteria, the relative importance attached to individual criteria being dependent on the objectives of the research and the intended application of results. Nor is it possible to produce a quantitative ranking of proposals based on these criteria. Nevertheless, they are important for examining proposals and sectoral balance more systematically. These criteria cover factors such as:

- the potential of an industry to generate wealth and employment including contribution to exports;
- the promise in each area for major scientific advances and the likelihood that they will be taken up;
- the availability of resources and skills.

Concentration of Effort

As part of the planning process attention will be given to greater concentration of CSIRO's research into areas of the highest priority. Resources allocated to a program will depend not only on its importance but also on the timescale necessary for its effective application. Institutes and Divisions will apply specific criteria when deciding whether to start or stop particular programs of research.

The selection of research topics for priority support and for termination, and the concentration into fewer areas by redeployment, must involve careful assessment of benefits and costs, consultation with users and flexible and fair personnel policies. These aspects are considered further below.

Evaluation of research

Both the quality of the research and its relevance to national objectives are important aspects of programs of research that must be regularly assessed. Division Chiefs will have primary responsibility for evaluating research and informing their Institute Directors and the Executive of the outcome of such assessments.

During the next five years, CSIRO will be emphasizing more systematic evaluation of research in our corporate planning and review processes. Evaluation of the potential benefits of research should be carried out:

- when the decision is made to begin work in a particular area;
- at regular intervals during the course of the research work;

- following completion of the research and adoption of results.

The first (prospective) evaluation will be carried out by the Chief and research staff in collaboration with Divisional advisory committees, which include user representatives, and also, when appropriate, with CSIRO's technology transfer company, Sirotech Ltd.

Periodic assessment of research quality and benefits will be carried out as part of 'Chief's program reviews', as a necessary complement to the formal Divisional review process. Many programs are already assessed frequently as a result of individual management practices by Chiefs, or through longstanding arrangements with funding and advisory bodies.

These evaluations will be used by Divisional review committees which assess the broad objectives and achievements of Divisions. The evaluations at each stage are therefore an important component of the Organization's on-going management process and in the development of our research strategies.

The final (retrospective) evaluation should provide a realistic check on the earlier assessments. It may also provide valuable information for other prospective assessments and for demonstrating the worth of research to the nation. However, evaluating the ultimate benefits of strategic research is a difficult task because the methods for doing this are the least developed. Part of our strategy is to pursue the development of these procedures.

Interaction with industry and the community

CSIRO's interactions with industry, government and the community are an important two-way communication channel we wish to strengthen. We have already implemented initiatives resulting from a number of recent reviews and others will follow (for example, from the recently completed review of external communications). Central to these moves has been the setting up of Sirotech Ltd to assist with the process of taking CSIRO inventions and technology directly into industry and bringing knowledge of industry's needs to CSIRO.

We will build on this effort by continuing to:

- interact with potential customers in the setting of research objectives and in evaluating the results of research;
- encourage more day-to-day contact between staff and potential customers, more secondments between CSIRO and industry and other bodies, and more user-oriented seminars and courses;
- take a more active role in persuading government to adopt policies which will generate greater awareness of science and technology in industry and the community.

Human resources

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 our work environment has enabled CSIRO to employ innovative staff of world class. It is crucial that the Organization 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 in order to be able to respond more rapidly to changing national needs and to maintain the maximum efficiency of staff.

Historically, CSIRO's personnel policies have been tied to those of the public service. This has limited CSIRO's ability to develop the most appropriate personnel management policies best suited to its objectives, role and funding arrangements. We will examine the relationship between CSIRO and the Public Service Board.

Our policies will emphasize training and staff development to improve CSIRO management skills and maintain the effectiveness of all staff. Individuals must be involved in decisions about career changes and accept the need in many instances for retraining.

We will examine the present merit promotion system to ensure it provides adequate motivation for senior levels in the various staff categories. Early retirement and superannuation are other areas we will address. Many staff are deterred from changing jobs because they want to keep superannuation entitlements. Also staff employed for fixed terms have difficulties in preserving their superannuation benefits if they move to other jobs in the private sector. We will be examining superannuation schemes in an attempt to optimize arrangements for all staff.

These areas will be examined, and action initiated, in close consultation with the Organization's line managers, staff and staff associations.

2. Distribution of Research Effort

This chapter sets out the current distribution of CSIRO's research effort and lists research topics identified by the Executive as growth areas for expansion. It forms part of the Organization's response to its statutory reporting obligations. The latter are discussed in detail in Appendix III.

CSIRO has developed a classification scheme which is used to present and describe its research effort. The scheme was originally prepared for strategic planning purposes and contains major sectors broken down progressively into sub-sectors and research areas. The scheme is used in CSIRO to meet management and reporting needs and continues to evolve in line with changes in these requirements.

For 1984/85 the classification scheme was revised and now covers seven sectors including the major new sector, Multi-sectoral Technologies, introduced to highlight the Organization's work in the emerging new technologies of biotechnology, information technology and space technology.

Table 2.1 shows the distribution of resources to research areas as at 30 June 1985 according to this classification scheme. A version of Table 2.1 has appeared in each annual report since the reporting year 1978/79 and, subject to the comments in the following paragraph, it is intended that year-to-year comparisons of Table 2.1 figures should indicate shifts in the allocation of CSIRO research resources between broad sets of national objectives. In this table percentage allocations are presented for professional staff directly involved in programs of research and for expenditure.

In the 1983/84 Annual Report attention was drawn to a new basis for allocating Divisional research programs to the research areas of the classification scheme. The most significant aspect of the new classification approaches introduced in that year was that programs were assigned proportionally to up to three research areas. They were allocated on the basis of the purpose for which the research was conducted, or the most direct Australian beneficiary or user. It was found that some of the research area categories carried forward from previous years were not well suited to this new approach to classification. Consequently a revision of the research area categories was carried out during 1984/85. These various changes to the classification scheme make comparisons between Table 2.1 data for 1984/85 and previous years difficult but are regarded as necessary to present more clearly the Organization's allocation of resources to major industry groups and areas of general community interest. In summary, major changes introduced in 1984/85 are:

- the separation at sector level of resources devoted to multi-sectoral technologies: biotechnology, information technology and space technology;
- the separation at sector level of resources specifically directed to international aid which had previously not been separately identified;
- some reshaping of the sub-sectors, notably in the Conservation and the Natural Environment, Manufacturing and Service Industries sectors; and
- at research area level, a general redefining of the research area boundaries and titles, particularly in the Rural Industries and Conservation and the Natural Environment sectors.

Research now classified under multi-sectoral technologies and international aid was previously classified mainly under manufacturing industries and rural industries, leading to drops in the latter two sectors. Readers wishing to pursue year to year comparisons in more detail should contact CSIRO.

Table 2.2 shows the allocation of financial and staff resources to the Divisions and independent research Units which make up the CSIRO Institutes.

Designated Growth Areas

The Executive periodically designates research areas where growth will be specifically encouraged. For 1984/85, the nominated growth areas were:

- biotechnology
- advanced materials
- generic (broadly applicable) manufacturing technologies
- information technologies
- water and soils
- plant diseases
- oceanography.

Significant changes or developments within each of these areas are described in the following section. For 1985/86, the Executive has revised the list following consultation within CSIRO and comment from the CSIRO Advisory Council. The 1985/86 growth areas are:

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 expansion of research in oceanography has taken place since the area was first designated for growth in 1979/80 and, while the area remains of high importance, the Executive believes that adequate resources are now being devoted to this area. The designation of advanced materials as a growth area has been deferred pending completion of the review of materials science, including advanced materials, which is due in October 1985, and subsequent decisions by the Executive on this review.

Significant changes within 1984/85 Designated Growth Areas

Biotechnology research continued to expand during 1984/85. In Divisions in the Institutes of Animal and Food Sciences and Industrial Technology work increased on vaccine production by genetic engineering and peptide synthesis techniques. The principal targets remain vaccines against rotavirus infections of animals and humans, sheep footrot, helminth parasites of sheep, infectious bursal disease and infectious laryngotracheitis of chickens, cattle tick fever, and cattle tick. Bluetongue is an additional important target. The Institutes' project, in collaboration with the Australian National University, on poxviruses as universal vectors for vaccine genes also received increased support. Research on the modification of the genetic structure of ruminants to gain higher productivity was expanded. The Division of Tropical Animal Science began work on embryo manipulation and in vitro fertilization, which are key techniques in eventually achieving animal gene modification. Work was strengthened in the Division of Animal Production on gene manipulation of rumen micro-organisms aimed at enhancing their ability to degrade low quality feedstuffs for higher energy yields. Additional resources were devoted to research on the genetic engineering of cheese starter bacteria to improve their reliability in factory use. The Wheat Research Unit has increased its effort on the cloning of genes relevant to grain quality. It has appointed a research scientist to work in the Division of Plant Industry, which is taking a complementary approach to the study of genes for cereal grain proteins.

In the Institute of Industrial Technology research on the scale up of biotechnology-based vaccines for infectious bursal disease virus (IBDV) in poultry and footrot in sheep has progressed rapidly and commercial agreements to transfer this technology to industry are currently being established with assistance from SIROTECH. The IBDV vaccine is being developed in an inter-Institute collaboration between the Division of Animal Health, the Division of Protein Chemistry and the Division of Chemical and Wood Technology, funded by a grant from the National Biotechnology Program. The footrot vaccine is being developed by the Divisions of Animal Health, Protein Chemistry, Molecular Biology and the University of Sydney.

The algal technology project in the Division of Chemical and Wood Technology has ended and three professional staff from this area have been transferred to the industrial microbiology section to assist in the commercial development of the IBDV vaccine. In the Institute of Biological Resources biotechnology-based techniques have been given additional emphasis in regard to plant viruses (see plant pathology), studies of the symbiosis of legume pasture plants and Rhizobium (the basis of nitrogen fixation in such plants), work on genes controlling photosynthesis and research into genetic manipulations which may produce better and safer insect pest control systems. With rapidly increasing knowledge of ways of manipulating genetic material, especially through recombinant DNA techniques, improvements in techniques for a range of biological research have become possible. A stage may be approaching at which advances in other aspects of biological research will become the limiting factor in determining the best uses for biotechnology methodologies.

A comprehensive statement on the current research in biotechnology in CSIRO, including areas expanded over the reporting year, is at Chapter 10.

Extra resources for **advanced materials** were not provided during 1984/85 pending the receipt, due in October 1985, of the subject review on materials science and the Executive's consideration of its recommendations. However, the momentum generated by the injection of new resources during the previous reporting year carried over into the current year and several advances were made. In the Institute of Energy and Earth Resources the second stage of the ICI-CSIRO joint project on zirconia manufacture is now under way following a successful search last year for suitable process concepts. ICI Australia is building a $6 million pilot plant in two

sections. The first will be used on a company site to evaluate a new process for extracting crude zirconia from zircon sand. The second, at the Division of Mineral Chemistry, will be operated jointly to test the new chemical purification process. The Division of Applied Physics in the Institute of Physical Sciences has made three research appointments to the area of thin film coatings. Thin films have application in coatings of optical components, hard coatings of tools and gears, and coatings of magnetic material for information storage, e.g. discs. The Division has also designed and constructed a plasma processor for the Division of Mineral Chemistry to produce zirconia from zircon sand for PSZ ceramic. The Division of Materials Science continues to provide scientific support for Nilcra Pty Ltd, whose major new manufacturing plant for the PSZ ceramic was opened during the year.

In the area of **generic (broadly applicable) manufacturing technologies** there was a further increase in staff in the Division of Manufacturing Technology within the Institute of Industrial Technology. Five professional staff have taken up posts in Melbourne to expand the work on robotics, flexible manufacturing systems, artificial vision and computer-aided engineering. Three additional positions are being filled in the Adelaide Laboratory of the Division for work on simulation and production planning and control. Three professional staff in Adelaide have been redeployed into this general area from other programs in the Division. In the newly-established Sydney laboratory of the Division four positions are being filled for work on machine control systems and laser development and applications. In the Division of Textile Physics work on filtration technology has been extended by the appointment of an additional research scientist.

In the Institute of Animal and Food Sciences the Division of Animal Health is collaborating with manufacturing industry on the development of new methods of anthelmintic drug treatment. The Division, together with the Division of Animal Production, is working with a commercial partner in developing the CSIRO-invented sustained release device to deliver anthelmintics continuously or intermittently in the rumen. This will enable a single administration of a device to achieve prolonged control of parasitic infections. The Division has discovered and patented a means of potentiating the action of anthelmintic drugs by the co-administration of another compound which alters the metabolism of drugs in the liver. This will enable the efficacy of certain anthelmintics to be improved or dose rates to be reduced.

The Division of Food Research expanded work on counter-current extraction which provides a highly efficient means of recovering soluble materials. The method has widespread potential in the food industry, especially for juice extraction, and commercialization is proceeding rapidly through Bioquip Australia Pty Limited.

In the Institute of Physical Sciences the Applied Physics Industrial Program has had its first year of complete operation. Five new professional staff have been appointed, and four scientists redeployed, to work in instrument development related to manufacturing. Areas covered include instrumentation for monitoring the shape of large gears, ultrasonic non-destructive evaluation of steel castings, industrial temperature measurement for manufacturing aluminium, cryogenic magnetic separation of minerals and ion-assisted optical coatings.

In the area of **information technology** the highlight of the year was the establishment of the Division of Information Technology within the Institute of Physical Sciences. The Division is setting up laboratories in Sydney and Melbourne to achieve the closest possible linkage with the Australian software and hardware industries and with university groups. During the year the CSIRO Collaborative Program in Information Technology was initiated and $320 000 was distributed to Australian industry and tertiary educational institutions to support collaborative work in information technology with various CSIRO Divisions. In addition, $500 000 was allocated to support further existing Divisional programs and the fostering of developments in software and hardware related to the particular industries served by those Divisions. Elsewhere in the Institute of Physical Sciences, many activities of the Division of Radiophysics are being reoriented towards core fields of information technology. Among these are new programs in gallium arsenide device technology, novel techniques for image and signal processing and special designs implemented on VLSI (Very Large Scale Integration) chips. The Division of Atmospheric Research has developed, jointly with a Melbourne company, a stand alone image analysis terminal capable of sophisticated manipulation of satellite image data.

In the Institute of Industrial Technology, several projects in the Division of Manufacturing Technology relating to artificial vision, modelling of solidification in casting and of control in arc welding have been modified to include some

information technology research related to manufacture. In the Division of Building Research there has been increased commitment to developing information technology, in particular to research on expert systems which will optimize the planning, design and use of constructed facilities and to developing and applying artificial intelligence techniques as computer-based decision support systems for the building industry.

The interests of the Institute of Biological Resources in this field concentrate on the use of information technologies in such applied fields as management decision programs and expert systems. The extensive use of computers and microprocessors in agricultural and biological research was outlined in the 1983/84 CSIRO Annual Report. The year 1984/85 was marked by the successful use of these innovations inside and outside CSIRO.

In the Institute of Energy and Earth Resources specialist integrated information systems are being developed in the Division of Mineral Physics to allow remote sensing data and geophysical data to be modelled and displayed using microcomputers in isolated field offices or in small organizations. The systems are based on computer software developed in collaboration with the mining industry through its research association AMIRA. The Division is also involved in developing portable digital data collection techniques for use in remote and harsh areas.

Research in **water and soils** is concentrated in the Institutes of Biological Resources, Energy and Earth Resources and Industrial Technology. In the Institute of Industrial Technology a continuing change in emphasis in the research program of the Division of Chemical and Wood Technology has seen an expansion in the work on biological techniques for wastewater treatment at the expense of physico-chemical techniques. Research is currently concerned with the disposal of organic materials in domestic wastewater but will be extended to the more intractable materials present in industrial wastewater. Three support staff have been redeployed into this area during the year. In the Institute of Energy and Earth Resources research is continuing in the Division of Groundwater Research on developing better methods for quantitative prediction of groundwater system behaviour and better management of some specific groundwater problems. In the Institute of Biological Resources work has been strengthened on the physical aspects of the relationship between water and soils and on hydrology, limnology and land stability. Related to this, a more closely integrated approach to research on soil/plant/water relations in heavy-textured irrigated soils is being developed as part of project SIRAGCROP, based on the Murrumbidgee Irrigation Area. In the Institute of Physical Sciences, erosion research has been strengthened by the appointment of a research scientist to the Division of Environmental Mechanics to work on aspects of water erosion.

In the **plant diseases** growth area, research in the Institute of Biological Resources is concentrated in the Divisions of Plant Industry and Tropical Crops and Pastures. As foreshadowed in the 1983/84 Annual Report, a senior officer has been appointed as CSIRO's plant pathology coordinator, and has been assessing needs on the basis of the earlier review decisions. Steps have been taken to strengthen the work on anthracnose disease of the tropical legume stylo by establishing a CSIRO-funded group at the University of Queensland. Work on nematodes affecting plant roots has been strengthened in the Division of Soils, partly by the transfer of an experienced scientist from the Division of Horticultural Research. Biotechnology approaches to virus diseases in horticultural crops and pasture plants have been strengthened by additional staffing. Work has commenced on biological control of the weed spiny emex, but at this stage it cannot be predicted whether plant pathogens or insects may prove effective control agents.

This was a year of consolidation in the area of **oceanography**, with the Division of Oceanography approaching full research strength. Staff moved into the Marine Laboratories in Hobart and the new oceanographic research vessel *Franklin* was commissioned. An independent steering committee, having a majority of members, including the chairman, external to CSIRO, was established to oversee the vessel's operation as a national facility, and a separate group has been formed to provide expert technical and management support for the vessel. Projects completed included the Australian Coastal Experiment, a major study of coastal trapped waves off the south east Australian coast, and a series of multi-disciplinary cruises in Bass Strait. In large-scale oceanography, expendable bathythermograph routes have been established using merchant shipping in the western Pacific and eastern Indian Ocean as part of a major international program studying climate predictability in relation to tropical ocean variability. A network of tide gauges to determine mean sea level also has been established as part of this program. *Franklin* undertook its first series

of research cruises to the Coral Sea, while development began on the BUNYIP programmable towed body for the study of ocean microstructure. A study was commenced of surface waves and swell in the Southern Ocean, supported jointly with funds provided on behalf of the off-shore oil industry, with wave rider buoys to be deployed off Tasmania's west coast.

Redeployment

Resources to undertake expanded activity in the Executive's designated growth areas come mainly through redeployment of existing resources. These fall into two main categories: vacant positions released for redeployment by the Executive as a result of the normal process of staff turnover, and personnel redeployed by Chiefs and Directors from work of lower priority or completed work. CSIRO's Budget allocation provided no additional funds to meet increased operating costs in 1983/84 and 1984/85, and insufficient funds were provided to cover the full cost of Government-directed repairs and maintenance and the Occupational Health and Safety Program in 1984/85. These factors required the Executive to cut programs. As a result, fewer redeployed resources were available to support increases in the growth areas.

In the Institute of Biological Resources, main redeployments were:

- the completion of the main round of staffing of the new plant/soil research group based in Perth;
- steps to redeploy research effort in north west Australia from Kununurra to Katherine, where the new work will be mainly on dryland agriculture;
- strengthening of soils work in south eastern Australia and the eastern tropic zone;
- increasing effort on rangelands research (based at Alice Springs and Deniliquin) and on nature reserves (based at Helena Valley, near Perth); and
- transfer of pine breeding staff from Mt Gambier to Brisbane.

Plans have been announced for redeveloping and expanding CSIRO's bushfire research through a National Bushfire Research Unit, with staff based at Yarralumla (ACT) and Aspendale (Melbourne).

Main redeployments in the Institute of Animal and Food Sciences were in:

- the Division of Animal Health which has been able to strengthen biotechnology by reducing the level of some more traditional areas of research in bacterial and parasitic infections and plant toxins;
- the Division of Molecular Biology which has reduced research on cell differentiation and epidermal growth factors;
- the Division of Tropical Animal Science which has ceased research on heat tolerance in cattle;
- the Division of Animal Production where 35 staff have been redeployed into biotechnology since 1980/81 from several areas of research such as early pregnancy diagnosis, lactation anoestrus, environmental physiology, and animal nutrition.

As positions have been filled at the Australian National Animal Health Laboratory, research effort in biotechnology has grown and now involves 40% of the research staff at the Laboratory.

In the Institute of Industrial Technology, 42 professional staff — amounting to 9% of the Institute's total professional staff — redirected their activities in the course of the year either to the Executive designated growth areas as indicated above or to other Institute priority areas accepted by the Executive. In particular:

- substantial redeployments were carried out in the Division of Applied Organic Chemistry to broaden the scope of its biological organic chemistry program and the use of its strategic polymer research to produce specific products in collaboration with three companies;
- in the Division of Textile Physics work on fibre physics has ceased and the effort directed to the more industrially-oriented fabric group;
- in the Division of Textile Industry new projects have begun which will lead to new end products for wool.

Professional staff numbers in the Executive's designated growth areas were unchanged in the Institute of Energy and Earth Resources, while in the Institute of Physical Sciences the main redeployment has resulted from closing the Australian Numerical Meteorology Research Centre, (ANMRC), the build up of construction work on the Australia Telescope, the preparation for closure of the Cloud Physics Laboratory in Sydney and significant moves into projects related to information technology and space technology in the Divisions of Atmospheric Research and Radiophysics. In the Division of Applied Physics the strengthening of advanced materials work and the expansion of the Applied Physics Industrial Program has resulted in a reduction in standards activities. The Division of

Atmospheric Research has made further cuts in cloud microphysics, weather modification research, and smog chamber studies. It has redeployed resources to remote sensing research and to the developing, and subsequent commercializing, of an image analysis system for satellite signals. The ANMRC was closed on 31 December 1984 and its resources were transferred to the Division of Atmospheric Research and to the Bureau of Meteorology. The Division of Information Technology was established primarily with new staff positions and using resources released by the transfer of the VLSI group to industry (See Chapter 10). The Division of Mathematics and Statistics has continued to move resources out of statistical support for biological sciences and into the designated growth areas of generic (broadly applicable) manufacturing technologies, oceanography and information technology.

Table 2.1 CSIRO Research Areas 1984/85

Manufacturing Industries	% of Total Direct Research Expenditure		% of Total Direct Professional Staff	
Technology — based manufacturing industries				
Scientific and electronic equipment and instruments	1.90		2.11	
Chemicals, polymers, pharmaceutical and veterinary products	3.31		3.46	
Fabricated metal products and processes	1.16		1.18	
Machinery and equipment	0.04		0.04	
Not specifically allocated	0.28		0.28	
		6.7		7.1
Resource — based manufacturing industries				
Food and beverages	3.45		4.24	
Textiles and leather	1.99		2.25	
Wood, paper and forest products	1.24		1.38	
Industrial mineral processing and basic metal products	1.26		1.53	
		7.9		9.4
Manufacturing — general				
Generic manufacturing technologies	2.06		2.05	
Advanced materials	3.26		3.81	
Not specifically allocated	0.10		0.12	
		5.4		6.0
Not specifically allocated		0.4		0.5
Total - Manufacturing Industries		20.4		23.0

Table 2.1 (cont.)

Rural Industries	% of Total Direct Research Expenditure		% of Total Direct Professional Staff	
Agriculture				
Cereal Crops	1.63		1.50	
Oilseed and legume crops	0.88		0.76	
Horticultural crops	1.62		1.76	
Fibre and industrial crops	3.04		2.10	
Pastures	2.67		1.89	
Sheep	1.26		1.25	
Beef cattle	2.14		1.56	
Dairy cattle	0.05		0.04	
Intensive livestock	0.07		0.06	
Minor livestock species	-		-	
Agricultural systems	1.56		1.47	
Multi-commodity research	3.77		2.89	
Not specifically allocated	2.75		2.41	
		21.4		**17.7**
Forestry				
Plantation forests	1.45		1.61	
Natural forests	1.05		1.17	
Bushfires	0.33		0.26	
Not specifically allocated	0.06		0.06	
		2.9		**3.1**
Fishing				
Fisheries	2.15		1.62	
Marine biology	0.86		0.68	
Not specifically allocated	0.04		0.05	
		3.1		**2.4**
Not specifically allocated		**0.6**		**1.1**
Total — Rural Industries		**28.0**		**24.3**

Table 2.1 (cont.)

Mineral, Energy & Water Resources	% of Total Direct Research Expenditure		% of Total Direct Professional Staff	
Mineral resources				
Exploration	2.06		2.33	
Mining	0.66		0.75	
Minerals benefication	1.76		2.14	
Not specifically allocated	0.15		0.23	
		4.6		5.5
Energy Resources				
Coal production	1.03		1.17	
Coal utilization	1.95		2.04	
Petroleum, natural gas and oil shale	1.98		2.27	
Renewable energy, energy storage, conservation and use	1.98		2.19	
Not specifically allocated	0.12		0.16	
		7.1		7.8
Water Resources				
Water resource management	2.79		3.18	
Water technology	0.57		0.66	
		3.4		3.8
Not specifically allocated		0.6		1.1
Total — Mineral, Energy and Water Resources		15.7		18.2

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	0.30		0.34	
Land use	0.49		0.63	
Soil conservation and management	1.00		1.12	
Not specifically allocated	0.59		0.65	
		2.4		2.7
Ecology and Environment				
Aquatic environment	0.99		0.79	
Terrestrial environment	1.00		1.01	
		2.0		1.8
Flora and fauna				
Flora	0.72		0.69	
Fauna	2.39		2.09	
		3.1		2.8
Oceans and atmosphere				
Oceans	1.38		0.80	
Atmosphere	1.68		1.73	
Not specifically allocated	0.06		0.05	
		3.1		2.6
Astronomy				
Astronomy	2.37		2.66	
		2.4		2.7
Environmental protection				
Land	0.24		0.24	
Water	0.24		0.20	
Air	0.72		0.80	
Human Environment	0.20		0.17	
		1.4		1.4
Not specifically allocated		-		0.1
Total — Conservation and the Natural Environment		14.4		14.1

Table 2.1 (cont.)

Service Industries	% of Total Direct Research Expenditure		% of Total Direct Professional Staff	
Urban and civil engineering				
Transport systems	0.12		0.13	
Geo-engineering	0.42		0.51	
Construction	1.25		1.53	
Urban planning	0.22		0.27	
		2.0		2.4
Health				
Nutrition and food safety	1.47		1.88	
Medical technology	0.34		0.12	
		1.8		2.0
Physical standards				
Standards	0.28		0.23	
Calibration services	1.79		1.71	
		2.1		1.9
Not specifically allocated		0.1		0.1
Total — Service Industries		6.0		6.4
Multi-sectoral Technologies				
Biotechnology		9.5		8.6
Information technology		3.1		3.2
Space technology		1.2		1.1
Total — Multi-sectoral technologies		13.8		12.9
International Aid				
International aid		1.7		1.1
CSIRO — Research Total		100.00		100.00

Note: Comparisons with previous years may not be possible — see text.

Table 2.2 1984/85

	% of Total Direct Research Expenditure		% of Total Direct Professional Staff	
Institute of Animal and Food Sciences				
Animal Health	2.7		1.9	
Animal Production	4.5		4.2	
Australian National Animal Health Laboratory	2.5		0.7	
Fisheries Research	3.8		2.9	
Food Research	4.6		5.6	
Human Nutrition	1.3		1.5	
Molecular Biology	1.2		1.3	
Project for Animal Research and Development — Bogor	0.5		0.2	
Tropical Animal Science	2.5		1.7	
Wheat Research	0.4		0.5	
Institute Total		**24.0**		**20.5**
Institute of Biological Resources				
Entomology	4.7		4.4	
Forest Research	3.1		3.3	
Horticultural Research	1.0		1.1	
Plant Industry	5.9		5.8	
Soils	2.9		3.4	
Tropical Crops and Pastures	3.9		2.4	
Water and Land Resources	2.3		2.6	
Wildlife and Rangelands	2.9		2.3	
Centre for Irrigation Research	1.0		1.1	
Institute Total		**27.7**		**26.4**
Institute of Energy and Earth Resources				
Energy Chemistry	1.9		1.6	
Energy Technology	1.3		1.3	
Fossil Fuels	2.2		2.5	
Geomechanics	1.3		1.4	
Groundwater Research	1.1		1.2	
Mineral Chemistry	2.1		2.7	
Mineral Engineering	1.9		2.2	
Mineral Physics	2.2		2.8	
Mineralogy and Geochemistry	1.6		1.9	
Institute Total		**15.6**		**17.6**

Table 2.2 1984/85 (cont.)

	% of Total Direct Research Expenditure		% of Total Direct Professional Staff	
Institute of Industrial Technology				
Applied Organic Chemistry	1.5		1.9	
Building Research	2.6		3.1	
Chemical and Wood Technology	2.8		3.2	
Manufacturing Technology	1.7		1.8	
Protein Chemistry	2.0		2.4	
Textile Industry	2.6		1.7	
Textile Physics	1.6		1.7	
Institute Total		14.8		15.8
Institute of Physical Sciences				
Applied Physics	5.6		5.1	
Atmospheric Research	2.0		2.1	
Chemical Physics	1.9		2.3	
Environmental Mechanics	0.5		0.7	
Information Technology	0.3		0.4	
Materials Science	1.5		1.9	
Mathematics and Statistics	1.5		2.7	
Oceanography	1.6		1.1	
Radiophysics	2.9		3.4	
Australian Numerical Meteorology Research Centre	0.1			
Institute Total		17.9		19.7
CSIRO — Research Total		100.0		100.0

3. CSIRO's Commercial Policies

CSIRO's functions under the Science and Industry Research Act 1949 include 'to carry out scientific research....assisting Australian industry or furthering the interests of the Australian community'. Successive governments have accepted the recommendation of the Independent Inquiry into CSIRO in 1977 that the Organization's main role under this function should be to conduct research of a broadly applicable and longer-term nature. This research usually leads to results of a non-proprietary nature, which are made available to potential users through such channels as seminars and scientific and technical publications. However, strategic research often also produces specific products or processes of immediate interest to industry. Additionally, CSIRO conducts a significant and increasing amount of tactical research, particularly for the manufacturing sector, which also gives rise to new products and processes.

The desirability of seeking patent or other protections for new technologies is considered carefully before research results are published in scientific journals or otherwise made publicly available, so that opportunities for commercialization by Australian firms are maximized. Where necessary, publication is delayed for this reason.

A review of CSIRO's commercial practices and policies was undertaken in 1982/83 with the aim of ensuring that they are effective in promoting industrial application. A concurrent internal examination of the Organization's commercial needs was also carried out. A major outcome was the establishment, jointly by CSIRO and other parties, of a company, SIROTECH Ltd. Its principal objective is to provide a business-oriented approach to commercializing CSIRO-generated technology.

SIROTECH does this within a policy framework appropriate for commercializing research results from a Government research organization. The Executive's decisions following the commercial activities review provide this policy framework.

The Minister for Science, the Hon. Barry O Jones, with the Chief of the Division of Chemical and Wood Technology, Dr Warren Hewertson, at the launch of Scrimber. This is a reconstituted timber material, manufactured from young trees bound together with polymers. The Division of Chemical and Wood Technology originated the research and has developed the material in conjunction with Repco.

Aims of CSIRO's Commercial Activities

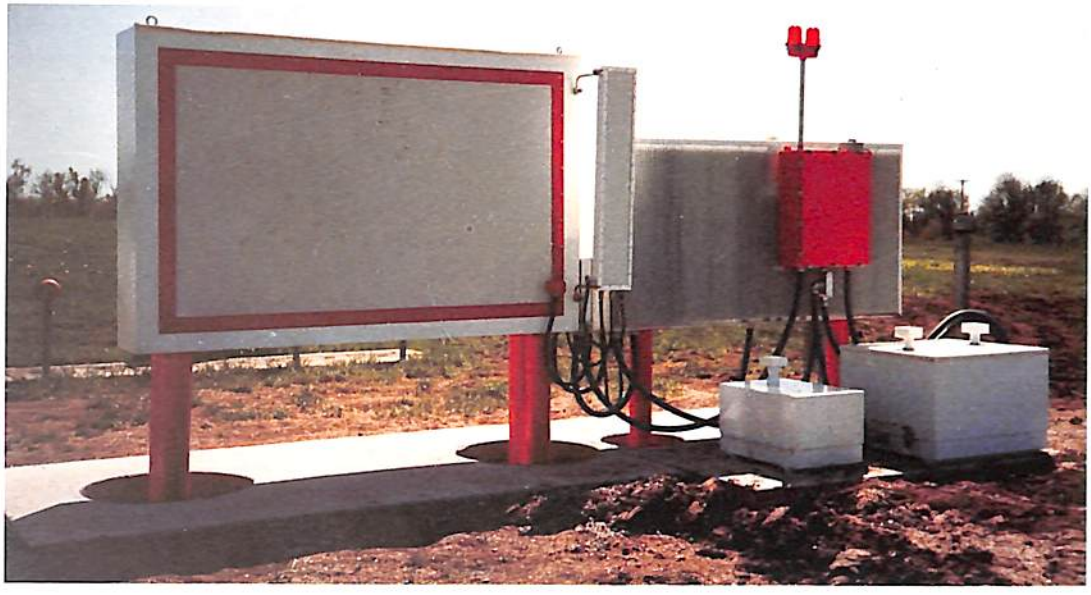
The main aim of CSIRO's commercial activities is to achieve the greatest possible national benefit by contributing to commercially viable innovation. This requires, firstly, research that can be exploited by Australian industry or that will otherwise bring benefits to Australia. This is conditional on the Organization planning its research in close consultation with the industry or community interests concerned. Secondly, CSIRO must choose its commercial partners with care and impose appropriate conditions.

The critical factors in selecting an industrial partner are:

- the economic and social benefits likely to flow to Australia from the partnership, and
- the partner's ability to develop, apply and market the technology.

Normally, economic and social benefits will be maximized through establishing in Australia manufacturing or other activities based on the CSIRO technology. This could be either in an existing industry or in a completely new area of industrial activity. The main benefit to the community comes from the resultant generation of wealth, employment and export income.

At the same time the CSIRO technology with the greatest potential to increase Australian industry's competitiveness will normally be that which industry is willing to pay most for — judged against the cost and profit structure of the sector or sub-sector of industry concerned. A secondary, but important, aim of CSIRO's



In 1978 the International Civil Aviation Organization (ICAO) adopted the principle of the Interscan microwave landing system (MLS) for the new generation landing guidance system for aircraft. The system concept had been proposed by the CSIRO Division of Radiophysics at the end of 1971 and developed jointly with the Department of Aviation.

This success led to the formation by the Australian Industry Development Corporation of Interscan Australia Pty Ltd (now Interscan International Limited) to develop equipment for the world market. Initially, the scanning-beam antenna systems were based on the CSIRO lens technology, but in 1981 the company changed to the development of phased-array technology to meet the needs of the U.S. market.

In association with its American partner, Northrop/Wilcox Electric Inc., the company won its first MLS contract in 1985. Five of the Interscan systems are being produced for the United Technologies Corporation for use on its airfields in Connecticut and Florida. Interscan International and Northrop/Wilcox are also teamed to bid for the U.S. Federal Aviation Administration's next procurement of microwave landing systems.

The photograph shows the azimuth installation of the Interscan MLS at the Richard Gebauer Air Force base in Kansas, USA. The system was installed in June 1985 for flight testing by Northrop/Wilcox.

The Interscan scanning-beam antenna at left was manufactured at Interscan's plant at Rydalmere in Sydney, while the structure on the right houses the electronic equipment built by Northrop/Wilcox. The backup battery power is stored in the boxes to the front of the electronics unit.

Photo by courtesy of Interscan International Limited.

This counter-current extractor is used for removing soluble materials and was developed from a Division of Food Research patent. This is one of two operating in South Australia for producing fruit juice. A third in commercial use recovers peat moss from casing soil used to cover mushroom beds.

commercial policy is to maximize CSIRO's revenue from its commercial transactions.

Licensing and Related Commercial Arrangements

CSIRO policy is that prospective industrial partners should be involved as early as possible in industrially-oriented research projects. Although the first appropriate opportunity for involvement can sometimes arise when potential for industrial application becomes apparent, i.e. when the research is already advanced, the Organization's strong preference is for establishing a partnership early in a project, or even before research has begun.

Whatever the stage of first involvement of a partner, it is CSIRO's policy that, wherever practicable, opportunities for commercial arrangements with CSIRO will be notified publicly to allow all companies with the necessary resources to be considered as possible partners.

CSIRO recognizes that commercial advantage and confidentiality can be key factors in a company's success, and that national benefits are often best realized by arrangements which allow individual firms to maximize their own returns on individual technologies. Therefore, exclusive licences are often negotiated with individual firms.

Occasionally, arrangements with overseas-based firms offer the best avenue for obtaining maximum benefits for Australia. This can apply, for example, when immediate access to overseas markets is necessary, when a product is not able to be manufactured in Australia but is needed by Australian producers or consumers, or where the scale of production is beyond the capability of existing Australian firms. It can also occur where overseas exploitation of CSIRO-generated technology will increase the value of an Australian export.

In such instances CSIRO's policy is to look for a higher financial return from the industrial partner, to seek local manufacture for at least the Australian market where at all feasible, and to provide for future involvement of Australian firms, with appropriate rights, should a local manufacturing capability develop. The Minister for Science is consulted in all such cases, as well as on certain other sensitive transactions, to ensure that CSIRO practices accord with Government policy.

CSIRO policy outlined above gives rise to a wide range of collaborative, contract research and consulting arrangements, in addition to licence agreements. Such arrangements often involve shared patent rights or the payment by the company of reduced royalties where the patent rights are already held by CSIRO.

The precise terms of such arrangements are determined on a case-by-case basis. Rights are proportioned, or royalties adjusted, in accordance with the relative inventive, technical and financial inputs of CSIRO, its industrial partners and other sponsors. The overriding requirement of all these arrangements is that they maximize the overall national benefit.

All licence agreements contain clauses covering non-performance and non-disclosure to third parties to protect Australia's return on CSIRO technology. They also guard against the transfer of proprietary rights, without CSIRO's agreement, in the event of a company takeover.

Further Development of CSIRO Technology

Frequently, translation from laboratory-scale to pilot-scale or to an industrial prototype is needed to confirm the industrial potential of CSIRO-generated technology.

The Organization on occasion undertakes and finances such work selectively to attract industrial partners more readily. It has recently doubled the resources devoted to assisting industry to carry out these tasks.

However, full-scale commercial development of CSIRO-generated technologies must be undertaken and paid for by industry itself, while CSIRO provides know-how and other technical assistance. CSIRO will often contribute to further development even during the production stage by agreeing to conduct additional supporting research.

Other Forms of CSIRO Support for Commercial Exploitation of CSIRO Research

While licensing agreements are the most common form of continuing involvement by CSIRO in commercial exploitation of its research results, exceptional circumstances can arise where equity investment by the Organization may be appropriate. This applies mainly to new companies established to market CSIRO technology, or where a joint venture arrangement for research, development and marketing of a particular technology is agreed at an early stage.

Where the 'public interest' value of a particular technology indicates that Government involvement or equity is necessary or desirable it is CSIRO practice to consult the Australian Industry Development Corporation, which is often the appropriate body for such commercial participation.

4. Research Reviews

Completed Reviews of Divisions

Divisions of Mineralogy and Mineral Physics

As foreshadowed in the 1983/84 Annual Report, the Executive considered the recommendations of the committee which reviewed the Divisions of Mineralogy and Mineral Physics and reached decisions on the report in September 1984.

While noting the review committee's favourable comments on the interdisciplinary strength of the Division of Mineralogy and the management and research leadership of the Division of Mineral Physics, the Executive agreed that the two Divisions required tighter organization and stronger scientific direction. The Executive examined the research interface with the Bureau of Mineral Resources, Geology and Geophysics (BMR) and referred aspects of this issue for further discussion to the Director of the Institute of Energy and Earth Resources and the Director of the BMR.

The review committee's emphasis on the importance of collaboration in research between CSIRO and the mineral industry was accepted by the Executive, which in May 1985 approved a restructuring of the Divisions to improve their interaction with industry. From 1 July, the Divisions are being consolidated into geographically-based multidisciplinary groups.

The Floreat Park, Western Australia, laboratory of the Division of Mineralogy will form the major part of a new Division of Minerals and Geochemistry, which will include staff from the Bentley, Western Australia, laboratory of the Division of Mineral Chemistry. The North Ryde, New South Wales, and Canberra laboratories of the Division of Mineralogy will combine with the North Ryde Mineral Physics laboratory to form a Division of Mineral Physics and Mineralogy. Remaining Mineral Physics staff at Lucas Heights, New South Wales, and Port Melbourne, Victoria, will become part of the Division of Minerals Engineering.

Plant Research Divisions

In February 1985 the Executive considered the recommendations of the review committees which examined the Divisions of Horticultural Research, Plant Industry, and Tropical Crops and Pastures and of the review committee which examined Interactions between Plant Research Divisions.

The Executive concurred with the committees' conclusion that, although plant research was carried out in several Divisions, the present structure allowed each Division to focus on specific areas of rural industry. Broad objectives for the three Divisions, which were to continue to be structured essentially as at present, were set by the Executive. These were based largely on their current objectives but with some variation to either describe more precisely the aims of the research or indicate an expanded role for the Divisions.

Generally the review committees were satisfied with the quality of scientific research in the three Divisions, but the Executive noted and agreed that certain areas required either strengthening, a change of orientation, or further assessment of their relevance. The Executive also agreed with the committees' views on the need for stronger links between groups in the various types of research, and joint involvement in research across Divisional boundaries. This would enable the Divisions to take greater advantage of the respective strengths each had built up.

The Executive noted the Interactions Review Committee's observation on the efforts already made by the Director of the Institute of Biological Resources for increasing interaction between the Divisions of the Institute.

The Executive accepted the committees' recommendations on policy relating to the three Divisions and referred recommendations on management issues to the Director of the Institute of Biological Resources for further consideration in consultation with other Institute Directors.

Several broader issues emerged from the Executive's consideration of the review reports. It was decided that studies should be commissioned by relevant Directors to define more closely the future involvement of the Organization in various agricultural and horticultural activities.

Aspects to be examined include:

- the balance of CSIRO's research work between temperate and tropical agriculture, and the means for correcting any imbalance;
- the organization of ecological research within the Institute of Biological Resources;
- CSIRO's role and future involvement in the genetic improvement of crop and pasture plants;
- CSIRO's role in tropical horticulture research, an area selected by the review committee as needing strengthening;
- the possibility of setting up an integrated inter-Divisional pasture research plan in collaboration with relevant State Departments.

Divisional Reviews in Progress

During 1984/85 the Executive commissioned the following reviews:

July 1984 — Division of Food Research. The review committee's report is expected to be considered by the Executive in December 1985.

September 1984 — Division of Environmental Mechanics. The review committee's report is expected to be considered by the Executive early in 1986.

The following reviews were established to commence in 1985/86:

Division of Groundwater Research
Division of Applied Physics
Division of Chemical Physics.

Subject Review in Progress

A recommendation from the committee reviewing the Division of Materials Science, recorded in the 1983/84 Annual Report, resulted in the Executive commissioning a subject review of CSIRO's role in developing materials science and technology in Australia. The review committee expects to report to the Executive in October 1985.

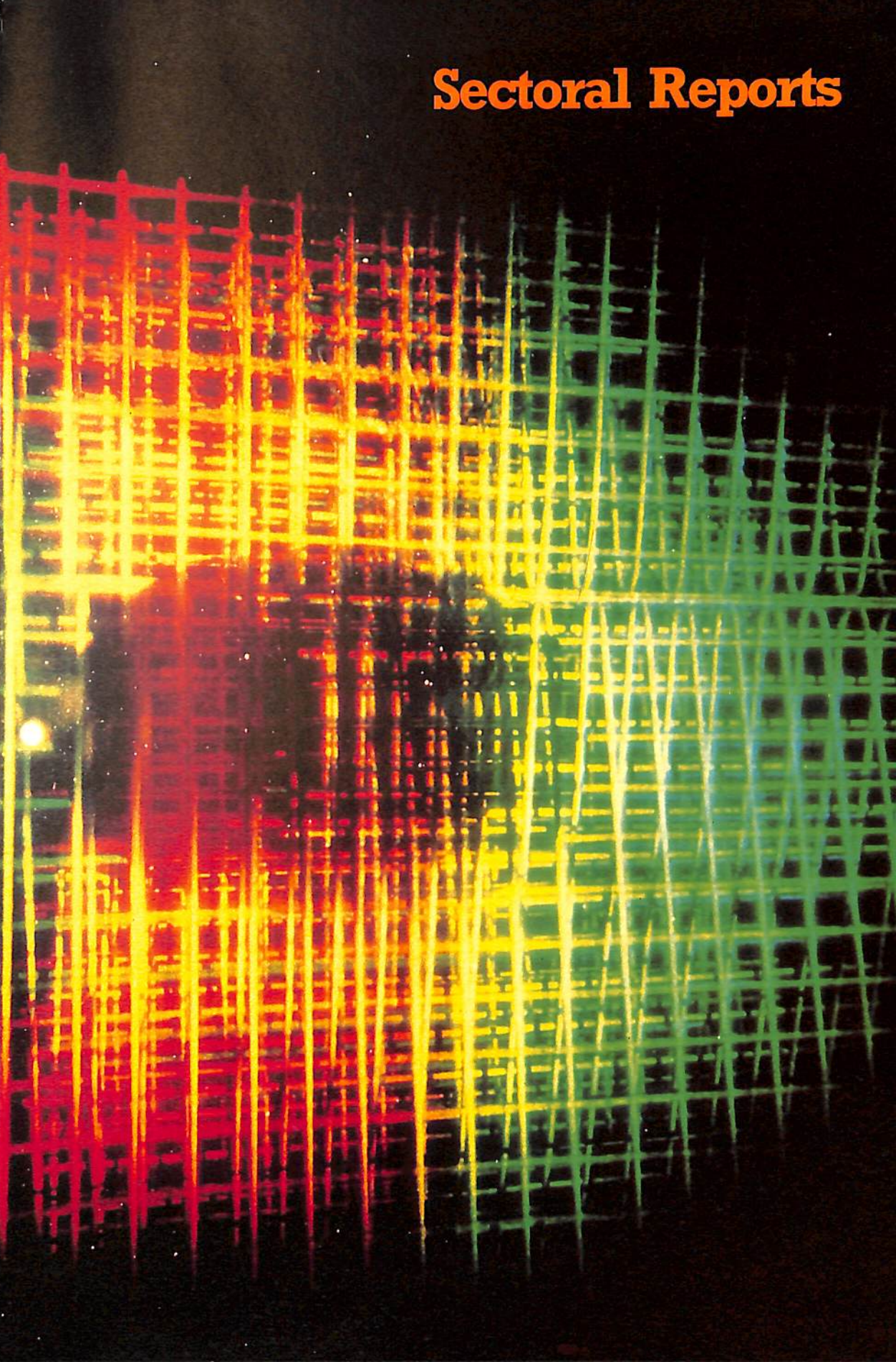
Calibration Services

In May 1985 the Executive considered the report of the review of calibration services commenced in November 1984 (see Chapter 9).

The Executive's main decisions on the report were:

- that a decision on the possible establishment of the National Measurement Laboratory as a separate Division be deferred pending the outcome of the forthcoming full review of the Division of Applied Physics; the need to identify the Division as Australia's ultimate reference point for legal measurement was recognized;
- that a high level Standards Advisory Committee be established involving the Division, the National Standards Commission, the National Association of Testing Authorities, the Department of Defence, representatives of other government users and industry as necessary; this Committee will advise CSIRO on a continuing basis on the adequacy of calibration services offered and on planning for future standards and calibration needs;
- that the Division will seek to conclude bilateral agreements for mutual acceptance of the validity of measurements with the National Standards Laboratories of the United States, the United Kingdom, Canada, Germany and New Zealand, and other bodies as appropriate; and
- that mechanisms will be further developed and implemented within the Division to schedule and monitor calibration services; this will serve to minimize turnaround time and improve calibration efficiency.

Sectoral Reports



5. Manufacturing Industries

CSIRO's policy for research for manufacturing industries, outlined in the 1980/81 Annual Report, stated that resources would be concentrated on research of a more strategic and longer-term nature than is normally conducted by individual firms. It also noted the Government's policy that individual companies should maintain a meaningful stake in research from which they stand to be the main beneficiaries. The Executive, recognizing this and the existence of Government industrial research and development support measures directed specifically at individual firms, confirmed its commitment to CSIRO research that is potentially valuable to large numbers of firms.

The policy was re-examined in the light of experience, and the 1983/84 Annual Report documented an expanded manufacturing industries research policy. It was developed in close consultation with the CSIRO Advisory Council and recognized that CSIRO must respond to industry's immediate requirements as well as its longer-term needs. Criteria were formulated and used to determine eight research topics having highest priority for CSIRO's manufacturing research (see Table 5.1).

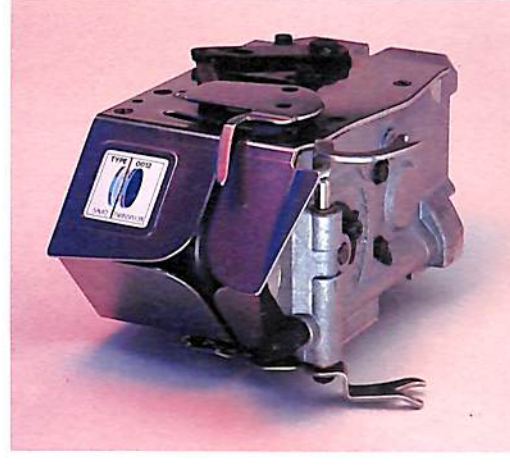
About 27% of the Organization's resources are devoted to research for manufacturing industries, embracing programs in some 20 Divisions. In 1984/85 considerable progress was made in these Divisions towards implementing the manufacturing industries research policy set out in the 1983/84 Annual Report.

Resources have been redeployed into the highest priority manufacturing research topics from lower priority programs. (See Table 5.1). Manufacturing Industry had previously been defined as a high priority area for expansion and now a sub-set — generic manufacturing technologies — has been identified for growth. These technologies include robotics, sensors, flexible manufacturing systems and computer-aided design and manufacture (CAD-CAM), which have the potential to be applicable in a wide range of resource-based and technology-based industries.

In line with a main thrust of the manufacturing industry policy, which states that CSIRO's primary contribution should be conducting longer-term research which can be utilized widely, much of this research is undertaken to increase understanding of how such technologies can be developed to suit Australian manufacturing industry. The knowledge built up through this strategic research is then applied to solving tactical problems. Work in these technologies is centred mainly in the Divisions of Manufacturing Technology and Applied Physics, and resources have been reallocated by the Executive to those areas.

At the Institute and Divisional level further resources have been redeployed into other areas of manufacturing industry not covered by generic technologies, but which are also important. For example, advanced materials, biologically-active chemicals, processing of Australia's mineral and rural resources, energy saving devices and metal fabrication processes are all regarded as important to Australian manufacturing industry, and specific examples of research achievements are given later.

Table 5.1 shows the number of professional scientists in 1984/85 working in each of the eight priority areas designated in the manufacturing industry policy compared with the number in 1983/84. In all areas the numbers at least held steady in the face of general budgetary constraints, and in certain areas there was increased activity. This was made possible by a special government allocation for new policy initiatives, coupled with some internal Institute redeployment and increased external funding. In line with Advisory Council recommendations that growth rate targets should be set for reallocating resources to highest priority areas in manufacturing, the Executive has set a target of 5% internal redeployment of resources for 1985/86, 2½% to



Traditional joining of yarn by knots can cause jams in the machine during knitting and weaving. This mechanical yarn splicer, developed by the Division of Textile Industry, joins ends with a splicing technique that is virtually invisible. Officine Savio Sp A, an Italian manufacturer, is marketing the device commercially.

Table 5.1 HIGHEST PRIORITY MANUFACTURING RESEARCH TOPICS

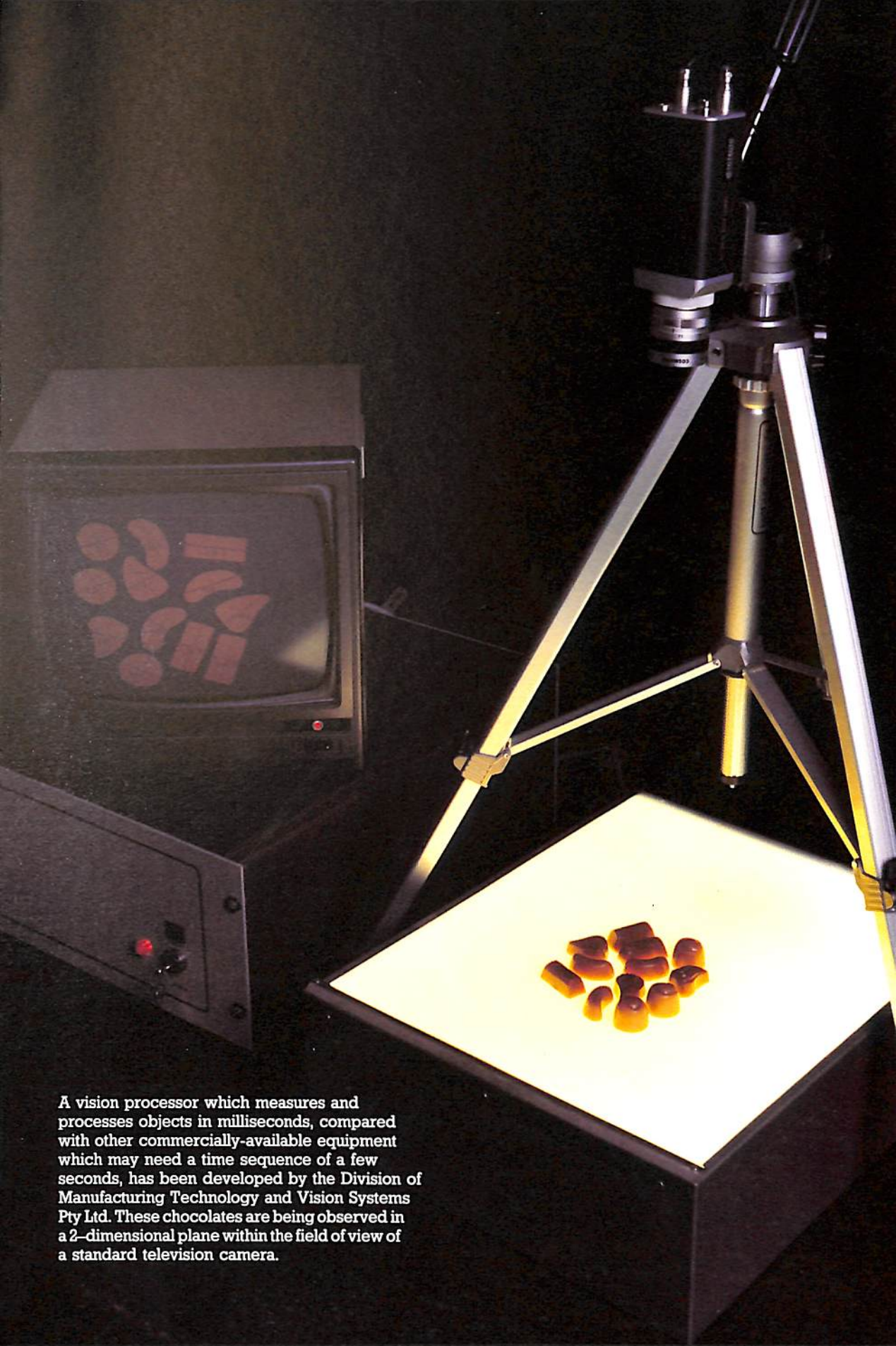
Research Topic	Level of Research Effort (Professional Staff Numbers) 1983/84	1984/85
Application of computer technology and microelectronics to industrial processes	26.9	27.0
Integrated engineering manufacture, particularly flexible manufacturing systems	9.5	9.9
Advanced technologies for process and quality control, including new industrial measurement systems	48.5	54.1
Advanced materials for new applications and for improved performance characteristics in existing applications	96.0	106.9
New technologies for processing minerals to produce materials with special characteristics and to improve production efficiency	14.5	15.7
Instruments and technologies for environmental monitoring and mineral exploration	26.5	31.8
Selected microelectronic devices and communication technologies, particularly devices for satellite communications	8.5	8.5 (45)
Agricultural chemicals, veterinary vaccines and selected medical pharmaceutical products	97.2	111.6 (122.9)
	327.6	365.5

Footnote: A redefinition of some areas has resulted in a substantial apparent increase in activity above the level of effort using the 1983/84 definition. This increase will be incorporated in the base figures to be used in subsequent years. The new base level is shown in brackets.

Executive designated growth areas, which encompass some of the topics listed in Table 5.1, and 2½% to Institute priority areas.

Divisions with activities in manufacturing industry make use of a variety of external advisory mechanisms for inputs into research planning and program selection. For example:

- The Division of Food Research has long had inputs from the Meat, Dairy and Fishing Industry Research Committees for its food processing work.
- The Division of Energy Technology has established a heat exchanger interest group in association with the Boiler and Pressure Vessels Manufacturing Research Association of Australia.
- The Division of Mineral Chemistry collaborates closely with the Australian Lead Development Association.
- The Division of Protein Chemistry has staff members on several technical committees of the Federated Tanners' Association of



A vision processor which measures and processes objects in milliseconds, compared with other commercially-available equipment which may need a time sequence of a few seconds, has been developed by the Division of Manufacturing Technology and Vision Systems Pty Ltd. These chocolates are being observed in a 2–dimensional plane within the field of view of a standard television camera.

Australia and the Sheepskin Manufacturers and Retailers Association.

- The Divisions of Manufacturing Technology and Applied Physics interact with the Australian Welding Research Association, the Metal Trades Industries Association research committees, the Standards Association of Australia and other industry-based committees.

The role of such committees is increasingly significant in helping to set priorities and in ensuring that the Organization's work for manufacturing is relevant and, equally important, that once the research is completed it is used effectively.

Ideally, these committees should represent an industry and speak with one voice for that industry. This would ensure that CSIRO's research was best placed to achieve maximum benefit for many companies. In the highly fragmented manufacturing sector the ideal is not always possible. Currently, discussions are under way with representatives of the car, timber, hides and skins and chemical industries to define industry-wide problems. These discussions will continue in order to define clear directions for research. Discussions will take place with other manufacturing industries as opportunities arise. Many Divisions also receive valuable advice on program selection and planning from individual companies, which frequently leads to collaborative projects with industry. There are now more than 200 such projects in which CSIRO and industry contribute.

Specific Industry Councils were established in 1984 as part of the Australian Manufacturing Council to determine the pattern for future development of the industry concerned. Eight senior officers of CSIRO are members of these Councils and this is proving to be an effective interface between research planning and industry planning.

Much of CSIRO's work for industry comprises longer-term strategic research, which individual companies would not be in a position to carry out. However, a portion of the Organization's effort must be devoted to tactical problems, often in collaboration with a single company. It is not appropriate to allocate a fixed percentage of the Organization's manufacturing industry research to tactical work because the requirements are different for each research program. Indeed, the balance within a Division changes with time.

In line with an Executive decision, Divisions are continuously monitoring their proportion of tactical, strategic and fundamental work and adjusting to current needs. It is essential to maintain an appropriate balance between strategic and tactical activities in Divisions. Many of the Organization's successes are consequences of cross-fertilization of these activities.

The Executive accepted a suggestion from the Advisory Council that, because of industry's short time-scale of planning, it should record predictions of the most likely timing of industrial implementation of its research projects. Consequently, the computerized research project database, which will be established during 1985/86, will contain an estimate of the probable time-scale of all projects. It will also contain an estimate for each research program of the balance between the different types of research, which will provide a means of monitoring both the levels and the changes in the balance between these types.

The Executive has recognized a need to perform an amount of research with objectives set by industry. It has introduced the CSIRO/Manufacturing Industry Collaborative Research Program which, with the help of SIROTECH Ltd, is expected to be under way in 1985/86. Companies and industry groups will be invited to nominate research projects addressing their major immediate technological problems. Selected projects will be established in the appropriate CSIRO Divisions.

The Division of Applied Physics started a similar scheme, the Applied Physics Industrial Program, late in 1983, in which proposals are invited from industry and are assessed by a joint industry/CSIRO committee. The maximum duration of all projects is three years, and the proponents are required to demonstrate their importance and relevance to Australian industry.

Often industry's most pressing problems can be solved with existing knowledge. Recognizing this, the Division of Applied Organic Chemistry is initiating the formation of SIROCHEM Pty Ltd, a high level chemical consulting company which will be a joint enterprise between SIROTECH Ltd and AMDEL. The Division will support SIROCHEM by seconding experienced chemists as consultants, and provide access to the Division's facilities. It is also forming an industrial group to bring industry's research needs into the research project selection process and to communicate results to industry rapidly. The details of the group's formation are being arranged in consultation with the Australian Chemical Specialities Manufacturers Association, representing many Australian chemical companies.

SIROTECH Ltd, CSIRO's commercial assessment and technology company which was

launched in March 1985, will play an increasingly important role in fostering new, and enhancing existing, CSIRO links with industry and encouraging the exploitation of CSIRO's technology by industry. It has already negotiated several major commercial agreements for CSIRO. The agreements range from a licensing agreement for the manufacture of SCRIMBER — a new timber product made from small trees and thinnings — to a joint venture with a large chemical company for commercializing a range of agricultural chemicals.

The Executive supports direct interaction of staff with industry and this is an important part of CSIRO's manufacturing industry policy. Many Divisional staff already spend considerable time with industry. The Division of Energy Technology has established an Industrial Awareness Program in which professional staff are seconded to a company for up to six months, at CSIRO's cost, to work on problems of mutual interest. Most of the Division of Mineral Engineering's professional staff spend up to three months each year working in industry. Conversely, many Divisions have industry staff based in their laboratories for varying periods. The Division of Manufacturing Technology insists on interchange of staff in its collaborative agreements with industry.

The new criteria for research scientists' promotions, which take greater account of technological achievements and successful work for industry, have eliminated one of the previously perceived barriers to increased interaction with industry. CSIRO staff now have a positive incentive to achieve industrial acceptance of their research.

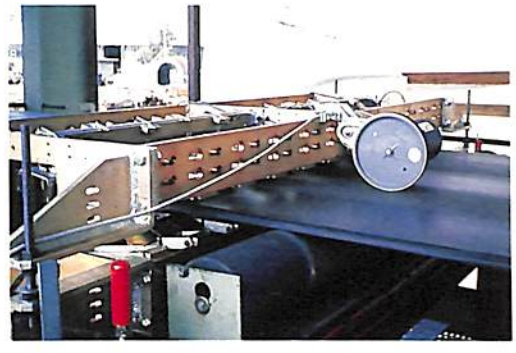
An important feature of manufacturing industry policy is promoting increased industry funding of CSIRO's tactical work. One criterion for selecting research projects is that there should be a demonstrable commitment by industry to exploiting research results. Support may take the form of cash or services. Many Divisions already receive a considerable part of their funding from external sources.

For example, 16% of the research funds of the Division of Chemical and Wood Technology, 15% of those of the Division of Manufacturing Technology and 15% of those of the Division of Mineral Engineering come from external resources. Other Divisions report a small but significant increase in external funding levels over the year. It is hoped that the introduction of the tax incentive scheme for industrial research and development, whereby companies can claim 150% of their expenditure on new research for tax purposes, will result in a more effective collaboration between industry and CSIRO.

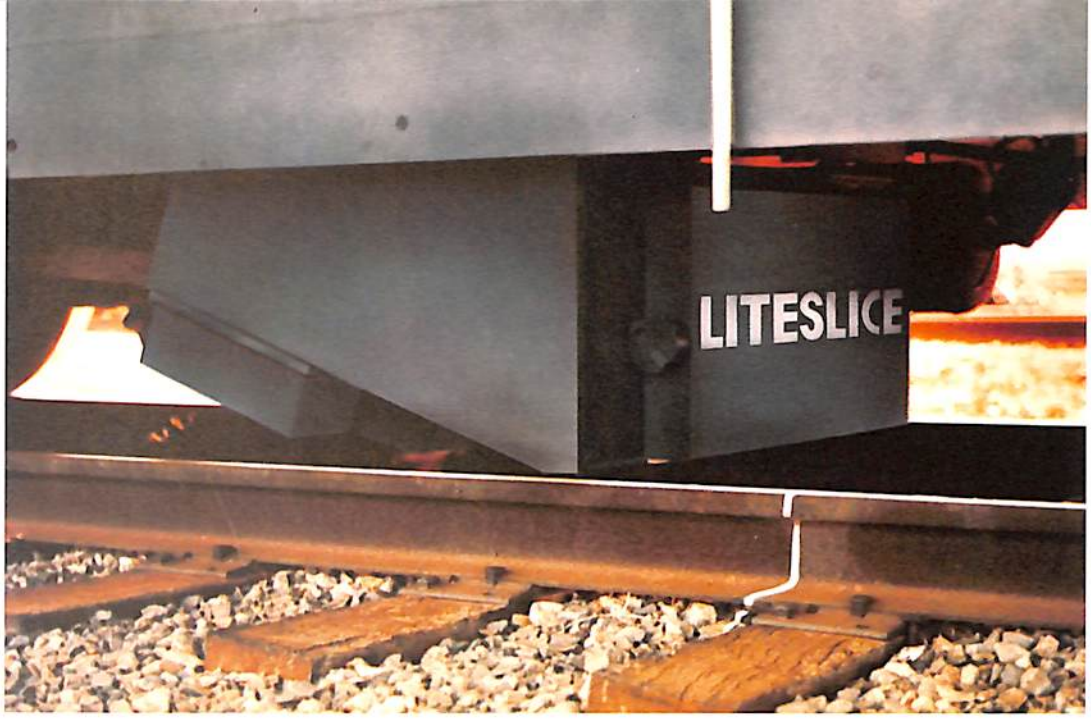
Commercial Development of Research Results for Manufacturing Industry

Many results of research are being developed or show promise for commercial development and discussions are progressing with potential industrial partners. The following list of some recently released, or soon to be released, new products and/or processes is an indication of CSIRO's contribution to manufacturing.

- Satellite data acquisition facility. Developed by the Division of Atmospheric Research, this system is to be marketed by PCM Electronics Pty Ltd with an expected release in mid-1985.
- Rail profile monitor. Worn out rails may cause train derailment. This equipment provides for an annual measurement of rail profiles from test vehicles at travelling speeds up to 80 kph, replacing the previous manual inspections. It is particularly useful where long trains with high axle loadings are in use; for example, in transporting iron ore from Hamersley Mines to the west coast ports. This development has been licensed to Aldetec Pty Ltd of Perth.
- A wireless hearing aid for deaf children. This has been developed by the Division of Applied Physics in collaboration with Plessey Pty Ltd. It is now being distributed by Plessey.
- Conveyor belt monitor device. An innovation from the Division of Applied Physics to detect flaws in belts. This is achieving good market acceptance in Australia and internationally.
- Hand held flux meter. The Division of Chemical Physics developed this device,



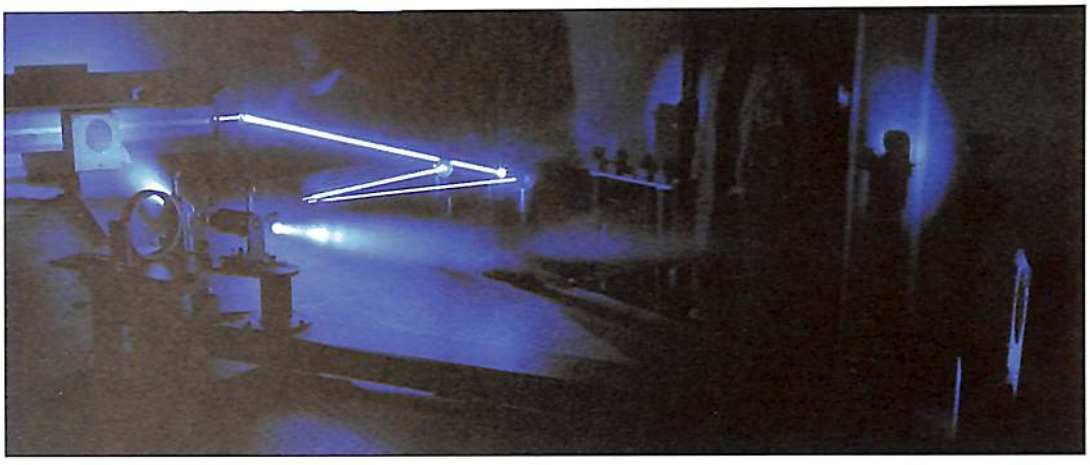
The Division of Applied Physics developed this conveyor belt monitor to detect flaws. It is finding good markets in Australia and overseas.



This rail profile monitor equipment enables railway lines to be measured from test vehicles travelling at 80 kph to detect worn out rails which could cause derailments, especially to long trains with high axle loadings such as are used to transport iron ore from the mines to the ports in Western Australia. It replaces the previous manual inspections.

which will pinpoint the sources of AC magnetic fields. A commercial product dubbed the Gauss Maus, produced in collaboration with the Arlungya Division of the Dindima Group Pty Ltd, is designed to be used in fine-tuning the operation of equipment affected by external AC magnetic fields.

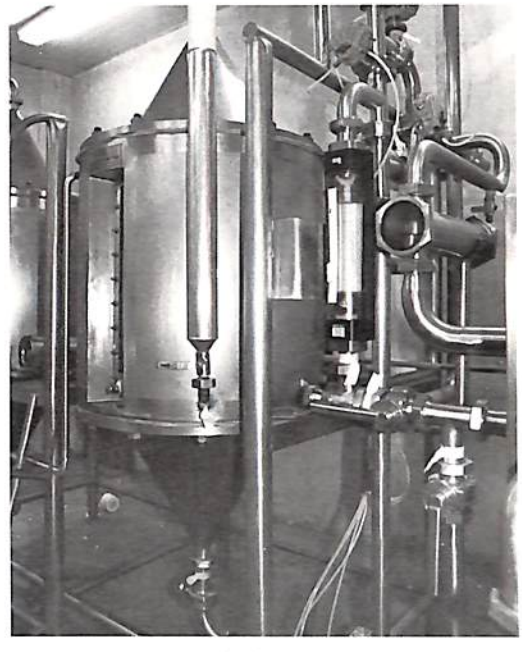
- Holographic diffraction gratings. A manufacturing technique producing gratings of improved quality and reduced cost — originating in the Division of Chemical Physics, in collaboration with Varian Techtron — has resulted in commercial production and incorporation of these diffraction gratings into a range of spectrophotometers.
- Reconstituted timber (Scrimber). This process, using low grade timber bound together with polymers, has reached commercial production of a new material. The research originated from the Division of Chemical and Wood Technology and was developed in conjunction with Repco Research Pty Ltd.
- Pigment emulsified creosote wood preservative. The Division of Chemical and Wood Technology has collaborated with Koppers Australia Pty Ltd to bring this to full-scale production.
- An improved sewage treatment process. The Division of Chemical and Wood Technology has brought this to a field trial with the Melbourne and Metropolitan Board of Works in a plant serving the equivalent of 20 000 people.
- Sirotherm desalination plant. A 1 million litre/day plant developed by the Division of Chemical and Wood Technology in collaboration with ICI Australia Ltd and in cooperation with AUSTEP Pty Ltd, has been constructed in Perth to demonstrate the technology. Markets are being sought.
- Water Clarification (Sirofloc). In collaboration with AUSTEP Pty Ltd, the Division of Chemical and Wood Technology has developed this process which is now receiving international attention. A demonstration plant has been constructed in Britain.
- Cheesebase. A product equivalent to cheddar cheese for manufacture, it incorporates all the proteins from milk and increases the yield of cheese solids. A full-scale plant has been commissioned in the USA by Schreiber Foods Inc., Wisconsin, in collaboration with the Division of Food Research. The technology is now proven and is available to Australian manufacturers.
- Immobilized enzymes for hydrolysis of lactose. The Division of Food Research has developed a system for hydrolysis of lactose in milk derivatives. The product has several potential uses, including forming the base for low-sugar flavoured milks. The first commercial plant is about to be commissioned in an Australian factory.
- Counter-current extractor. This equipment, used for extracting soluble materials, is based



Holographic diffraction gratings, using a high power gas laser to record in photoresist an optical interference pattern. A manufacturing technique developed by the Division of Chemical Physics and Varian Techtron produces gratings of improved quality at reduced cost.

on a Division of Food Research patent. Three commercial units have been installed in Australia; two for producing fruit juice and one for recovering peat moss from casing soil used to cover mushroom growing beds. The Division is collaborating with BIOQUIP Australia Pty Ltd.

- Treatment of effluent from the dried vine fruits industry. The Division of Food Research has developed an anaerobic process treating waste water from dried fruits packing houses which is expected to be operating at three processors at Mildura by the end of 1985.
- An improved cattle slaughtering apparatus. Another product from the Division of Food Research. The technology is being incorporated in the design of a new commercial abattoir.
- Extended shelf life of chilled, vacuum-packed, lamb carcasses. The US Food and Drug Administration has approved a Division of Food Research acetic acid treatment which extends shelf life. This process will extend the range of export markets which can be serviced by surface transport.
- Ceramic reader holders and unlubricated bearings. NILCRA Ceramics Pty Ltd has utilized the novel ceramic partially stabilized zirconia (PSZ), developed by the Division of Materials Science, in ceramic reader holders for a new generation of high-speed floppy discs for computers and also for unlubricated bearings which can operate in dusty conditions in the mining industry. The strength and toughness of PSZ is crucial in reducing the fabrication wastage rate of the disc reader holders — 75 machining operations are necessary to make these



This reactor is part of a full-scale plant to produce hydrolyzed products: liquid milk; milk powder, and whey syrups. The system has serveral potential uses, including forming the base for low sugar flavoured milks. It has recently been installed in an Australian dairy factory.

complex parts — which is unacceptably high when using conventional ceramics.

- Low temperature oxygen sensor. The Division of Materials Science has developed, on a non-exclusive basis with several companies, a new low temperature oxygen sensor to assist with industrial process control where temperatures of 300–600° Centigrade are incurred. Conventional sensors work only above 600° Centigrade. The new sensors are being produced commercially.
- Software for metal forming strain analysis (Sirostrain). An Adelaide company, Kodiak Pty Ltd, is selling a software package developed by the Division of Manufacturing Technology.
- Die design software for diecasting (Metlflow). Originating from diecasting research at the Division of Manufacturing Technology, this is being marketed world-wide by Moldflow Pty Ltd.
- Vision processing system. A collaboration between Vision Systems Pty Ltd, Western Pacific Pty Ltd (a management investment company) and the Division of Manufacturing Technology, is expected to yield a high-speed, low cost, vision device for sale by late 1985.
- Electronically-controlled lead acid battery test equipment. This has been developed by the Division of Mineral Chemistry in close collaboration with industry. Test equipment is now being sold in Australia and overseas.
- Direct smelting of lead (Isasmelt). A new technique developed by the Division of Mineral Engineering, in collaboration with Mount Isa Mines, is going into large-scale operation.
- Field test kit for deficiencies of phosphorus and nitrogen in pastures and crop plants. Australian Fertilizers Ltd has supported the Division of Plant Industry in developing a prototype.
- Splicing of yarns. The Division of Textile Industry has developed an improved splicing technique. A major machine manufacturer has agreed to exploit this technique commercially.
- Determination of gluten in processed foods. The use of gluten in food materials is growing rapidly, and a ready test for detecting its presence is important, particularly for people who suffer from coeliac disease. The Wheat Research Unit has devised such a test based on monoclonal antibodies. An Australian company, Mabco, will release a test kit.
- Protein fractionation, using electrophoretic techniques. This is a development of the Wheat Research Unit for rapid identification of genetic origins of food materials. Equipment and consumable items are being manufactured and marketed by a collaborator, Gradient Laboratories Pty Ltd.

Protein fractionation, using electrophoretic techniques, allows the genetic origins of food materials to be identified quickly. The process was developed by the Wheat Research Unit.

6. Rural Industries

The rural industries sector of CSIRO's research activities includes agriculture, forestry and fisheries.

Agricultural Research

The importance of agriculture to Australia's economy is recognized in the Executive's policies for current and future agricultural research and priorities which were described in the 1981/82 Annual Report. In those policies the Executive emphasized that CSIRO research would establish principles, practices and technologies to improve the efficiency and long-term viability of Australian agriculture and its capacity to respond to changing needs. The Executive also stressed that the Organization would cover all the environmental regions of Australia and seek a regional balance in its agricultural research.

High priority research areas were nominated and included plant and animal breeding for:

- improved performance in production characteristics
- resistance to pests and diseases
- identification of characteristics important in breeding, whether by traditional or novel approaches (e.g. salinity tolerance in plants).

Also included were such areas as soil physics, plant root function, salinity management, biological control of pests and integrated management for irrigated cropping. Future opportunities for new breeding techniques, such as embryo manipulation and recombinant DNA, or genetic engineering, were also recognized. (Because these new techniques are now classified as biotechnology, research concerning them is discussed in Chapter 10).

Forest Research

The Executive's forest research policies in CSIRO have been based largely on decisions arising from the Review of the Division of Forest Research (reported in the 1979/80 Annual Report) and the Review of Forest and Forest Products Problems (reported in the 1981/82 Annual Report). The policies are concerned with CSIRO's role in providing a scientific base for the balanced management of Australia's forests and for providing and using wood and related products. Forests yield a range of uses and values to the community and it is CSIRO's policy that both native and exotic species and natural and plantation forests should be studied.

Fisheries Research

CSIRO policies for fisheries research, embracing fisheries and marine biology, were included in the Executive's statement of policy on marine science in the 1979/80 Annual Report. The statement followed the Federal Government's decision of November 1979 to declare Australia's jurisdiction over the 200 nautical mile fishing zone. CSIRO's stated policy was to continue to support the Government's fishery management agency, the Department of Primary Industry. At that time the Executive decided to split the fisheries and oceanography research functions of the CSIRO into separate Divisions. Oceanography has since been accorded the status of a high priority research area and favoured for growth, and fisheries research has been accorded protected status.

Implementing Policy

The Organization's policies for agricultural, forestry and fisheries research have not changed during the year. However, steps have been taken to implement policies and the following report describes these steps. It also includes details of changes in emphasis in research priorities, especially in agricultural research, as well as brief descriptions of significant research achievements.

Australian National Animal Health Laboratory

On 1 April 1985, the $160 million Australian National Animal Health Laboratory (ANAHL) — Australia's maximum security laboratory for the diagnosis and study of exotic animal diseases — was opened in Geelong, Vic., by the Governor-General, Sir Ninian Stephen. The CSIRO group responsible for ANAHL had been given Divisional status in November 1984, and its Officer-in-Charge promoted to Chief.

CSIRO and the Department of Primary Industry will share equally the operating costs of ANAHL. The present staff of 145 is expected to grow to 180 by 1986/87, with salary and operating costs of around $8 million a year. In September 1984, the Federal Government finalized its decisions on ANAHL's management and functions. The following were the most significant decisions:

- The setting up of a joint CSIRO/Department of Primary Industry Board of Management to be responsible to the CSIRO Executive for the general operation of ANAHL.

The Governor-General of Australia, Sir Ninian Stephen, unveiling the plaque at the official opening of ANAHL, 1 April 1985.

- The appointment of an ANAHL Policy Advisory Committee to advise the Board on major operational policy matters.
- The appointment of a Research Advisory Committee to advise the Chief of ANAHL on the research program.
- A ban on the importation of live foot-and-mouth disease virus to continue until the end of 1987, when the matter will be reviewed by the Federal Government.
- A change in the consultation mechanisms and the seeking of community accord about exotic pathogen imports when microbiological security has been established at ANAHL. The change includes a requirement that Cabinet endorse each importation when the consultation process has been completed.
- The confirmation of ANAHL's functions of diagnosis, research and training. It will also provide diagnostic assistance to south west Pacific countries, including New Zealand and Papua New Guinea, which are free from foot-and-mouth disease.
- Research on, and development of, new vaccines and the testing of locally produced and imported vaccines are to take place in ANAHL. The production of vaccines is to be undertaken if necessary by a commercial vaccine manufacturer.
- State governments are to be involved in ANAHL's epidemiological investigations.

Research programs are already in progress. An ANAHL research team based at the Animal Virus Research Institute at Pirbright, in England, is developing sensitive new diagnostic tests for foot-and-mouth disease. Their aim is to improve the ability of staff at ANAHL in Geelong to diagnose the disease without using the live virus. Current work at ANAHL involves genetic engineering techniques to develop more accurate diagnostic tests and safer vaccines for various other livestock diseases. Currently only those organisms already present in Australian livestock, such as bluetongue virus, are being used for research at ANAHL. However, once the Laboratory's microbiological security has been established, these will be supplemented progressively by exotic organisms that have been approved formally for importation.

Animal Welfare

CSIRO policy on the use and care of animals in its research programs was outlined in the 1982/83 Annual Report. Two bodies have since been formed to advise on the welfare of research animals:

- The Animal Welfare Liaison Group (AWLG) coordinates the activities of the 18 on-site Animal Experimentation Ethics Committees and includes the chairperson of each Ethics Committee.
- The CSIRO Advisory Committee on the Ethics of Animal Research (CACEAR) advises the Executive on: ethical issues; the perceptions and education of the public; views of animal welfare groups; principles to be followed in developing codes of care and practice; and matters referred to it by the AWLG. The Committee has a membership with a wide background, including two CSIRO officers, and members from university philosophy departments, animal welfare societies, livestock industries and a medical research school.

CSIRO Marine Laboratories

The Division of Fisheries Research completed its transfer from the Cronulla, NSW, site to its new Headquarters Laboratories at Hobart during the year. The Hobart complex was opened officially by the Minister for Science, the Hon. Barry O Jones, as reported in Chapter 15. The Laboratories also house the Division of Oceanography. The siting of the two Divisions in the Marine Laboratories accords with the Executive policy of encouraging joint activities and the sharing of facilities and services at regional laboratories.

AIMS-CSIRO Liaison Committee

At a meeting of the Council of the Australian Institute of Marine Science (AIMS) and the Executive in May 1984, it was decided to establish a Liaison Committee to promote research collaboration between the two organizations. This step is consistent with stated Executive policy of CSIRO collaboration with other marine science research bodies to promote the optimum use of research resources in the national interest. The Chiefs of the Divisions of Fisheries Research and Oceanography are included in the CSIRO membership of the Liaison Committee.

Regional Forest Research

The Division of Forest Research has consolidated its regional research activities in the Division's five research stations which, in line with an Executive decision following the Divisional review, have been renamed as follows to reflect more accurately their research activities:

- Tropical Forest Research Centre, Atherton, Qld;
- South Queensland Forest Research Group, Brisbane (St Lucia and Samford);
- Tasmanian Forest Research Group, Hobart;
- Plantation Forest Research Centre, Mt Gambier;
- Western Australian Forest Research Group, Floreat Park.

Research in Western Australia

The 1982/83 Annual Report referred to a proposal to form a collaborative group from the Divisions of Plant Industry and Soils in Perth. Membership is now at full strength and the group occupies temporary facilities at Floreat Park. The group is concerned with the long-term implications of cropping practices for the fertility and stability of the light-textured soils common in western and southern Australia under Mediterranean climatic conditions. With the onset of the dry season these conditions impose severe moisture stress on plants. The group will develop collaborative projects with other CSIRO groups in Western Australia on the role of the pasture phase in cropping systems.

Root/Soil Biology

A CSIRO scientist was nominated to coordinate and so improve the effectiveness of CSIRO's research in root zone biology and root function. The work currently is spread over several Divisions. The coordinator will ensure that the Organization's research is directed towards increased production, reduced fertilizer use and more efficient water use, as well as investigation into such factors as the physiological basis of salt tolerance in plants.

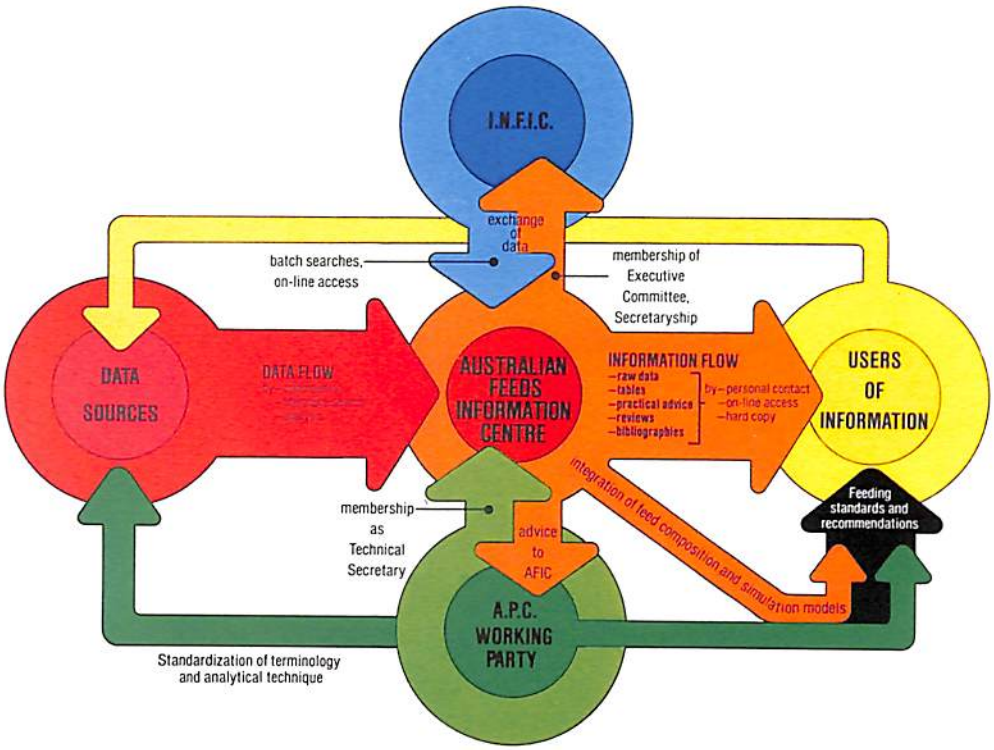
Irrigation Management Systems

The CSIRO policy of carrying out collaborative research with State departments of agriculture has been implemented in the SIRAGCROP program aimed at supplying computer-based information on managing all irrigated crops in south eastern Australia. The program is based at the CSIRO Centre for Irrigation Research (formerly the Division of Irrigation Research), located at Griffith, NSW, in the Murrumbidgee Irrigation Area. The Centre's role is to develop methods of improving the productivity of irrigated crops, particularly in relation to fine-textured soils, and improving efficiency in managing water use in collaboration with other CSIRO Divisions and outside bodies. (See also Chapter 7).

The CSIRO Divisions of Plant Industry, Soils, and Water and Land Resources, the NSW and Victorian Departments of Agriculture, the Bureau of Agricultural Economics, and the Irrigation Research and Extension Committee are collaborating with the Centre in the SIRAGCROP program. Irrigation scheduling of wheat in relation to factors such as soil type, stage of growth and climate has reached the on-farm testing stage.

Tropical Field Crops

Research on dryland crops for the tropics in the Division of Tropical Crops and Pastures is being strengthened by transferring irrigated agriculture resources from the Kimberley Research Station, Western Australia, to the Division's Research Station at Katherine, Northern Territory. The transfer will enable an expansion of studies designed to develop stable farming systems for the semi-arid tropics based on legume leys. The program to develop tropically-adapted soybeans has also been relocated from the Kimberley Research Station to the Burdekin Basin where collaborative research with the Queensland Department of Primary Industries is planned.



A computerized database, prepared by the Australian Feeds Information Centre, helps the livestock industry to recognize the nutritional quality of feeds. The Centre is operated by the Division of Animal Production.

Changes of Emphasis in Research Priorities

Nutrition of Grazing Animals

Renewed attention has been directed towards this area of research. Recent reviews of the activities of the Divisions of Plant Industry and Tropical Crops and Pastures have emphasized that many introduced species — in the southern temperate regions and the tropical north — have been selected primarily for their ability to establish themselves and to persist in the environment. The poor nutritive value of many of these pasture species, as well as of native grasses, throughout much of the year has been reflected in the production per head of beef, lamb and wool which, in Australia, is less than half the genetic potential. Consequently, research is being concentrated on selecting pasture species for nutritional value. For example, work has begun in Western Australia on subterranean clover; in Queensland, grasses with greatly increased digestibility are being tested, and other research opportunities are undergoing thorough analysis.

Research on the grazing animal is directed towards the possibility of manipulating rumen micro-organisms so that, for example, the highly fibrous tropical grasses might be broken down more fully to digestible carbohydrates. Attention is also focused on mineral supplementation for grazing cattle in the tropics. Very poor quality dry season feed is deficient, not only in protein and energy content, but also in the mineral requirements of grazing animals. A device developed by the Division of Animal Production is being tested for delivering supplementary mineral nutrients to sheep and beef cattle. Selected nutrients can be loaded into a capsule which is designed to ensure a slow, steady release of the nutrients into the rumen of sheep and cattle.

Computers are also assisting in managing grazing animals. GRAZPLAN, a major project involving the computerized management of animal production from grazed crops and

pastures, was initiated by the Division of Plant Industry. It aims to develop software enabling managers to explore a range of management options for properties, based on information about their plants, animals, soils and climates.

Immunization for Higher Animal Production

Immunization is an important new direction for research in improving productivity in sheep. This has been borne out by the successful commercial launching in October 1983 of the vaccine, Fecundin, to increase the sheep ovulation rate and hence birth rate. Normal tissue factors inhibit tissue development in animals; they work in concert with other factors which promote tissue growth. Together these factors dictate overall body composition. Selective use of vaccines against the growth-inhibiting factors in economically valuable animals may lead to higher wool production, more meat and less fat on the carcass and other desirable production characteristics. Genetic engineering approaches to livestock breeding parallel the continuing research into the selective use of vaccines, since both depend on a close knowledge of the physiological factors underlying animal productivity.

Plant Pathology

In February 1983 a Plant Pathology Review Committee recommended to the Executive the appointment of a senior plant pathologist to assist the Director of the Institute of Biological Resources. This coordinator was appointed during the year under review to give the desired focus to CSIRO plant pathology research, and to liaise with State departments, universities and other research institutions. This has led to increased collaboration with these bodies. Examples of these activities are:

- Division of Tropical Crops and Pastures, in collaboration with the University of Queensland — research into anthracnose diseases of Stylosanthes species, important tropical pasture legumes
- Division of Plant Industry, in collaboration with State departments of agriculture — a nationwide survey of virus diseases of subterranean clover
- Division of Horticultural Research, in collaboration with the University of Adelaide — a horticultural virology group established to investigate the use of molecular biology techniques to identify and, where possible, eliminate virus-like diseases in fruit species.

National Bushfire Research Unit

Project Aquarius was a three-year project, initiated in 1981, to assess the effectiveness, compared with conventional firefighting methods, of aerial bombing techniques for fighting bushfires. It received special Commonwealth funding for three years. A wet summer in 1983/84 delayed completion of the planned research and funds were made available by the Executive to continue the project in 1984/85.

On the completion of Project Aquarius the Executive decided that CSIRO's expanded bushfire research should continue and a National Bushfire Research Unit was set up in the Division of Forest Research. A sub-unit will be formed in the Division of Atmospheric Research to study fire/weather. This Unit will receive substantial Appropriation funding, but will also seek funds externally. These are expected to come from organizations interested in improving bushfire prevention and control.

Rangelands Research

The Division of Wildlife and Rangelands Research was formed in 1984 by combining the previously-existing rangelands research group and wildlife research personnel in the Division of

These Australian milking zebus, sprecially bred by the Division of Animal Production, give a high milk yield in tropical zones.

Wildlife Research. Additional staff have been allocated to this new Division which has led to a strengthening of CSIRO's research into Australia's arid and semi-arid sheep and cattle grazing lands.

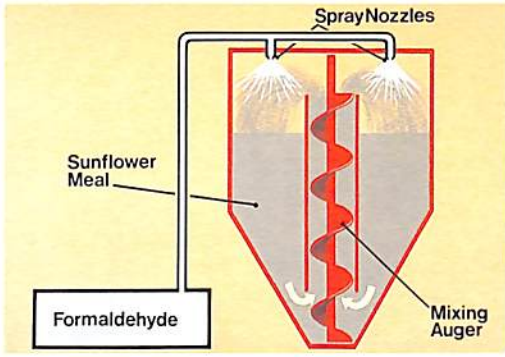
Selected Research Achievements

Division of Animal Health

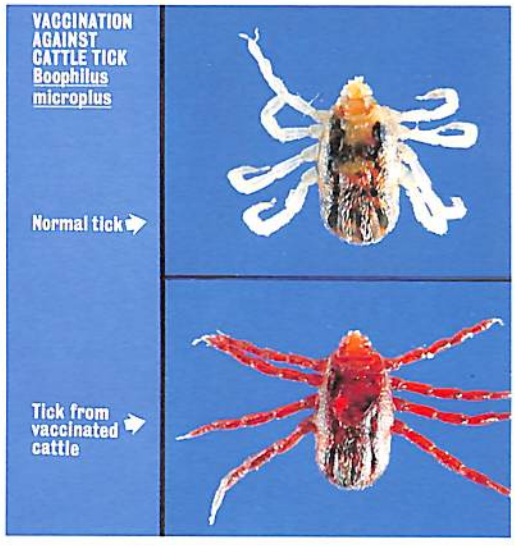
- Developed Wormkill, a chemically-based control scheme for worm parasites in sheep in the summer rainfall zone. The scheme reduces the frequency of treatment required and contends with drug resistance in the parasites. A large pharmaceutical corporation has produced a special formulation to combine the two drugs in Wormkill. In cooperation with the NSW Department of Agriculture, Wormkill has been promoted in the industry and adopted enthusiastically by wool growers in the State's summer rainfall zone.
- Developed a test for the poultry disease, leucosis, which has been taken up by all the major poultry breeders and has proved effective in lowering the prevalence of the disease.

Division of Animal Production

- The Division released a new poultry breed, the SIRO-CT layer, which has an increased rate of egg production. It was bred from an Australorp strain, specially selected for high egg production, and a commercial White Leghorn strain.
- The Division's procedures for formalin treatment of meals to increase milk production in dairy cows have been adopted by the dairy industry, initially in northern NSW. The treatment results in less protein being degraded in the rumen, making more available for conversion into milk.
- There has been renewed industry interest, locally and overseas, in the Australian Milking Zebu, specifically bred by the Division to give high milk production in the tropics.
- The Australian Feeds Information Centre (AFIC), operated by the Division, has prepared a computerized database for the public. AFIC provides details of the nutritional quality of feeds for all types of livestock. It incorporates information from State departments of agriculture.



Schematic diagram showing the process developed for protecting protein meals for increased milk production in dairy cows. A plant based on this system is now in operation at Norco Pty Ltd, Lismore, NSW.



Fifteen million cattle in northern Australia are affected by cattle tick. A vaccination technique which leads to the death of ticks through gut damage, developed by the Division of Tropical Animal Science, has reduced tick numbers experimentally by up to 90%. The red colour of the lower tick is the result of bovine blood leaking from the badly damaged gut of the tick.

Genetically-altered sheep blowflies which introduce genes for sterility and other defects are being field tested. These examples show forms with (a) two deleterious mutuations: rusty body and featherless arista and (b) three deleterious mutations: rusty body, featherless arista and white eye.

Division of Tropical Animal Science

- Research has led to the successful experimental immunization of cattle against the cattle tick, *Boophilus microplus*. Commercial vaccine production, using recombinant DNA technology, is being investigated in a collaborative project with Biotechnology Australia Pty Ltd.

Division of Tropical Crops and Pastures

- Rumen micro-organisms able to break down a toxic chemical in the foliage of the shrub, *Leucaena*, have been identified and introduced from overseas by the Division. These micro-organisms spread naturally in cattle herds in the field. Without the micro-organisms, cattle grazing *Leucaena*, an otherwise highly nutritious legume, can be poisoned by the toxin mimosine and its rumen breakdown products.
- In cooperative research with the University of Queensland and the Western Australian Department of Agriculture, the Division has developed a new system for growing soybeans on saturated soils which produces experimental yields up to 8·0 tonnes/ha, 25% greater than the best yields of conventionally-grown crops.

Division of Entomology

- A commercial system for controlling oriental fruit moth has been developed from the Division's research based on the use of a synthetic version of the natural female pheromone blend and the results have so far been most encouraging. An Australian company, Biocontrol Ltd, has developed and marketed the system in Australia and the USA.
- Australian horticultural industries are benefiting from the use of parasitic nematodes for controlling insect pests. In Tasmania the nematodes are controlling the

currant borer moth and the black vine weevil. The Division is collaborating with the Guandong Entomological Institute in China in developing pest control by parasitic nematodes.

- Genetically-altered sheep blowflies have been released in a major field trial in the Shoalhaven Valley of NSW to test their ability to control wild flies. The altered flies introduce genes for sterility and other genetic defects, such as blindness in females, into the field populations.

Division of Plant Industry

- The Division has produced a new line of linseed by chemical mutation. It has edible-quality oil which could make linseed an attractive alternative crop for wheat farmers. The character now needs to be incorporated into high-yielding lines which are readily distinguished from current industrial-quality linseed cultivars.
- A new variety of cotton plant, SIOKRA, developed by the Division, has enhanced insect resistance compared with existing commercial varieties, yet retains comparable cotton yields and quality.

This isomate dispenser, based on the use of a synthetic version of the natural female pheromone blend, controls oriental fruit moth. Developed by the Division of Entomology, the system is being marketed in Australia and the United States.

Division of Soils

- A soil test procedure — based on research by the Division — to decide on the application of chemicals against cereal cyst nematodes.

Division of Horticultural Research

- A tissue culture system for the rapid propagation of disease-free grapevines, developed by the Division, is now being used by State departments of agriculture, private tissue culture firms and the New Zealand Ministry of Agriculture and Fisheries. Its purpose is to multiply varieties which are limited in supply and to shorten the period required for moving grapevines through quarantine.
- A highly effective water-filled plastic wrap has been developed by the Division for protecting young grafted fruit trees and ornamentals growing in frost-prone areas. The wraps are being manufactured commercially in Australia and have generated considerable interest overseas.

Division of Forest Research

- The Division has developed a simulation model to estimate the economics of bushfire control with different types of aircraft. The model is based on data derived from Project Aquarius. The model also can be used to assess the economics of other approaches to fire management, such as fuel reduction burning.

Division of Textile Physics

- Successfully concluded the TEAM project, begun jointly in 1981 with the Australian Wool Testing Authority Ltd and the Raw Wool Services Department of the Australian Wool Corporation. This project involves including the measurements of staple length, staple strength and clean colour in the woolbuyers' catalogue in such a way that they can use the results in their buying strategy, together with those which have been in standard use since 1972. The use the buyer makes of the additional measurements reflects the use the manufacturers make of them. This represents a radical change in the techniques available to the wool manufacturing industry.

7. Mineral, Energy and Water Resources

Policies

The Institute of Energy and Earth Resources conducts 80% of CSIRO's research into minerals and energy and collaborates closely with mining companies which fund a significant proportion of mineral research. The 1982/83 Annual Report included a policy statement for minerals research covering exploration, mining, and mineral beneficiation, as well as their environmental impact.

The Institute also contributes to CSIRO's manufacturing industry sector through its research into smelting and metals production.

Three major developments during the year have been:

- The Executive decisions following the review of the Divisions of Mineralogy and Mineral Physics.
- The Executive's endorsement, as a priority area, of expanded research on raw materials processing, including minerals, wool and agricultural products; this is a response to the Federal Government's encouragement of secondary processing of materials in Australia to increase export earnings and employment.
- The opening of the Division of Geomechanics laboratory in Brisbane to improve interaction with the coal mining industries of Queensland and northern NSW, and to support Australia's position as the world's leading coal exporter.

CSIRO's policy for energy research was established in 1979 and revised in 1981. Energy research was designated as a priority area for expansion. The budget for energy research in 1979 represented 7.2% of CSIRO research expenditure. By 1983 the allocation had increased to 9.9% and the area employed 10.7% of the Organization's professional staff. At this stage the Executive judged that the area had sufficient resources and should continue operating at this level.

Initially, the production of substitute liquid fuels, especially from coal, received major attention because of the likely shortage of oil. Now Australia's coal export industry, which has grown to some $4 000 million a year, is considered more important. This has involved the development of improved technologies for coal preparation, transport and combustion. Research on substitute liquid fuels is continuing, the emphasis being redirected from coal to oil shale and natural gas as the raw materials.

Water research is a continuing priority area. The Institutes mainly involved are Biological Resources, Energy and Earth Resources, and Industrial Technology. Professional staff numbers have risen in five years from 2.5% to 3.6% of CSIRO's total.

Research is changing to reflect a national trend towards seeking better management of current water resources rather than developing new ones. To this end Divisions are forging stronger links with operational agencies to determine their needs and to ensure that information and suggested management strategies are transferred smoothly.

Recent expansions of research effort have concentrated on three main aspects — groundwater, catchment hydrology and water quality. Increasing emphasis in the first two instances is centred on developing quantitative computer models to help identify the effects of proposed changes in water and land management. Fundamental research on water movement through porous media is complementing applied work on the movement of water through soils and aquifers.

Studies of salinity in irrigated and dryland regions are a feature of water quality research. The pollutant effects of agricultural chemicals are also being investigated. Research into methods of treating saline and effluent waters has now moved to studies of combined physico-chemical and biological techniques.

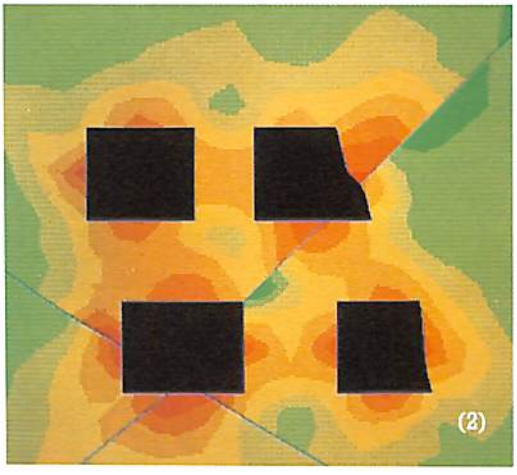
Minerals: Remote Sensing

CSIRO's introduction to Australia of remote sensing by satellite and aircraft, and its subsequent significant contributions to this technology, have laid the groundwork for much of its initiative in space sciences. Several Divisions now use remote sensing technology for research into Australian resources — for example, minerals, water, forests and crops — as well as in atmospheric and meteorological research. The two Divisions most involved in the mineral studies are the Division of Mineral Physics in Sydney and the Division of Groundwater Research in Perth.

The availability of large quantities of data from multispectral scanners flown in aircraft in the past two years has enabled a rapid evolution in the geological applications in Australia of remote sensing. These new systems have offered much greater spatial and spectral resolution than is available from instruments in the Landsat earth resources satellites.

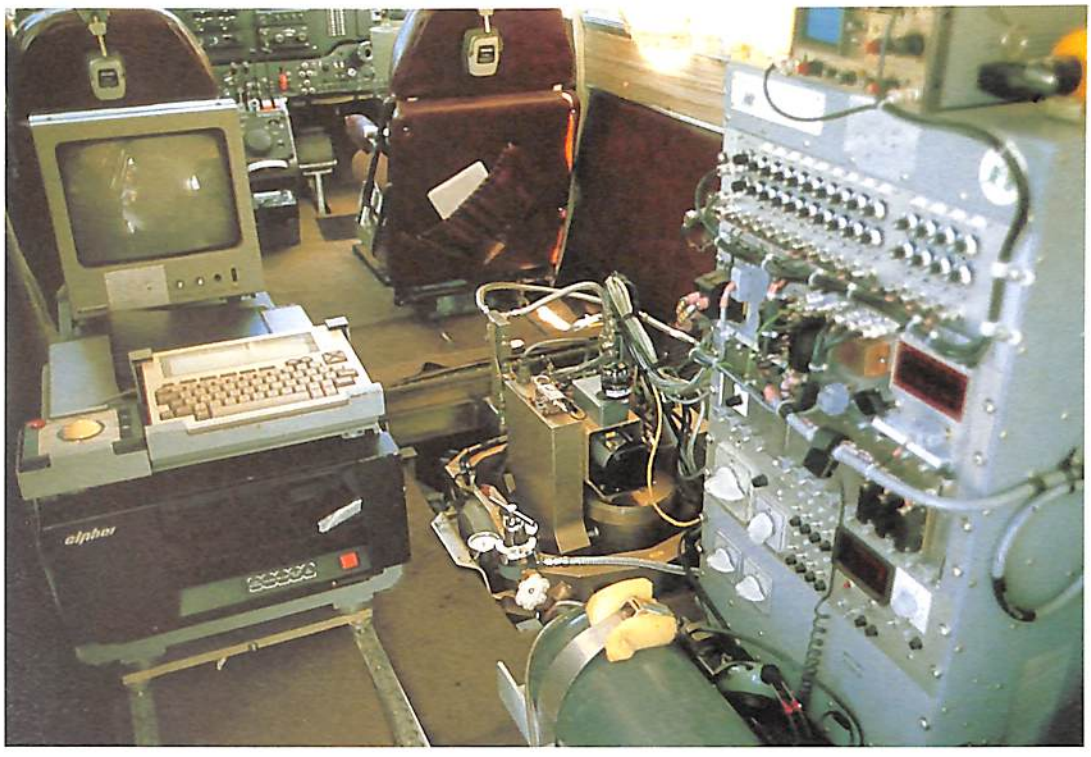
The Divisions had foreseen this development at the end of the 1970s and redirected their research from Landsat to a detailed study of the spectral properties of Australia's terrain. Some

In any excavation work, whether it is for buildings or underground mines, it is vital to know what kind of stresses are placed on the surrounding rocks, both before and after work has begun. The Division of Geomechanics conducts research into improving measurement of these stresses and presenting the results in a helpful way. The mobile hydraulic fracturing unit (1) was designed and built by the Division to estimate natural stress in rocks up to 1000 metres below ground surface. Successful trials of the unit were carried out this year for mining companies and government bodies. The Division uses computer graphics to display other stress measurements made in rocks surrounding underground mines (2). The principal stresses can be seen as contours surrounding the black shapes of excavations. Thus a mine engineer can see at a glance how stable a mine layout is and what might happen if the shape of the excavation were to be changed.



exciting possibilities for identifying minerals have emerged. For instance, researchers in the Division of Mineral Physics have demonstrated that more than 20 minerals containing hydroxyl (OH) groups — such as kaolin, talc, topaz, muscovite — can be identified by sensitive airborne spectrometers. Work in optical and electronic technology is continuing, with mining industry support, to improve the accuracy of this detection technique, which can be especially useful in areas where weathering has produced chemically-altered residual soils. In addition to mapping the more usual clays produced by the weathering process, the spectrometers can map those minerals (e.g. talc or muscovite) that survive weathering relatively unchanged.

The Division of Mineral Physics is exploiting this research through a continuing program of instrument development which includes:



The Carr Boyd-Geoscan 15–channel multispectral scanner, developed by CSIRO, detects water and mineral deposits. Here the scanner is located in a hole in the floor of a light aircraft with the realtime display, tape drive and controls on the left, and the electronic package, Winchester disc and cooling gas cylinder on the right.

- the construction of systems with greatly improved sensitivity;
- a joint study with the University of New South Wales of advanced array detector systems;
- a package of the currently most advanced airborne equipment being brought to Australia, in association with the NASA Jet Propulsion Laboratory, for testing on a wide variety of mineral exploration targets;
- a cooperative project with CSIRONET and the Division of Radiophysics to develop an experimental capability for acquiring thematic mapping data from the new series of Landsat to improve satellite reception and data processing.

The Division of Groundwater Research is Australia's Principal Investigator in the Jet Propulsion Laboratory's imaging radar experiment on the space shuttle missions. The object of this experiment is to see how radar images can provide more information about land topography. The Division also collaborates with other CSIRO Divisions in Western Australia, the WA Institute of Technology and the WA Department of Lands and Surveys to provide facilities for remote sensing research, development, applications and training.

The Divisions of Groundwater Research and Mineralogy and Geochemistry in Western Australia are evaluating jointly the use of data from instruments in the National Oceanographic and Atmospheric Administration (NOAA) satellites to discriminate sub-surface features in the Canning and Officer Basins of Western Australia. The NOAA satellites are used in preference to Landsat because they give a wider coverage, including thermal wavebands, and their data can be taken directly by the receiving station in Perth, set up jointly by CSIRO and the WA Institute of Technology.

Infrared NOAA images taken at night show up ancient river drainage networks now buried by sand. These and other features can be used in geological models constructed to help in the discovery of minerals, fossil fuels and groundwater in unexplored areas. In the Yilgarn Block, in Western Australia, where minerals such as nickel and gold occur, several exploration companies are already investigating prospective areas identified by this method.

Remote sensing technology, being developed by the Division of Groundwater Research primarily to assist water research, has potential use in mineral exploration. For example, techniques developed for the rapid transmission of sea surface temperature maps, derived from satellite data transmitted to the personal computers of fishermen, can also be adapted to transmit other types of data to field geologists.

Energy: Oil Shale Research

Australia's known oil shale resources contain 10–15 times more oil than that found in Bass Strait. However, at 80–100 litres per tonne of shale, the oil content is relatively low. Australian shale deposits differ considerably in composition and processing behaviour from those found overseas, and also among themselves. Consequently, no single existing technology can be applied readily for their exploitation, and the industry needs substantial research and development assistance to develop suitable technologies.

The Institute of Energy and Earth Resources provides a significant part of this assistance, concentrating its research on the important aspects of oil shale treatment. These involve:

- understanding the chemistry of the organic and mineral compounds in the shales and how they behave when heated in retorting;
- establishing the nature of the oils produced by retorting and the upgrading treatment needed;
- developing or improving retorting processes and methods of disposing of spent shale;
- investigating the environmental impact of mining and processing oil shales.

Most of this work is supported by substantial funding from the National Energy Research Development and Demonstration Program and from oil shale companies.

The Division of Mineral Engineering and CSR Ltd have patented jointly a new process for extracting oil from Julia Creek shale which will reduce production costs by $4 a barrel when compared with the cost of existing technology. Spent shale, which contains 6% carbon in coke-like form, is burned in fluidized-bed combustors at relatively high temperatures to provide the process heat required for retorting the incoming new shale. The process is completely self-sufficient in heat and the burning of part of the oil shale to give heat is unnecessary. A valuable feature of the process is the action of lime and lime components, formed in the reaction, to absorb the resulting gaseous pollutants. Not all shales are so amenable and research is now progressing to develop comparable processes for other large deposits.

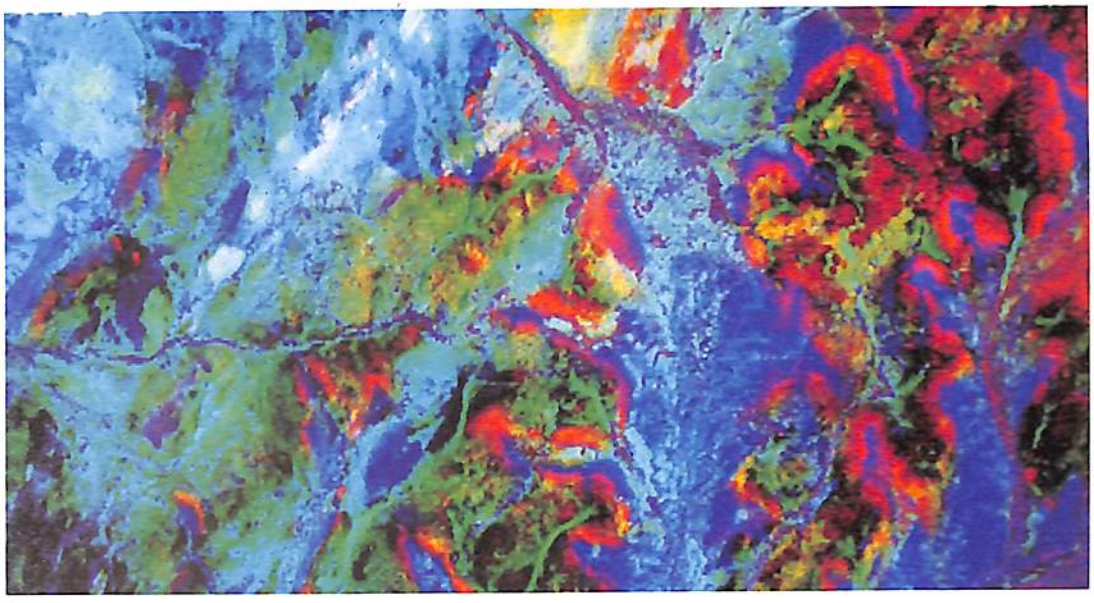
The Division is collaborating with Peabody Australia Pty Ltd in investigating Yaamba oil shales, which contain three groups of shales with distinct processing properties. Several alternative process schemes are being designed to treat the different shale types.

Knowledge of the structure and behaviour of the components of oil shale is essential for developing process concepts, and several Divisions are engaged in aspects of this research. The Division of Fossil Fuels is collaborating with the University of Wollongong in a systematic characterization of all Australian oil shales, as well as studying their geological ageing and the oxidation of their organic matter after processing. It is also developing further its unique method for laboratory simulation of the natural processes of oil shale generation. The Division of Energy Chemistry is using fluidized-bed technology to provide information on the processing behaviour characteristics of seven Australian oil shales. The results obtained from an experimental unit processing up to 30 kg of shale an hour will be added to detailed mass balance and kinetic information to create the most comprehensive large-scale study undertaken in Australia of oil shale retorting. In studies of organic components of oil shales, the Division of Energy Chemistry has already demonstrated that, for some shale types, retorting in high-pressure hydrogen can increase oil yield fivefold.

Data for calculating the heat balances required for the design of commercial oil-from-shale processes have been obtained by using a differential scanning calorimeter at the Division of Mineral Chemistry. When correlated with the results of other analyses, the data define the chemical reactions occurring at various temperatures during the conversion process.

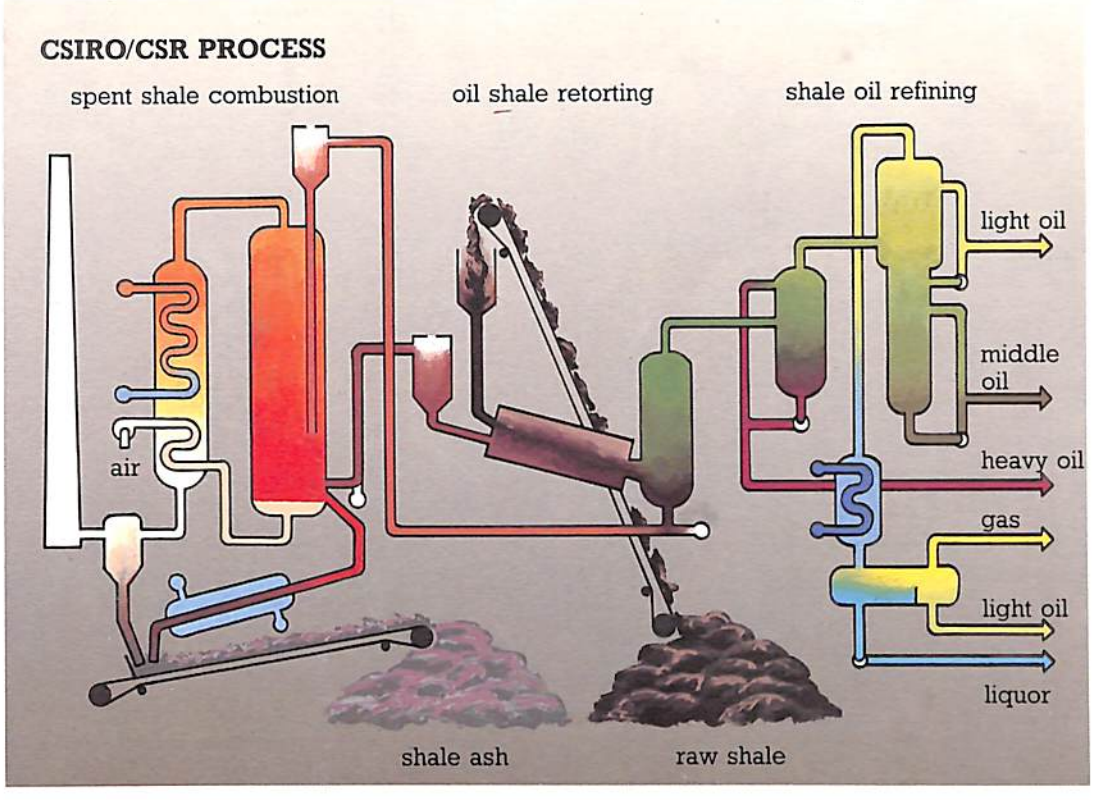
The oil liberated from shale by most retorting processes has to be upgraded to remove impurities such as nitrogen, sulphur and oxygen. Hydro treatment is used for this upgrading. It results in a product similar to crude oil, which can then be converted to liquid fuels in conventional oil refineries. The Division of Energy Chemistry is collaborating with CSR Ltd on techniques to hydrotreat part of the Julia Creek shale oil to produce gasoline directly, avoiding a refining stage; early results are encouraging.

The possible environmental effects are another important aspect of an oil shale industry being investigated by CSIRO. Researchers in the Division of Energy Chemistry are analysing various shales to detect trace chemical elements which could cause environmental problems and to find out if they are mobilized during retorting. The waste waters from shale processing contain some pollutants that are potentially toxic to plant or aquatic life. Studies of their toxicities in fresh and sea water are being assisted through a Marine Sciences and Technologies Scheme grant.



CSIRO is developing new airborne instruments with greater ability to distinguish specific minerals, including a thematic mapper which measures the visible and infrared reflectance of surface materials. In this image of an area near Leonora, WA, iron rich lateritized basalts appear green, weathered rocks rich in clay are orange-red and grass-covered alluvial plains appear blue. Red-orange bands highlight the eroded edges of laterite profiles.

The Division of Energy Chemistry is collaborating with CSR Ltd to develop techniques to hydrotreat shale oil at Julia Creek to produce gasoline directly, avoiding a refining stage. Most retorting processes, using hydro treatment, have to be upgraded to remove impurities such as nitrogen, sulphur and oxygen from the oil.



The Division of Fossil Fuels is conducting laboratory, field and computer modelling studies to help determine the release rate of the inorganic effluents which may be leached from the solid wastes generated by possible Rundle operations and to predict the fate of such leachates in local streams.

The Division of Materials Science, a member of the Institute of Physical Sciences, is working on the development of catalysts designed to upgrade whole shale oil to finished middle distillate fuels (diesel, jet fuel) in a single stage. This requires a catalyst of high hydrocracking activity, while simultaneously having the ability to remove the heteroatom impurities (nitrogen, oxygen and sulphur). The most active commercial hydrocracking catalysts are based on platinum or palladium, supported on zeolite. These catalysts are, however, rapidly poisoned by very low concentrations of sulphur or nitrogen, and their use would require a preliminary hydrotreating step to remove the sulphur and nitrogen. The Division has recently patented a new catalyst system which displays high hydrocracking activity, good sulphur and oxygen removal ability, and a higher nitrogen removal activity than any commercial catalyst tested. Single-stage production of finished middle distillate fuels is therefore feasible. It is expected that the catalyst will also be applicable to other heavy feedstocks, for example heavy crude oil residues, and coal-derived liquids.

Water: Irrigation Crops

Irrigation agriculture accounts for 74% of the water used in Australia. Many irrigation methods employed are inefficient and result in waterlogging of soils, salinization of soils and surface water, and low crop yields. A 20% saving in water used for irrigating would release 2 million megalitres annually — equivalent to the average output of the Snowy Mountains Scheme for irrigating the Murray and Murrumbidgee Valleys.

The Centre for Irrigation Research, at Griffith, NSW, is investigating techniques for achieving these savings, as well as for increasing the yield of irrigated row crops. The research serves the industries involved in irrigation agriculture and government departments or agencies responsible for agriculture and water resources.

A practical result of this research is an on-line computer system, SIRAGCROP, developed jointly by the Centre for Irrigation Research, other CSIRO Divisions and the NSW Department of Agriculture. By linking their microcomputers into the CSIRO host computer, farmers receive irrigation advice, an electronic mail service, news releases and a current events calendar.

During 1985 SIRAGCROP is being tested on 14 farms, backed by an intensive on-farm research program. An essential part of this program is infrared measurement of the foliage temperature of irrigated crops. Since this temperature is sensitive to soil water level, and indicates when irrigation is needed, wastage of water and yield reduction can be avoided. The accuracy of the evapotranspiration data used in the predictions is being refined through a large soil/plant weight device — a lysimeter — located at Griffith.

CSIRO is developing a network of electronic weather stations, accessed automatically once a day by the host computer, to enable SIRAGCROP to be extended to all Australian irrigation areas. The system is also being widened to cover other management aspects of irrigated crops, starting with wheat. (See also Chapter 6).

Specific limitations in the plant root zone severely restrict crop yields and lead to inefficiencies in water use. Exciting results are being obtained at the Centre from techniques developed to combat this problem. Equipment to improve the low productivity of irrigation soils is being prepared for commercial marketing in collaboration with SIROTECH Ltd.

The problem of high water tables and widespread salinization has prompted collaborative work between the Centre and the NSW Water Resources Commission. The basic processes involved in salinization and capillary rise are being studied in an advanced lysimeter facility and at the Whitton Field Station the re-use of saline water is being tested by mixing it with high-quality irrigation water and applying it to a rice crop.

CSIRO Divisions are monitoring soil salinity in irrigation areas as a vital aid in ensuring that irrigation development does not lead to using land in excess of its safe capability. The Division of Mineral Physics is extending the application of its Sirotem technique (used for locating buried conductive orebodies and coal seams by measuring electrical impulses) to determine sub-surface salinity profiles, a technique which could drastically reduce the cost and extend the scope of salinity monitoring. The Divisions of Groundwater Research and Water and Land Resources, with the aid of pictures from the GMS and NOAA satellites, are investigating the measurement of the broad extent of surface salinity and the saline burden of surface soils.

A lateral move irrigator traverses the field automatically and applies a predetermined volume of water to experimental plots by overhead spray. Adjustments enable different rates to be applied to different plots in one pass.

8. Conservation and the Natural Environment

Introduction

The management and conservation of renewable resources have become important issues in Australia in the past decade. The Government has recognized this through its support for the World Conservation Strategy and the National Conservation Strategy of Australia. A prime issue is the impact of human activities on the environment which is the basis for national decisions about competing uses for the land. Submissions concerning areas nominated for World Heritage listings have recognized both Australia's concern to protect, and its responsibility to manage, areas over which it has sovereignty.

Responsibility for conserving and managing the natural environment lies with Commonwealth and State governments through a variety of bodies and legislation. CSIRO research is aimed at providing information and techniques to assist this management.

Areas of research in conservation and the management of the natural environment include soils and land use; ecology and environment; flora and fauna; oceans and atmosphere; astronomy and environmental protection.

CSIRO's role in these research areas is to pursue research that:

- provides the essential theoretical framework and develops appropriate methodologies for resource analysis suitable for Australian conditions;
- develops a general understanding of Australia's land, marine, inland surface waters, plant and animal resources to ensure their sustained diversity, productivity and value;
- provides the basis for ecologically-sound but pragmatic solutions to problems in management of natural renewable resources;
- supports and complements more applied work of Federal and State Government departments; and
- provides a basis for ameliorating the impact of human activity on the environment.

Many of the research problems in this sector can be solved only by supporting interdisciplinary research groups. For instance the physical ecology group in the Division of Environmental Mechanics — consisting of mathematicians, physicists and plant physiologists — actively studies the nitrogen cycle between soils, crop and pasture plants and the atmosphere in collaboration with agronomists in the Divisions of Plant Industry and Tropical Crops and Pastures.

Soil Resources, Conservation and Management

The basic mapping of Australian soils has been carried out by the Division of Soils. This has required inter alia the development of a classification suited to the Australian situation, but compatible with major classifications used elsewhere in the world. The Division has also developed techniques for soil and mineralogical analysis which have broad applicability, for example, the widely used neutron moisture meter.

Most research on soil conservation in CSIRO is carried out in the Division of Soils. It concerns soil inventories, stability, nutrients, and infiltration and runoff of water. Soil conservation has also been included in the goals of programs in other Divisions — Water and Land Resources, Wildlife and Rangelands Research, Tropical Crops and Pastures and Environmental Mechanics.

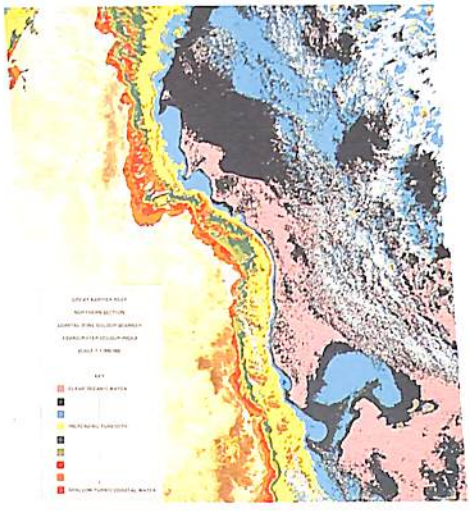
A 'gentleman's agreement' more than 50 years ago assigned responsibility to the States for ad hoc and local problems of land management. The then CSIR's role was to pursue research to enhance the general understanding of important processes in the environment and to provide knowledge to support and complement the States' more applied work. This role remains valid, although certain State departments now have research arms strong enough to undertake some national work.

Land Use

The obligation to conserve the values of land — productivity, water yield, nature conservation, living environment — is shared by many groups, including owners, managers and State governments with legal title or planning control.

Research in this field relevant to the Organization is strategic, including the understanding of inter-relationships at a geographically detailed level and over a wide scale, the development of frameworks for planning and management and education in management principles.

The Division of Water and Land Resources program on Resource Management aims to develop explicit, computer-based methods of inventory, evaluation, planning and management of land and water resources covering a wide range of potential uses including agricultural, pastoral, forestry, conservation and recreation. The methods provide reliable predictions of the probable ecological and economic outcomes of a particular use. Much of the methodology



Phytoplankton distribution and water masses

The blue band allows delineation of current-induced transport of phytoplankton between the Great Barrier Reef and reefs in the Coral Sea (the striking jet off Cairns). The band combinations processed by the BRIAN computer system at CSIRO Division of Water and Land Resources allow delineation of distinct optically-separated water masses — oceanic, shelfbreak, GBR lagoon, nearshore and coastal types.

Ultimately the environmental data from remotely sensed imagery will help assess the distribution and status of the corals — through a combination of field checking and low level remote sensing from aircraft during surveys planned on the basis of the general level satellite imagery.

developed has anticipated needs rather than responding to existing needs.

A second program in the Division of Water and Land Resources undertakes multidisciplinary research directed at producing new methods for land resource analysis suitable for Australian conditions using satellite imagery and computer-based techniques for survey, monitoring and data analysis. Current emphasis is directed towards cost-effective methods suitable for government agencies and environmental consultants with limited computer facilities.

Research on rangelands aims to develop appropriate management strategies that will maintain arid and semi-arid land used for the extensive grazing of sheep or cattle in a stable and productive state. These strategies are ecological in nature and depend on an understanding of how the vegetation changes in response to climate and management. Most emphasis is placed on fire regimes and grazing strategies. Rangelands research also involves developing systems for monitoring the condition of these lands by ground survey or by the enhancement of satellite imagery, and the effect of economic structures and land tenure on the adoption of appropriate management practices.

CSIRO's role in research into landscapes is typified by experimentation which, from its strategic nature, is often medium- to long-term, and by its relevance to land management for water yield and quality, and to nature conservation, grazing use and wood products.

Few government departments are active in this field. Some collaborate with the Organization; for example, the Department of Defence in conserving training areas and the Great Barrier Reef Marine Park Authority (GBRMPA) in marine park management. In land resource studies, the multidisciplinary, computer-based strategic research carried out by CSIRO makes use of basic geographic source data from the Australian Survey Office and the Division of National Mapping in the Department of Resources and Energy . As a result of methodology developed for analysing land resources, CSIRO computer packages are now used by State government land resource agencies, such as national park services and forestry commissions, and also by local government.

An important and effective avenue for transferring technology and results to users such as government departments is through collaboration, both in planning and carrying out the research. Remote sensing projects developed in this manner include the Barrier Reef Image Analysis System (BRIAN), used by the GBRMPA

for management and a package to assist the mapping of shallow waters and offshore reefs used by the Australian Survey Office. The estimated savings as a result of the latter research and development are $21 million compared with the costs of traditional survey methods.

Ecology and Environment

This area covers both terrestrial and aquatic environments. In the former, CSIRO contributes significantly to Australia's research effort in plant and animal ecology, especially strategic long-term research which can serve as a basis for shorter-term collaboration with State departments and universities.

Research on plant ecology concerns the fundamental processes by which fire, grazing and nutrient levels affect natural plant communities. These three factors exert profound influences on the structure, composition and biomass of plant communities, which in turn affect water runoff and quality. The conservation of Australian native plant communities is enhanced when research provides an ecologically-sound basis for management, for example, the use of host-specific agents for biological control of introduced weeds. Other programs in plant ecology investigate the effects of physical processes on organisms and their relation to the energy balance and evaporation at the earth's surface, to fertilizer use, and to environmental quality.

CSIRO provides strategic research information in animal ecology for use by State departments which have the administrative responsibility for managing wildlife. Research projects are generally long-term and are less likely to be undertaken by State departments or by tertiary institutions. CSIRO aims to develop an awareness of the factors that control animal populations and the chemical and biological understanding of parasites and attractants that may be used in control programs. Emphasis is also placed on understanding the distribution, dynamics and role of species groups or communities that are of conservation interest.

In addition, research is undertaken in several environments in which plant and animal ecology are closely integrated, for example, tropical monsoonal wetlands, the arid zone, rainforests, and nature reserves isolated by clearing in the Western Australian wheatbelt.

The aquatic environment concerns surface inland waters and the marine environments. Ecological studies on inland waters (limnology) are directed towards evaluating factors which affect water quality and the reliability of supply. They aim to improve the understanding of the systems and their management for various uses, such as providing water and recreation facilities. Research is also directed at the biological and entomological control of aquatic weeds which interfere with water supplies. CSIRO is well placed for this research in terms of expertise, national level of responsibility, infrastructure and availability of research facilities both within Australia and overseas. State water resource authorities and tertiary institutions collaborate or cooperate in most studies.

In the marine environment the Organization undertakes research into biology, ecology and the dynamics of marine plant and animal populations, and supplies information for developing management strategies for Australian fisheries.

There are more than 100 professional ecologists in CSIRO, most of whom work full-time on ecological projects. Some extensive projects are Australia-wide, but intensive or regional projects are concentrated around regional research centres, especially in south-eastern Australia. Moves are being made to increase the research effort in tropical regions. Ecosystems receiving most attention are open forests, woodlands and grasslands. The most common research themes are habitat management, particularly pest management and species conservation, followed by temporal fluctuations, plant-environment interactions and spatial heterogeneity.

The results of plant ecological research have been transferred to users as management plans. Animal ecologists have developed a methodology for extensive aerial surveying of large kangaroos which is being used by wildlife services of several State governments to monitor population levels of harvested species. The results of research on aquatic weeds are transferred to Federal and State bodies through the National Coordinating Committee for Aquatic Weeds, a joint committee of the Australian Agricultural Council and Australian Water Research Council.

In the rural research sector, State government departments concerned with agriculture generally have capable research arms. In conservation and the natural environment, resources in research arms in State authorities have been relatively smaller than in agriculture. Consequently CSIRO plays an important role in management-oriented research through consultancies and collaborative projects.

Flora and Fauna

CSIRO has a coordinating role with research interests in flora and fauna that transcend State boundaries. The Organization also has an active role in studying the evolution of Australia's unique flora and fauna.

Its work on endangered plant species has involved a national survey of species believed rare or threatened in Australia. A start has been made on collecting the seed of endangered species which is to be stored in newly-established long-term, low-temperature seed storage facilities.

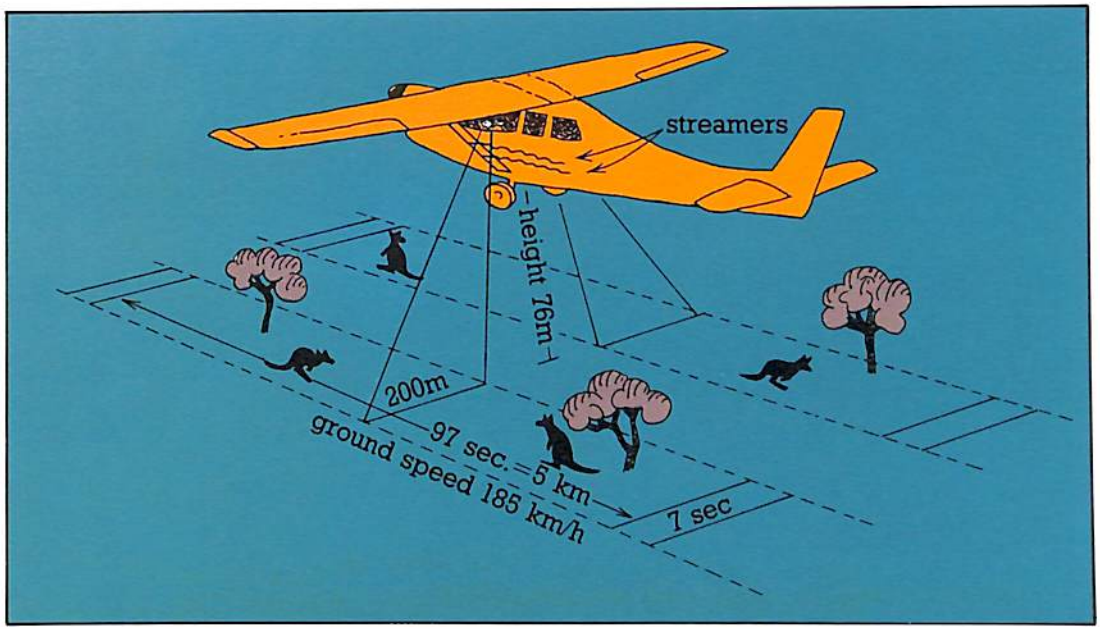
Aerial Surveying of kangaroos

The technique of counting animals from the air has been widely adopted. It involves flying at a height of 76 m above the ground at a ground speed of 185 km per hour with two observers counting kangaroos over a 200 m wide strip of ground, viewed through their respective side windows and demarcated by an outer and inner trailing streamer attached to the wing strut. Counts are made along each transect within a time interval of 97 seconds (= 1 sq km per observer) followed by a break of 7 seconds. A set of calculations has been developed to convert the number of kangaroos counted into the number of kangaroos distributed over the area covered by the full map sheet.

Plant taxonomic research is concerned with the discovery and delimitation of species of the Australian flora and with their patterns of variation, relationship, distribution, reproductive biology and evolution. Another stream of research is related more directly to the genetic basis of variation in identified resource stocks, including wild relatives of cultivated plants, potential new crops and disease organisms with which they interact. This line of research aims to develop techniques and principles of exploiting and conserving germplasm.

In the field of entomology, CSIRO has a significant role in research on all aspects of the systematic biology of the Australian insect fauna, with a strong taxonomic bias.

The Organization is responsible for developing and maintaining three national biological collections, each gazetted as a national heritage by the Australian Government. They are the Australian National Wildlife Collection, the Australian National Insect Collection and the Australian National Herbarium. Collections are also maintained of Australian fish and of unicellular marine algae. They are curated to high standards and provide much unique information about our flora and fauna and, to a lesser extent, those of other countries. These collections serve a variety of purposes. Each is used for research on intra-species diversity, taxonomy and evolution. Taxonomists involved in the Insect Collection, for instance, collaborate with and provide services to scientists engaged in



The new CSIRO Marine Laboratories at Hobart, Tas., built to accommodate the Divisions of Oceanography and Fisheries Research. The buildings were architecturally designed to harmonize with the historic Battery Point area.

economic, systematic, behavioural and ecological studies relating to insects. The Herbarium is important in studies of genetic resources represented by native species related to crop plants.

Basic research is also undertaken on the physiology and habitat requirements of vertebrates, particularly Australian marsupials. This includes the physiology of reproduction, development, water metabolism, thermal exchange and nutrition. The results are valuable to ecologists dealing with strategic research.

The publication of a national list entitled Extinct and Endangered Plants of Australia, which has been updated three times, gives conservation authorities and others access to the results of studies on rare and threatened plants.

Oceans

In the 1980s it has become apparent that the surrounding oceans play a significant but ill-understood role in determining Australian weather and climate.

In 1980 the Government agreed to a $25 million package for expanding CSIRO's oceanographic research, involving the creation of a new Division of Oceanography and the relocation of the marine science complex to new facilities in Hobart. A purpose-designed and built oceanographic research vessel, *Franklin*, to be operated as a national facility, was part of the agreed package.

The Division of Oceanography has prime responsibility for investigating the oceans and applying results for the national good, while the Division of Atmospheric Research has a subsidiary effort concerned with air-sea interactions and remote sensing of sea surface temperature. The work of the Division of Oceanography concentrates on physical oceanography with a subsidiary effort in chemical oceanography. That Division's objectives and their raison d' être are:

- identifying and quantifying the link between the dynamics and thermodynamics of Australian regional waters and the variability of local and global climate;
- quantitative description of regional current systems and phenomena and their physical controlling mechanisms to assist the design of marine structures, navigation, ship routing, search and rescue, pollution and waste disposal, and fisheries resource assessment;
- characterization of principal water masses in relation to subsurface transfer, the supply of nutrients and deep ocean circulation;
- description of the sea surface state such as waves, swell, and storm surges in relation to wind and weather and the influence of the surrounding seas upon continental weather;
- determination of the basic chemical processes and pathways involved in interaction between the water column, atmosphere, the bottom and marine biota; and
- dynamical, chemical and biological interaction between the deep ocean, continental shelves and nearshore zones, to define the basic primary productivity of Australian coastal waters.

Atmosphere

In atmospheric research, CSIRO's role is to introduce new ideas into the study of atmospheric processes, particularly into the study of weather, climate and atmospheric pollution to promote knowledge for the national benefit.

The major programs are located in the Division of Atmospheric Research, recently established by amalgamating the Divisions of Atmospheric Physics and Cloud Physics and the CSIRO component of the Australian Numerical Meteorology Research Centre. In addition there is an important micro-meteorology program in the Division of Environmental Mechanics and peripheral atmospheric studies are undertaken in the Divisions of Water and Land Resources, Fossil Fuels, Entomology and Oceanography.

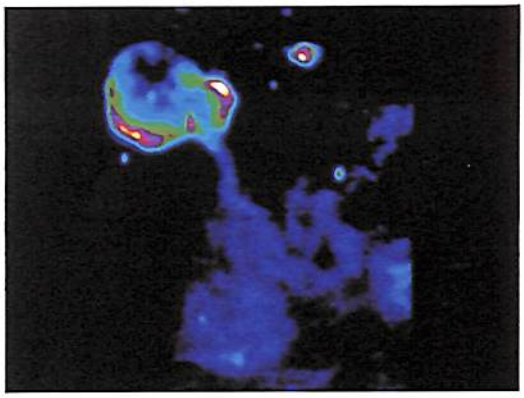
The Bureau of Meteorology is clearly an important ultimate user of the results of the Organization's atmospheric research, although the Bureau has primary responsibility for the conduct of research in support of its own operations. Collaborative work takes place also. For example, a recently completed joint 15–year program on computer modelling of synoptic-scale circulation has led to numerical analysis and prediction schemes which are used routinely at the Bureau to provide synoptic scale weather information and forecasts. State instrumentalities, such as electricity commissions and environmental protection authorities,are users of other aspects of the Organization's research on pollutant dispersal and aspects of local and regional meteorology.

Several items of advanced equipment developed by the Division are being commercialized, for example, a satellite data acquisition and analysis system, and an image analysis terminal for data-processing.

Astronomy

Construction of the Australia Telescope is proceeding on schedule. The Culgoora civil works contract began during the year. It includes the laying of a 3–kilometre railtrack on the CSIRO site, an 86–metre track on land three kilometres from the main site, access roads, causeways and the 37 stations along the tracks at which the antennas can be positioned. The successful tenderer for the $15 million contract to construct the seven 22–metre diameter antennas should be known in mid–1985. The Division of Radiophysics has taken delivery from Austek Microsystems Pty Ltd of 6000 of the 10 000 or so CSIRO-designed VLSI digital correlator chips which will be used for signal processing. In addition, the Parkes radio-telescope, one of the key elements in the Australia Telescope, has undergone a major upgrade over the past three years. This is in preparation for its role as the prime receiving station for signals beamed back from NASA's Voyager spacecraft in its fly-by of the planet Uranus in January 1986, and from the European Space Agency's (ESA) Giotto spacecraft in its encounter with Halley's Comet in March 1986. Contracts totalling $500 000 from NASA and ESA have assisted in the upgrade.

Astrophysicists at the Division have made several advances during the year, one of the most striking being the discovery of remnants of a most unusual stellar explosion. Exploding stars, or supernovae, are fairly common events. When massive stars burn up all their nuclear fuel a giant explosion is triggered creating, in most cases, shells of expanding and radiating gas and debris. A neutron star or black hole may also be 'born' at the centre of the explosion. The Crab Nebula



A false colour radio image of the supernova remnant Kesteven 32 obtained by CSIRO Division of Radiophysics scientists at a frequency of 843 megahertz using the Molonglo Observatory telescope operated by the University of Sydney. In this image the darker coloured regions are emitting less radiation than the lighter coloured regionsAn expanding shell of emission which today is 82 light years in diameter and which first started to form approximately 5000 years ago at the time the central star exploded at the end of its life has emanating from it a 'jet' of emission which has expanded out to form a 'plume'. This strange, newly-discovered feature of the 'jet' and 'plume' coming out of a supernova has not been noted before near supernovae. The implications for our understanding of the physics of 'dying' stars are important and astronomers are currently working on this problem.

is one well-known remnant of a supernova. The newly-discovered supernova remnant was found as part of a research program, using the Molonglo Telescope operated by the University of Sydney, to study the life-cycle of stars. The remnant is unique in that it consists of a strong jet of matter radiating from the site of the exploded star, as well as the shell of expanding debris which is normally associated with such an explosion. Jets of this type have not been observed before and the discovery will lead to a re-evaluation of current theories about the physics of 'dying' stars.

The search for new supernova remnants by CSIRO scientists is continuing, since the environments around such exploding stars create a physical laboratory for studying radiation processes that could never be emulated on earth.

Environmental Protection

CSIRO's research on environmental protection involves land, water, air and the human environment. The land element of the research is carried out in several Divisions, including Mineralogy and Geochemistry, and Soils. The former Division is concerned with treating and disposing of large volumes of caustic red mud residues from alumina refineries in the south-west of Western Australia which will ultimately cover 7000 ha. The Division of Soils is concerned with heavy metals in soils, particularly around the lead-zinc smelter at Port Pirie, South Australia. It is also investigating the contribution from the city and from geological and agricultural origins to the lead content of Adelaide and its environs.

In addition, research projects are being undertaken in the Division of Soils and the Division of Water and Land Resources on the salinization of land.

Research projects on the environmental protection of water in the Division of Fossil Fuels seek to identify and characterize processes important in controlling the release of heavy metal ions from mining operations and their subsequent transport in streams. The aim is to achieve an understanding sufficient to predict the likely magnitude of releases of contaminants from prospective mining operations and the extent and duration of the resulting effects on the aquatic environment. The approach is applicable generally to chemical contamination in other surface waters such as estuaries, soil-water and groundwater systems.

Research in the Centre for Irrigation Research pertinent to this field includes the study of the impact of aquatic herbicides on water quality and the turbidity and eutrophication of surface waters.

CSIRO's work in protecting the atmosphere falls into two main categories: regional problems involving the more immediate effects of industrial emissions, and global problems because of changes in levels of trace atmospheric constituents caused by human actions. Examples of this research are found in the Divisions of Atmospheric Research, Environmental Mechanics and Fossil Fuels.

Local and regional pollution research is concerned with physical processes responsible for the transport and dispersion of air pollutants and with chemical transformations producing secondary pollutants, for example, photo-chemical smog, or acting as sinks to remove pollutants.

Much of this work concerns basic physical processes such as cold air drainage, buoyant plume rise and dispersion, plume visibility, and the effect of topography on airflow. These can be studied theoretically by laboratory simulations, and by specialized field measurements. These studies are directed mainly at understanding and alleviating practical problems in regions of heavy industrial and urban development. Areas included are the Latrobe Valley, Melbourne, Sydney, and major electricity-generating areas of Queensland and New South Wales. Such studies aid the development of realistic control and regulatory strategies.

In relation to global pollution, the past 10 years have seen a procession of alerts concerning the quality of the large-scale atmospheric environment. These included the effects of spray-can aerosol gases and supersonic aircraft on ozone levels and the concomitant effects of ultra-violet irradiation on human and other life forms, as well as the accumulation of certain 'greenhouse' gases which might influence global and regional climate on decadal time-scales. In particular carbon dioxide has been studied extensively and is widely regarded as the key global environmental issue.

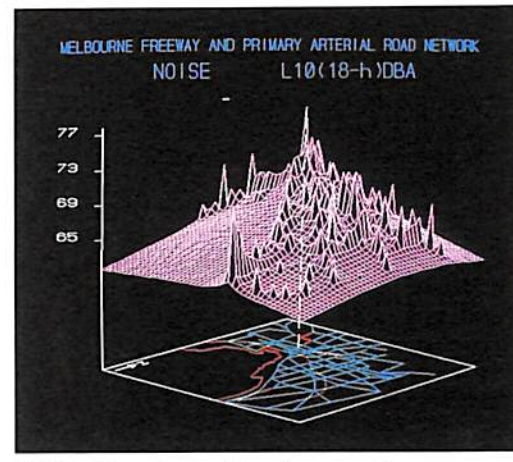
The Division of Atmospheric Research studies on gases such as carbon dioxide, methane, ozone, nitrogen oxides and halocarbons, and on background aerosols have been at the forefront of a well-coordinated global effort to improve fundamental understanding in this hitherto neglected field. This will enable predictions and assessments of perceived threats to be properly undertaken.

Research on the protection of the human environment includes studies in the Division of Entomology of insect pests such as wasps, bushflies and Portuguese millipedes.

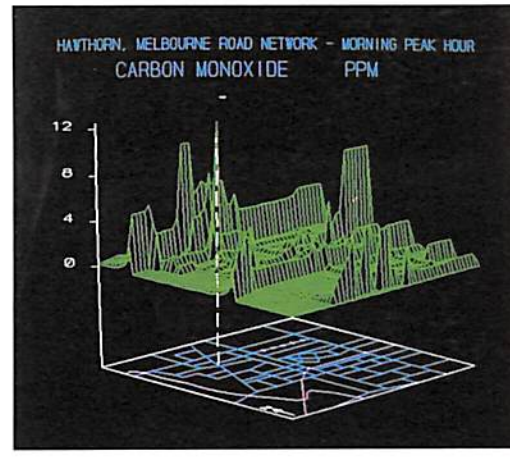
9. Service Industries

CSIRO is not concerned with all service industries but only with a limited selection, defined in part by the activities of other government agencies and in part by the special skills of the Organization. Urban engineering encompasses aspects of the construction and transport industries and extends to the application of advanced techniques to urban planning. Health deals mainly with nutrition and food safety, with a smaller component of medical technology derived from the special expertise of some of the physical science Divisions. Standards, as here defined, relate to the primary physical standards and calibrations derived from them; other types of regulatory standards are subsumed in their substantive fields.

The following sections document recent changes to CSIRO policy on urban engineering, health and physical standards of measurement, and describe research achievements during the past year.



(A) Traffic noise arising from travel on Melbourne's freeway and primary arterial road network.



(B) Carbon monoxide levels from traffic through the Melbourne suburb of Hawthorn show a peak near the busy Kew Junction.

Traffic engineering microcomputer programs, URPOL, POLDIF and SURVU, developed by the Division of Building Research, are used to produce vehicle pollution models. In (A), volumes and speeds have been simulated and the resultant distribution of traffic noise over the urban area estimated and graphically displayed. In (B) the distribution of carbon monoxide emitted from vehicles travelling during a typical morning peak hour in summer has been modelled.

Urban and Civil Engineering

CSIRO seeks to bring science to bear on the traditional practices of the building and construction industry and to foster innovation for the industry. Consistent with its national responsibilities, the Organization carries out scientific research which benefits industry and the community by concentrating on general problems of the building industry which transcend peculiarly regional or local issues.

Work on urban and civil engineering in CSIRO is mostly concentrated in the Division of Building Research whose research objectives embrace design for durability, life cycle performance, safety and risk, and shelter and infrastructure. The Division collaborates extensively with industry. In such a fragmented industry collaboration is with industrial associations representing particular sectors of the industry, or with the more innovative or technically-adventurous entrepreneurs by videos directed to builders and building surveyors. Contributions in kind, access to building sites and experiments with new techniques/processes are the usual forms of industry collaboration rather than the direct provision of funds. The results of the Division's work are widely disseminated by technical associations, by Divisional publications aimed at specific industry sectors, and by changes in the standards and building codes which can make mandatory beneficial

innovations or prohibit practices demonstrated as unsafe or inefficient. Publication in the formal scientific literature is secondary to these other communication processes.

While there have been no major CSIRO research policy shifts in urban engineering during the year, the Division of Building Research has made significant research progress in several areas. Some examples follow.

Aggregate Stability

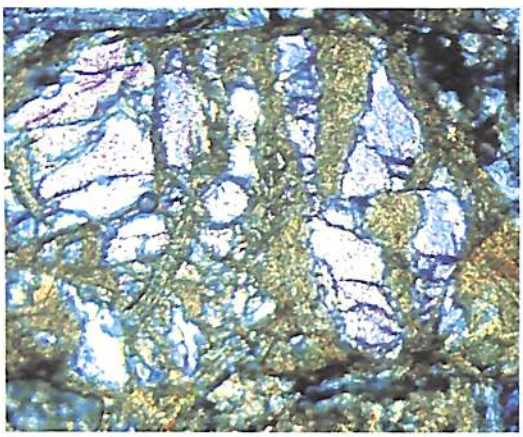
In the classical model for set concrete, the coarse aggregate and sand are merely fillers used to extend the active component, that is the cement paste, which is considered to be the source of all the properties of the concrete, such as its strength, durability and shrinkage. Over the last decade it became apparent, through unfortunate field experiences, that this model could no longer be considered valid. It had to be recognized that the stone, particularly the coarse aggregate, is an active component which can influence greatly the concrete's behaviour. Some of the earliest studies of this phenomenon were done by CSIRO 40 years ago at the former Division of Industrial Chemistry.

Most of the more recent problems have arisen from the presence of clay-type minerals in the aggregate. The Division of Building Research has contributed significantly to identifying the types of minerals causing dimensional change in the aggregate, the extent to which they can contribute to dimensional change, and the extent to which this change is influenced by the distribution of the minerals throughout the stone. The identification of these factors has meant that empirical tests, formerly used in evaluating stone for concrete or road construction, can be replaced by more rational measurements. As a result it has been possible to continue operating some quarries conveniently close to population centres, but which were about to be closed because of allegations of producing unsound stone. This has not only been economically important to quarry operators but socially and environmentally useful in avoiding the need to open up new quarries near residential areas.

This work has been extended in the last year, through a Queensland Water Resources Commission sponsorship, to the examination of a microgranite source rock which was proposed for use in concrete in a dam. Analysis by X-ray diffraction showed that smectite, a swelling clay, had formed in the more weathered samples at the expense of the clorite and feldspar constituents. This alteration greatly influenced dimensional stability, and the finding was important in deciding on the choice of the source of aggregate for the dam. If this material was to be used, a simple method of analysis was needed for applying at the quarry site to control the quarrying operation. The method chosen showed that methylene-blue dye absorption indicated the smectite content of powdered rock from easily obtained percussion-drilled samples and that a highly significant correlation existed between the drying shrinkage of prisms cut from the diamond-drilled cores and dye absorption of these samples in powdered form.

Using the methylene-blue absorption test, the source rock was evaluated for dimensional stability and 85% of the rock was found to be stable and suitable for structural concrete. The methylene-blue absorption test enables considerable saving in laboratory time and labour in making an assessment.

There will be an increasing need for this type of study as the best aggregate material near large population centres is used up and it becomes necessary to balance the costs of what, at first sight, appears to be slightly inferior material against the increased transport costs and environmental disturbance involved in opening up quarries of the best material in remoter areas. One road construction authority, recognizing the importance of the Division's work, has appointed its own staff of geologists and mineralogists to carry out similar evaluations.



Photomicrograph of a thin section of a basalt showing smectite clay rims forming from an olivine phenocryst. This alteration renders the rock dimensionally unstable and mechanically weak and therefore unsuitable for use in either road construction or concrete structure.

Slab-On-Ground for Domestic Construction

Early in 1985, the Standards Association of Australia issued for public review a Draft Code of Practice for Residential Slabs and Footings. This was the penultimate stage in realizing work done over many years by the Division which has led to a change in flooring materials in Australia's new houses from the almost universal use of timber to the adoption of concrete in about 60% of the market. In Western Australia, the penetration of the market by concrete is much higher, approaching 100%.

Although cost has at times determined which material will be used, generally the technical properties of concrete floors appear to have led to their acceptance. The work on concrete floors in the Division began with demonstrations of their undoubted thermal advantages in flattening out the peaks of high temperature and filling in the troughs of low temperature experienced in normal housing. These experimental studies resulted in a whole new suite of computer programs, designed to calculate indoor temperatures. Concrete floors were found not only to have distinct thermal, but also acoustic, advantages.

For many years, the engineering theory to allow these floors to be designed to support houses on the moving soils which are the common foundation material in Adelaide's suburbs and in the western areas of Sydney and Melbourne was lacking. These soils can rise and fall more than 50 mm a year with changing moisture content between seasons. Division of Building Research work filled this need, and the design procedures devised have been used to derive standard designs now incorporated in the Victorian Building Regulations. These and other features arising from the Division's work have now been incorporated in the Code of Practice for Residential Slabs and Floorings. The final form of the Code is expected to be adopted by all States.

An important definition in the proposed Code is that of acceptable crack widths. Acceptance of the definition will substantially reduce current litigation over allegedly defective design and construction and should reduce housing costs. At various stages work on the Code has been sponsored by Cement and Concrete of Australia, and the Steel Reinforcement Promotion Group.

Information Technology and Local Government

The building and construction industry is probably the most fragmented of all the major economic sectors and its efficiency depends on effective communication between the many small units. Three years ago the Division of Building Research decided to introduce microcomputers wherever possible throughout its laboratories and to develop software to make microcomputers available quickly to all levels of the building industry and in local government. Thus the possibility of a computer revolution in the industry became real.

The decision provided an excellent basis for developing knowledge-based and other expert systems, particularly for branches of local government. This work is receiving financial support from several external sources and forms a major part of CSIRO's effort in information technology which is discussed in Chapter 10. Collaborative research arrangements with two software houses will ensure that the Division's software is marketed throughout Australia and overseas.

The continued development of software technology, particularly expert systems, will improve communication and efficiency in the many sectors of the building and construction industry. This will benefit Australia as a nation, and the competitiveness of many industries which invest in building.

Health

A medical research policy for CSIRO, formulated by the Executive in 1979, was recorded in the 1978/79 Annual Report. Reference was made at that time to the formation of the CSIRO Medical Research Liaison Committee in 1973 to promote the effective use of CSIRO discoveries relevant to human health and to the establishment of the Division of Human Nutrition in 1975. The policy was re-examined in 1983 and a revised policy, endorsed by the Minister for Health, the Hon. Neal Blewett, was reported in the 1983/84 Annual Report.

The revised policy represented a significant change from the earlier one by expressing a positive CSIRO research role in human nutrition and food safety directed to solving problems of human health. The policy reiterated that CSIRO findings with possible medical relevance in other areas of biological and physical sciences would be pursued as formerly in collaboration with medical scientists. The Medical Research Liaison

Committee remains an important source of assistance to the Executive, as well as being its main source of advice on medical research matters.

The 1983/84 Annual Report also recorded Executive decisions on the review of the Division of Human Nutrition, which is responsible for the Organization's main effort in human health research. It was noted that it had made significant contributions to the knowledge of human nutrition and its research programs generally were appropriate to Australia's needs. The Executive decided to continue the Division with only minor variations to its programs.

There was no change in CSIRO medical research policy or its emphasis during 1984/85, but a significant step — the Executive's decision to name human nutrition as a designated growth area in 1985/86 — was taken towards implementing it. Designated growth areas are eligible to receive additional research funding from the Executive, and are allocated extra resources by redeployment within Institutes.

The Institute of Animal and Food Sciences also emphasized human nutrition in its Strategic Objectives, formulated during the year and endorsed by the Executive. It took into account associations between diet and human health. Specifically, the Institute aims to expand research on the links between human diet and disease, on the microbiological safety of foods, and on producing leaner meat. The last area recognizes that a significant source of fat in the diet is 'non-visible' fat in meat products from cattle and sheep.

Research programs in human nutrition are continuing in the Division of Human Nutrition, with a smaller component in the Division of Food Research, which has the main carriage of food safety research. Projects in animal nutrition, genetic and immunological research by the Division of Animal Production — a constituent Division of the Institute of Animal and Food Sciences — aim to produce leaner cattle and sheep meat.

Considerable attention is being paid to medical technology by CSIRO, based in particular on the expertise of the Divisions of Applied Physics and Radiophysics in the physical sciences.

In November 1984 the Division of Applied Physics held a colloquium, in conjunction with the newly-formed Medical Engineering Research Association, which has an office in the Division, to describe its research and expertise in medical technology. The research includes developing instruments for optical use, measuring biomagnetism as a potential non-intrusive diagnostic technique, and constructing ultrasonic devices for surgical use and blood analysis. The Division's expertise in lasers is relevant to medical practice in the area of laser surgery, which is expanding rapidly, and also in holography, which is only in its early phase of application to medical science.

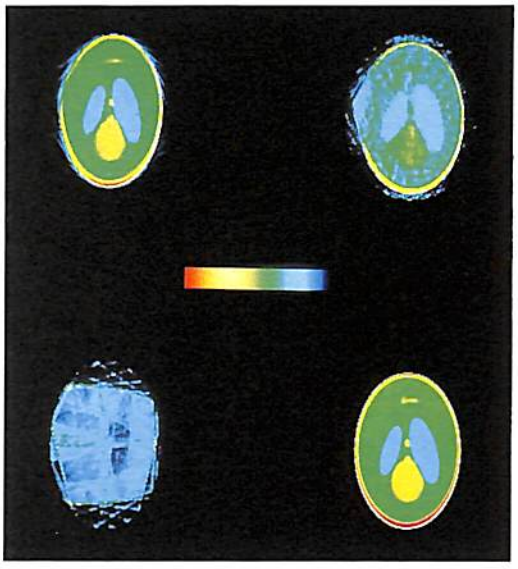


Image reconstruction from sparse data. Tomographic reconstructions in false colour from data calculated using a model of a cross-section of the human head was used for this typical CAT scanner geometry. Top left: reconstructions using a full data set equivalent to 128 views taken over an angular range of 360°. Top right: reconstruction from 16 views over a range of 180° by the method used in most modern CAT scanners. Bottom: reconstructions from 16 views over a range of 180° by two new algorithms, being developed by the Division of Radiophysics and Macquarie University.

The Division of Radiophysics has particular expertise in electronics and signal processing, which it is applying to medical areas. Computer reconstruction of images from sparse data, now directed primarily to mining and radio-astronomy, could be used with CAT scanners. By reducing the amount of data required, the total exposure of patients to X-rays could also be reduced. Other research has been directed to aiding the handicapped to exercise control over electrical and electronic devices in everyday use such as telephones, televisions and kitchen appliances.

Research achievements during 1984/85 included:

Division of Human Nutrition

- Demonstration that the depressed growth rates of Aboriginal children in the Kimberley region of Western Australia are not due to a deficiency of dietary zinc.
- Demonstration that diets with a high ratio of polyunsaturated to saturated fats alter the fatty acid composition of membranes in the heart and, in experimental animals, protect against cardiac muscle arrhythmias, and hence sudden cardiac arrest.
- Isolation in pure form of two growth-promoting substances from milk and their identification as an insulin-like growth factor — I/somatomedin and a modified highly-potent form of that protein. The medical and commercial applications of these discoveries, made in association with the University of Adelaide, are being explored.
- Formation of an international consultative group, the International Council for Control of Iodine Deficiency Disorders (ICCIDD), with a secretariat based in the Division and supported by the Australian Development Assistance Bureau and UNICEF (New York). The Council will advise international agencies and countries, particularly in Africa and Asia, on control programs to prevent mental retardation arising from iodine deficiency.
- Demonstration that up to half Australia's population are using a wide variety of dietary supplements. However, most people are unaware of causal relations between specific components of the diet and health and disease.
- Identification of causative factors in the diet linked to gallstones and bowel cancer.

Division of Food Research

- Determination of the conditions which allow the growth of potentially pathogenic *Vibrio* spp. in oysters. This information will enable appropriate control measures to be taken. Previous tests showed that these bacteria are naturally present in oysters and may not be removed by current oyster purification procedures.
- Demonstration of a relationship between the production of physiologically-active amines and phenols in the human infant gut and the nature of the diet. These compounds — if absorbed — are potentially harmful.
- Identification of the molecular mechanism by which dietary saponins reduce plasma cholesterol.

Division of Applied Physics

- Development of an instrument to measure the shape of soft corneal lenses.
- Preparation of new standards reflecting associated health hazards for exposure to ultra-violet radiation in welding arcs and domestic sun lamps.
- Development of a new instrument for measuring red blood cell deformability using the sound absorption coefficient. Major applications include the assessment of red blood cell preservation in stored blood.
- Development of a small portable ultrasonic device for locating kidney stones which allows a surgeon to remove the stones with minimum damage to the kidney.
- Engineering design and manufacture of glass plates for an automated viscometer and microscope to assess the behaviour of red blood cells in zero gravity. The apparatus was designed to withstand the constraints of space flight, and was flown aboard the space shuttle, Discovery, in January 1985.

Division of Radiophysics

- Demonstration of an electronic control system which enables disabled people to dial telephone numbers automatically and to switch household appliances on and off. Controlled by keyboard or code selection, the system also responds to a voice-operated switch.

Physical Standards of Measurement

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 was amended substantially in 1984. Formerly, it had been known as the Weights and Measures (National Standards) Act 1960. It 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'.

Dr Randolph Sparco takes blood samples from Aboriginal children at Kalumburu in the Kimberley area as part of a program investigating the potential relationship between depressed growth rates and deficiency of zinc in their diets.

Australia's ultimate physical standards of measurement are known as the Australian primary standards. Current CSIRO policy is to maintain all of the primary standards in the National Measurement Laboratory of the Division of Applied Physics, except those for measuring ionizing radiations. (The latter are maintained by the Australian Atomic Energy Commission and the Australian Radiation Laboratory, these bodies having been formally appointed as CSIRO agents for this purpose.)

Primary standards are designed to have the highest accuracy attainable and to be reproducible over a long period; usually they comprise a complex assembly of physical components. Generally, however, they are not suitable for direct use in providing the diverse calibration service required by industry and the community. For that purpose CSIRO derives from the primary standards a wide range of Australian secondary standards. For example, the Australian primary standard of electromotive force (emf) is a Josephson junction between two superconductors, maintained at cryogenic temperatures and irradiated with microwaves. It provides an extremely reproducible dc electromotive force of a few millivolts. In addition, the National Measurement Laboratory finds it necessary to maintain a wide range of secondary standards of emf to provide for magnitudes ranging from nanovolts to megavolts, not only for dc measurements but also for ac ranging from power-frequencies to audio-, radio- and microwave-frequencies.

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 service to promote this objective. Since only a small fraction of the total number of calibrations required can be provided by a single organization, 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.

Review of Calibration Services

In November 1983 CSIRO commissioned a review of the calibration services provided by the Division of Applied Physics. The review took place during 1984 and in May 1985 the CSIRO Executive made 20 decisions on the basis of the recommendations included in the review report (see Chapter 4).

The Executive recognized the vital importance of the standards and calibration functions and identified these as absolute commitments for the Division. It noted the marked reduction in staff numbers over recent years, and decided that these had reached a minimum level consistent with adequate performance of the standards/calibration functions. Several mechanisms were identified for improving client services, including greater automation of calibration facilities and improved scheduling and monitoring of calibrations. The Executive decided that the Melbourne and Adelaide branch laboratories, which hitherto had been operating on a trial basis, would be retained subject to accommodation continuing to be available.

The Committee of Inquiry into Commonwealth Laboratories (Ross Committee) had earlier noted the lack of a formal advice mechanism to CSIRO on standards matters. To establish such a mechanism a high-level Standards Advisory Committee is to be set up involving appropriate representation of outside bodies and with an external Chairman. The Division is to heed advice from this Committee in preparing a long-term strategic plan for standards/calibration activities, including the identification of existing or perceived gaps in the services offered.

The Executive determined that the Division should continue to provide scientific support and encouragement to NATA, NSC and the Standards Association of Australia (SAA). Record keeping and other clerical procedures associated with the Division's calibration services should meet all the requirements imposed on NATA-accredited laboratories. The Executive decided, however, that it was inappropriate for the Division to become a NATA-accredited laboratory in view of its functions as the custodian of Australia's primary standards.

At the international level, the Executive decided that the Division would seek to conclude bilateral agreements of mutual acceptance of the equivalence of physical standards with the national standards laboratories of appropriate foreign countries. This assists Australian manufacturers and exporters in having their measurements accepted abroad and follows

similar bilateral agreements between Canada, the UK and the USA. The Executive decided also that the Division should continue limited and carefully selected basic research on primary standards to maintain Australia's reputation in international standards science.

Measurement Traceability for Offset Manufacturing Contracts

Australian manufacturers seeking offset contracts with companies overseas are often pressed to establish measurement traceability to a foreign national standards laboratory, rather than to CSIRO and the Australian measurement system. In most cases there is no technical justification for such a procedure, and the practice is detrimental to the local manufacturer and to Australia's industrial standing.

A collaborative program has been initiated between the National Measurement Laboratory, Philips Electronic Systems (Australia) and the Hughes Aircraft Company of the USA in an attempt to alleviate this problem. Philips has established a modern standards laboratory near Sydney to support its manufacture of modules of the advanced radar system to be installed on the RAAF's F/A–18 Hornet tactical fighters. During 1985 and 1986 an extensive series of measurement intercomparisons are being performed by the three organizations to confirm in a practical way that traceability to CSIRO is equivalent to traceability through Hughes Aircraft to the US National Bureau of Standards.

Research and Development Highlights

Significant progress continued in most standards fields during 1984/85, but four areas require special mention.

Microwave Calibrations at Higher Frequencies.

To satisfy a need expressed by several clients, including the Department of Defence, Telecom and AUSSAT, the National Measurement Laboratory has been extending beyond 12 GHz the frequency range over which it can provide microwave calibration services. Calibrations of noise, attenuation, impedance, phase shift, antenna gain, horn gain and power are now available up to 18 GHz. Further work is in progress to extend some of these services to 26 GHz.

Electromagnetic Distance Measurement.

For measuring distances ranging from about 100 m to a few kilometres, traditional surveying techniques are being replaced increasingly by a new class of instruments that in effect determines the time-of-flight of electromagnetic waves. The National Measurement Laboratory has been collaborating with the Surveyors-General of the Commonwealth and the States, and with the National Standards Commission, to establish the reliability of the new instruments and to ensure that measurements made with them are properly traceable to the primary standard of length. This is particularly important for the numerous base-lines that the Surveyors-General are providing throughout Australia for calibrating such instruments. The collaboration has led to more reliable calibration methods and operational procedures, but has shown that some commercially available instruments are more affected by temperature variations than had originally been suspected.

The Measurement of Low Temperatures

The fundamental concept of temperature that occurs in the laws of physics is thermodynamic temperature, but this is difficult to measure directly. So practical temperature measurements are made in terms of the International Practical Temperature Scale (IPTS), which ascribes temperature values to a number of fixed points and specifies the measurement techniques to be used for interpolating between those points. From time to time the IPTS is revised to bring it into closer agreement with thermodynamic temperature and to make it more convenient to use. The National Measurement Laboratory, as part of a program to upgrade its thermometry at low temperatures, has recently completed the determination of a precise scale of thermodynamic temperature over the range 13–300 K, using the techniques of gas thermometry. This work has been welcomed internationally as a major input for the next revision of IPTS, and it is particularly satisfying that the results are in good agreement at both ends of the range with measurements made overseas.

International Collaboration on Electrical Standards

Two international conferences scheduled for 1986 are expected to lead to:

Staff of the Division of Applied Physics are seen here advising a senior surveyor of the NSW Crown Lands Office in the use of the latest equipment for electromagnetic distance measurement. The device is a geomensor and replaces the simple surveyor's tape. Such instruments are able to measure kilometres to within a few millimetres.

(a) a small adjustment of the practical magnitude of the volt, and
(b) a new standard of measurement for the ohm.

The National Measurement Laboratory has made important contributions to both objectives. A scientific by-product will be a more exact evaluation of two basic expressions involving the fundamental constants e (electronic charge) and h (Planck's constant).

Although the adoption of Josephson junctions as primary standards has greatly improved the uniformity of realizations of the volt around the world, there is increasing evidence of a systematic difference between the volt so realized and the value according to the SI definition of the unit. One important piece of evidence is the Division's recently completed 'absolute' measurement of the volt in terms of the mechanical units, which indicates that the present Josephson volt is too small by about eight parts per million. International agreement is required to increase the value 483 594.0 GHz/V that is currently recommended for the Josephson constant (2e/h) to remove this inconsistency.

Current research in several national standards laboratories, including the National Measurement Laboratory, appears to confirm that the recently discovered phenomenon of quantized Hall resistance (QHR) offers an excellent and convenient new standard for the unit of electric resistance, the ohm. At present the world's most reliable determinations of the ohm are made using calculable capacitors of the type developed in the laboratory some 25 years ago. Before the new QHR standard can be recognized, however, it must be evaluated very precisely against a calculable capacitor. Because of the high regard accorded the CSIRO calculable capacitor, several of the world's major standards laboratories wish to relate their QHR measurement to the CSIRO ohm. This has been facilitated by the development in the laboratory of extremely stable standard resistors that better withstand the rigours of transport. These have enabled the value of the CSIRO ohm to be transferred to the International Bureau of Weights and Measures near Paris with an uncertainty of only two or three parts in one hundred million. An off-shoot of this work will be the international adoption of an agreed value for the factor (h/e^2).

Participation in the Applied Physics Industrial Program

The calibration service referred to earlier is by no means the only benefit to the community resulting from standards-related activities. For example, standards staff have been particularly active in collaborating with manufacturing industry in the first year of the Division's Applied Physics Industrial Program. Collaborative projects have included the development of high-grade instruments for commercial manufacture in Australia, such as an electronic voltage reference, an automatic salinometer, and a precision power amplifier; an investigation of infrared, diffuse reflectance techniques for mineral processing; the development of techniques for measuring very large gears, as used in the mining and sugar industries; the application of superconducting magnets to mineral separation; the development of a new type of gas-flow meter; and the application of multi-wavelength pyrometry to the aluminium industry.

The main assembly of the gas thermometer used to establish part of the international thermodynamic temperature scale.

10. Multi-sectoral Technologies

Biotechnology

CSIRO conducts a wide-ranging biotechnology research program embracing the development of useful products and processes from micro-organisms and mammalian cells, and genetic modification of plants and animals to improve productivity. Many research projects involve recombinant DNA — genetic engineering — a powerful and pervasive technology that is already having a profound impact on medical, veterinary, agricultural and industrial science around the world. CSIRO has projects in each of these areas but emphasis is being given to improving animal health and animal and plant production systems of economic significance in Australia.

When the revolutionary research and commercial potential of biotechnology became apparent in the late 1970s, the Organization began to move resources into this field. The report of the review of biotechnology research, commissioned by the Executive, appeared in 1981. It proposed support for this research, and CSIRO has continued to transfer resources to biotechnology. Substantial external support through funds and personnel has further added to the growth and amounts to some 16% of total funding for CSIRO biotechnology research.

Organizational steps which have been taken since 1981 include:

- upgrading of the Molecular and Cellular Biology Unit to the Division of Molecular Biology
- establishment of an Industrial Microbiology Unit in the Division of Chemical and Wood Technology

Biotechnology research is now carried out in 12 Divisions in four of CSIRO's five Institutes and involves 238 professional staff years of effort — 24% of total effort in these Divisions. In 1981 the level was 61 staff years in seven Divisions.

The research ranges from basic/strategic studies to applied research. The basic work covers such fields as techniques for DNA manipulation and gene expression in manipulated systems, and this expertise is applied to studying biochemical systems. Applied research already being developed commercially includes novel vaccines for livestock and highly specific probes for identifying viruses. Most of the research is oriented to the agricultural sector as the end-user. Other expected developments include novel industrial processes, such as speciality pharmaceuticals, foods, diagnostic materials, biomaterials, improved oil recovery and treatment of wastes, and improved strains of plants and animals. The work follows broadly that proposed by ASTEC in December 1982 in its report 'Biotechnology in Australia: A Supplementary Report to the Prime Minister'.

Given the international importance of plant and animal production, it can be anticipated that new products or processes developed for Australian industries will find substantial export markets as well as benefiting Australian agriculture production.

New Vaccines

The immune system fights disease by producing protective antibodies against specific antigens on the surface of invading micro-organisms. A micro-organism may present a range of antigens for recognition by the immune system, but normally

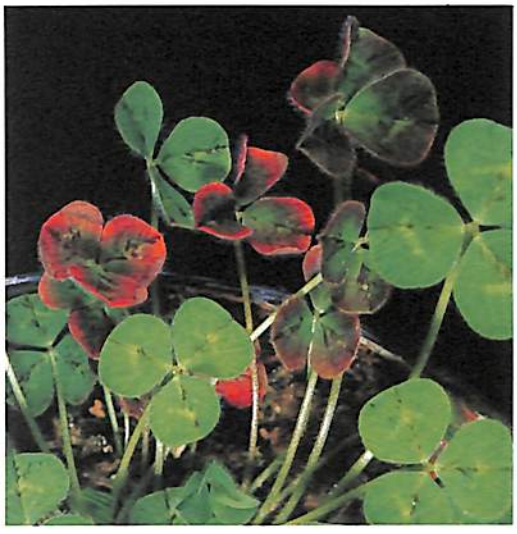
A hybrid soybean, (centre) produced by crossing the soybean cultivar *Glycine max* 'Improved Pelican' with a hybrid between the Australian species *G. argyrea* and *G. canescens* (right). The new hybrid is sterile, and efforts are being made to restore its fertility. Australia's native *Glycine* species are a potentially valuable source of genetic variation for commercial soybeans.

only one or two play any significant role in invoking the protective response. In conventional vaccines based on killed or weakened organisms the presence of superfluous biological material may cause the immune response to be diffused against unimportant antigens, instead of being focused on key antigens. The problem is accentuated where there are several antigenically-distinct strains of the pathogen that must be combined in a single vaccine. For the same reason, very complex organisms such as parasites invoke only a weak immune response, making vaccine development difficult.

Advances in immunology and recombinant DNA technology now enable identification of the key protective antigens in a pathogenic organism, whether it be a virus, a bacterium or a parasitic intestinal worm, and then isolation of the genes which encode the antigens. When these genes are inserted into a genetic blueprint of a bacterium or yeast cell, the antigen can be produced in extremely pure form by bacterial or yeast cultures for use as a vaccine. Because they contain only the key protective antigens, recombinant DNA vaccines invoke a powerful, focused immune response which will protect the host against subsequent infection by the pathogen. This focused response also means vaccines can be developed against a much broader spectrum of pathogens that have been beyond the scope of conventional vaccines.

The Divisions of Animal Health, Molecular Biology and Protein Chemistry, in collaboration with Sydney University's Department of Veterinary Clinical Studies, are using this approach to develop a new recombinant DNA-based vaccine against sheep footrot. Conventional vaccines have proved expensive to manufacture because of the fastidious growth requirements of the organism and the need to incorporate antigens from each of the various strains of the pathogen in the final vaccine. The new vaccine can be produced cheaply in commercial quantities by splicing the genes for these antigens into other bacteria. Vaccine trials are under way and a commercial agreement with two Australian companies is being negotiated for further development and commercial testing.

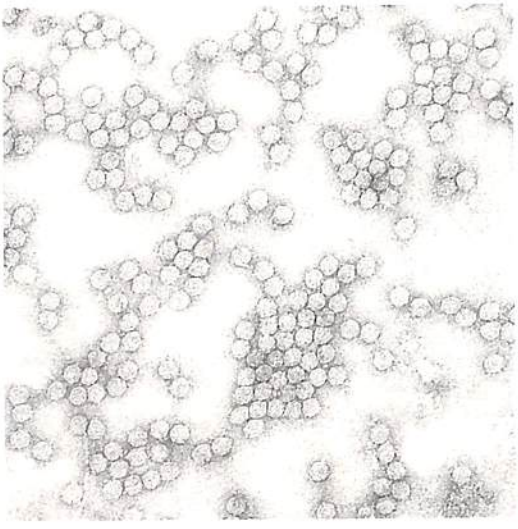
Three Divisions are collaborating in a project to develop a recombinant DNA vaccine against a major poultry pathogen, infectious bursal disease virus (IBDV). The IBD virus attacks the immune system, rendering chickens susceptible to other diseases and severely reducing their growth. The Divisions of Animal Health and Protein Chemistry have identified a single viral protein as the key antigen, and have confirmed its ability to stimulate antibodies that neutralize the IBD virus. The gene for this protein has been isolated, cloned, and fully sequenced and is being cloned and expressed in a bacterial host. The Division of Chemical and Wood Technology is working to develop a commercially-viable production system. The selection of a commercial partner to develop and market the vaccine is in progress.



Subterranean clover leaves showing symptoms of SCRLV which causes severe productivity losses. Using a monoclonal antibody or a nucleic acid probe, the plant pathologist will be able to distinguish virus infection from the symptoms of stress or nutrient deficiency.

The Australian National Animal Health Laboratory has made substantial progress towards isolating and cloning the gene for the key antigen of the bluetongue virus. This pathogen causes a serious, often fatal, disease in sheep in Africa and America, although strains of the virus currently found in Australia in cattle do not cause disease. Problems with the potency and safety of vaccines currently used overseas make them unsuitable for use against an Australian outbreak of bluetongue. There would be a risk that genetic material from exotic strains of the virus could interact with that of Australian strains to produce new, virulent strains of the bluetongue virus. Researchers are seeking to define antigenic regions on the protein which might serve as the basis for a synthetic sub-unit vaccine.

The Division of Tropical Animal Science has discovered a novel mechanism which could be



An electron micrograph of particles of subterranean clover red leaf virus (SCRLV). The nucleic acid probe developed by CSIRO and the University of Adelaide can detect the virus's genetic material in clover sap.

used in developing vaccines against external parasites, using antigens which normally are not exposed to the host animal's immune system. The cattle tick, buffalo fly and sheep blowfly are all external arthropod parasites which ingest serum from the animals they attack. The Division has demonstrated that extracts containing antigens from the gut of the cattle tick will raise serum antibodies that will disrupt the female tick's feeding and breeding cycle. A recombinant DNA vaccine based on the key tick antigens could find extensive international markets. The Division is collaborating with Biotechnology Australia Pty Ltd to develop the tick vaccine.

Diagnostic Probes

Research advances in recent years have provided two highly specific and sensitive types of probe for seeking out specific genes or biological compounds produced by living organisms — monoclonal antibodies and nucleic acid probes — that can be used to diagnose disease or to detect foreign or allergenic substances in foodstuffs.

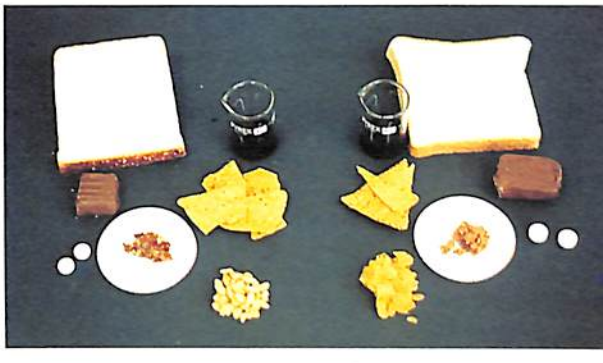
The Division of Plant Industry is developing diagnostic probes for a number of economically-important plant virus diseases. The Division's researchers have isolated unique nucleic acid sequences that can discriminate between the two major types of barley yellow dwarf virus (BYDV), as well as a shared sequence that can detect both types. BYDV is an important disease of cereal crops, including wheat, and the probes will eliminate any confusion over whether unhealthy plants are infected with the virus, or are suffering from nutrient deficiency or some other form of stress. The Division has also developed a nucleic acid probe against the economically-important pathogen of subterranean clover — subterranean clover red leaf virus (SCRLV). In collaboration with the University of Adelaide, the Division is developing probes that will signal the presence of a virus through a simple colour change, as an easier and more convenient alternative to radioactive labelling of probes.

The Wheat Research Unit and the Division of Molecular Biology have been developing a monoclonal antibody probe for detecting gluten protein in flour, particularly trace amounts in gluten-free dietary foods, which causes an allergic reaction in sufferers of coeliac disease. The probe targets a heat-resistant fraction of gluten, so that cooked and baked foods can be tested. The probe can also be used for quality control of foods that have gluten as an essential component.

Genetic Surgery for Better Plants and Animals

Recombinant DNA technology seems certain to have a major impact on agriculture in the next few decades. It offers a means of endowing plants

Selecting gluten-free groceries can be difficult. The bread, food flavouring, corn chips, chocolate, analgesic tablets, processed meat, and breakfast cereal on the right contain gluten. Those on the left are gluten-free.



and animals with new characteristics, or enhancing their productivity by controlled manipulation of specific genes.

The Division of Animal Production has isolated and cloned the sheep growth hormone gene, and plans to modify it so that it will be expressed in sheep liver cells. The object is to produce a faster-growing animal for the fat lamb industry.

Wool production in sheep is limited by the availability of sulphur-rich amino acids in the diet. Normally, much of the sulphur in these amino acids is degraded to sulphur dioxide by micro-organisms in the rumen before it can be assimilated by the animal. The Division has isolated and cloned two bacterial genes for high-sulphur proteins, which may allow sheep to synthesize their own sulphur-rich proteins for increased wool production.

The Division is also studying several anaerobic fungi which colonize the rumen and enhance digestion of low-quality pasture. Researchers hope to identify the genes involved in breaking down harsh feeds, and transfer them to more abundant bacterial species that also colonize the rumen.

Using storage protein amino acid sequence data provided by the Division of Protein Chemistry, the Division of Plant Industry has isolated and cloned the genes for the important storage proteins of legumes, and is planning to use them to improve the nutritional qualities of animal feed formulas.

Amino acid imbalances caused by low levels of sulphur-rich proteins limit the assimilation of a significant part of the protein available in legume seeds. The Division is seeking to correct the problem by incorporating extra copies of genes for minor, sulphur-rich proteins into plants of the same or other species — transgenic plants. An alternative approach being explored is to change individual codons — letters in the DNA code — in existing sulphur-deficient genes, so sulphur-rich amino acids will be substituted in their proteins.

The Division of Plant Industry has recently succeeded in transferring foreign DNA into maize cells, and is developing a system that will indicate rapidly when a gene has been successfully transferred, without the need to grow cells into adult plants.

The system is based on a gene whose enzyme product can readily be detected in maize cells by a simple test. Current work aims to increase the level of enzyme produced in transgenic cells by linking the gene to more efficient promoter sequences from other genes. Once expression can be obtained at a satisfactorily high level, the modified gene will be linked to a special 'switch' from the alcohol dehydrogenase gene of maize which responds to the anaerobic conditions of tissue culture.

Information Technology

It is characteristic of the information technology industry that it comprises many small, and often transitory, companies scattered around the feet of a few high technology giants like IBM.

Australia must compete in appropriate niche areas, as well as in large technology markets such as telecommunications. In addition, it must introduce the benefits of modern information technology into existing mature industry.

CSIRO has a significant role in this scenario, and during 1984/85 its initiative in information technology, documented in the 1983/84 Annual Report, became a reality. Many aspects of this new development will not start attracting attention until 1985/86, but three components are already in place. They are:

- the establishment of a Division of Information Technology to focus on CSIRO's advanced research and development;
- the fostering of information technology-related activities in CSIRO Divisions having close contact with client industries;
- the setting up of collaborative programs between CSIRO Divisions and appropriate industrial or academic partners.

The Organization will strive to maintain, across all areas of information technology, an appropriate balance between short-term, product-oriented tactical research and longer-term strategic research, bearing in mind that the balance and time-scales are somewhat different in information technology from those applying in other research areas.

Such are the rapid advances and intense competition throughout the information technology field that often no more than five years elapse from the concept of a new product and it being overtaken by more advanced technology. All the development, commercialization and marketing, and most of the return on investment must be crammed into this short period.

The Division of Information Technology came into existence formally on 1 January 1985, through the detachment of a small research component from the former Division of Computing Research. The larger part of that Division now constitutes the quasi-autonomous CSIRONET computer network. Dr G E Thomas, formerly Director of the Edinburgh Regional Computing Centre, will take

up his appointment as Foundation Chief of the new Division in August 1985.

Planning is under way for a balanced development of the new Division in Sydney and Melbourne. This will maximize interaction with the Australian computer industry and enable the Division to take advantage of strong State government interest in high technology industry. Staff are being recruited for both centres, and the possibility of further parallel development in other States is under review.

Software engineering and aspects of computer networking have been identified as initial areas of activity. Close contact will be developed with industry and academia.

It is likely that, given the short time-scale for information technology product development, much of the new Division's work will involve collaborative projects with industry. Intellectual stimulus and a solid disciplinary background will be needed to support these projects, and the Division will build up on-going expertise and longer-term research to provide this. The philosophy will be upheld by recruiting young graduate staff on term contracts with a leavening of permanent senior staff and short-term visitors from Australia and overseas.

The major part of the former Division of Computing Research now operates as CSIRONET, under a management board, to provide advanced computing and network services to CSIRO and to the Australian community. Its Cyber 205 supercomputer is now fully commissioned and is being used for a wide variety of scientific tasks. To ensure optimal use of this powerful machine CSIRO has made available to research workers throughout Australia $1 million worth of computing time to be allocated according to the scientific merit and national priority of the work.

The scheme, which will continue in 1985/86, is administered by a small committee with representation from CSIRO and the Australian Vice-Chancellors' Committee. This Committee has already allocated computer time for projects as diverse as quantum chemistry, drought research and fluid dynamics.

CSIRONET's Cyber 76 computer, which has given excellent service since 1976, is becoming too expensive to maintain and is being phased out. Its load is being transferred progressively to either a set of FACOM machines or to a Cyber 845, which also serves as a front end for the Cyber 205. Further upgrading of CSIRONET continues with the replacement of its PDP-11-based node computers with purpose-built micronodes developed in the Division.

The second component of the information technology initiative relates to activities in other CSIRO Divisions. There is no intention to centralize these activities. Rather, they will be fostered in close contact with the particular industries which form the focus of each Division's substantive research objectives.

The boundaries of information technology merge with communications, space technology, computing and day-to-day research of Divisions. This makes it difficult to estimate the Organization's total expenditure on information technology. Conservatively, more than $3.5 million was spent on Divisional information technology-related activities in 1984/85 (excluding the Division of Information Technology and CSIRONET). Central funding enhanced these activities to the extent of $500 000 in 1984/85, and this supplementary funding will be maintained or expanded.

A group within the Division of Building Research is applying the techniques of expert systems and artificial intelligence to buildings and urban facilities planning. This innovative approach should have particular benefits for the construction industry and local government urban planners.

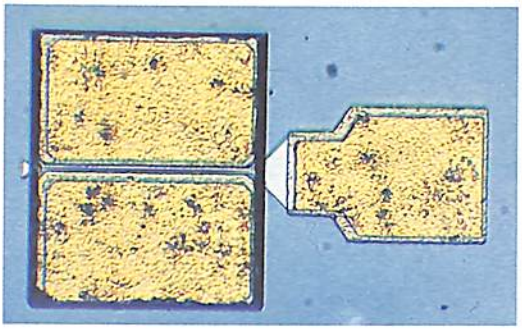
The implementation of software developed under this program is attracting considerable industrial interest. Several collaborative programs between the Division and industry will transfer techniques to the computer-aided design (CAD) industry, builders, engineers, architects, planners and appropriate government departments.

Hardware development in the information technology program is concentrated in the Divisions of Radiophysics and Applied Physics. Substantial development is proceeding on:

- image processing
- signal analysis
- hybrid optical processing
- high-frequency *gallium arsenide* components
- implementing designs on VLSI silicon chips.

Optical techniques for image processing, measurement and display also are being developed by the Division of Manufacturing Technology, which is concerned with vision systems for robot control. (Other aspects of developing hardware systems for processing satellite images are described under Space Technology.)

The many techniques being developed and exploited for applying databases and simulation models are even more widely disseminated. Areas as diverse as crop irrigation, animal nutrition, factory inventory scheduling and



The particular device shown is only 125 microns long, about a tenth of a millimetre, so several thousand devices are made at a time. The grey background is the gallium arsenide, a semiconductor material similar to silicon, but able to operate much faster. The gold areas are contact pads for bonding the fine gold wires used to make electrical connection to the device. The actual working part of the device is covered by the thin aluminium gate stripe down the centre between the two pads, which is only one micron, one thousandth of a millimetre, wide.

geographical data retrieval are involved. In all cases, the information technology component is considered to reside not in the original scientific work on which the data or simulation are based but in the design of the database system and of a 'user-friendly' interface. This allows flexibility and simplicity in using the system for genuine management and production tasks in business and industry. Examples supported under the information technology program are SIRAGCROP, developed by the Centre for Irrigation Research to aid farm planning, and the Barrier Reef Image Analysis System (BRIAN), developed by the Division of Water and Land Resources for managing the Great Barrier Reef Marine Park.

The CSIRO Information Technology Program makes grants to researchers outside CSIRO to support collaborative projects between CSIRO Divisions and industrial or academic partners on a 50/50 basis. They are allocated by a committee with members from industry, universities and CSIRO. Some $320 000 were distributed to these programs in 1984/85, many of which were exploratory or feasibility studies. Funding is expected to increase in 1985/86.

The CSIRO VLSI project culminated this year. The three-year program, established by the Division of Computing Research in 1981, was set up to develop and commercialize the design of VLSI silicon chips down to 3-micron feature size, with a component count of up to 100 000 per chip. This program was completed in June 1984. A further five months was spent in transferring the technology to the newly-established Australian company, Austek Microsystems Ltd, of Adelaide. Most of the VLSI project's staff transferred to Austek Microsystems as planned.

The first significant project of the new company was to implement the design of a revolutionary new correlator chip to form the heart of the Australia Telescope's signal processor. The fabrication and delivery of the 10 000 or so chips required for the complete correlator are now at an advanced stage.

Space Technology

Space technology is a core technology for a modern industrial state, and promises to be especially cost effective in a large, sparsely populated country such as Australia. It provides new and improved tools and systems for such varied applications as communications, resources management, meteorology, oceanography, navigation, and search and rescue.

Australia is already a substantial user of space technology for communications, meteorology, and resources development, having so far spent about $500 million on operational space systems, principally INTELSAT and AUSSAT. Relatively little of the associated equipment has been manufactured in Australia. In the next decade Australia will outlay a further $1 000 million on space technologies, and if its industry is to gain a more equitable share of this expenditure it must raise its competence and perceived capabilities in space technology (see Table 10.1). CSIRO's contribution to this goal is twofold:

- devising applications which will be used in Australia; and
- fostering innovative projects which enhance Australian industry's capability to compete effectively in international space technology.

Because of the multiplicity of potential applications which transcend industry and disciplinary boundaries, new space technologies and their applications will be developed in at least 14 CSIRO Divisions. The CSIRO Office of Space Science and Applications (COSSA) will coordinate the Organization's space research effort. (See Chapter 12 outlining the establishment of COSSA.)

During the reporting year, CSIRO Divisions were engaged in a wide and diverse range of space research and development projects, some of which are described briefly here.

Space-based communications

The Division of Radiophysics' work on advanced feedhorn design, together with the design and development of an advanced antenna measurement facility, has placed it at the forefront of satellite earth station technology. The Division completed two contracts from Overseas Telecommunications (OTC) to upgrade the feed system of the Carnarvon tracking, telemetry, command and monitoring antenna, and the antenna to access the new Intelsat V Moree I series of satellites. It also built a near field antenna measurement facility and is producing a small antenna for use in microwave links and satellite communications in collaboration with MITEC, and is studying the production of contoured-beam antennas, and the coupling effects in antenna arrays.

Remote Sensing R&D

The Division of Mineral Physics flew the Canadian MEISS II scanner over Australian sites, in addition to its own modified Daedulus scanner, to identify the best configuration for a multispectral scanner. It is currently collaborating with the University of New South Wales in developing a new generation scanner designed for Australian conditions.

The Division of Radiophysics has recently completed an anechoic chamber (12 x 6 x 4.5m) which operates at frequencies above 1.5 CHz. This is used for measuring the frequency characteristics of antennas designed for small earth stations.

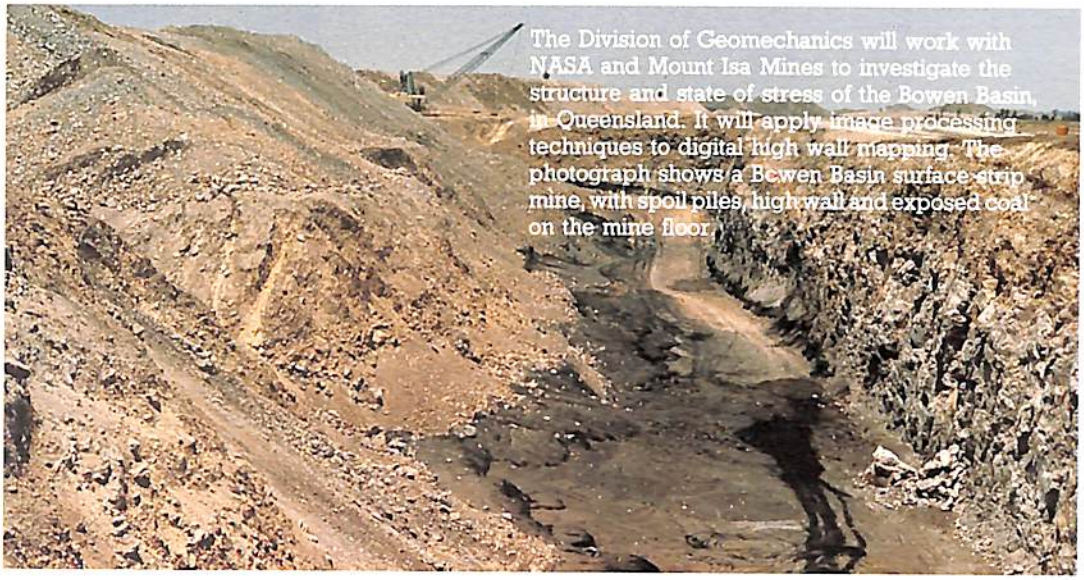
The Division of Groundwater Research developed an airborne multispectral scanner in collaboration with Carr Boyd Minerals, and studied the thermal characteristics of the Leeuwin Current with the Advanced Very High Resolution Radiometer (AVHRR) scanner on NOAA–7, in collaboration with the Division of Oceanography. This work has implications for the fishing industry and for geologists. Landsat data was used to discriminate saline areas, and thermal imagery was applied to studies of rock type discrimination, topography and palaeodrainage.

CSIRONET is developing image processing software for analysing satellite and other remotely-sensed data in various applications in collaboration with Quentron Optics. Other agreements are being established to interface with Australian-designed and-manufactured display systems. Export sales to South East Asia and elsewhere for image processing software and systems are expected to increase. CSIRONET also was involved in the ALS-CSIRO Signal Processing Experiment, and in studies of the reception of the European Remote Sensing Satellite (ERS-1).

The Division of Water and Land Resources developed the Barrier Reef Image Analysis System (BRIAN) for Landsat imagery in a collaborative project with the Barrier Reef Marine Park Authority and the Australian Survey Office. The Survey Office is applying this technology in shallow water mapping in Australia and Papua New Guinea. The Division also collaborated with the Division of Mineral Physics, using its airborne thermal scanner to study the incidence of frost.

The Division of Geomechanics will use space-borne sensing techniques to investigate the structure and state of stress of the Bowen Basin, Queensland. It has applied the image processing techniques developed in these studies to digital high wall mapping in large strip mines, and will evaluate Landsat Thematic Mapper imagery in the Bowen Basin in collaboration with NASA and Mount Isa Mines.

The Division of Wildlife and Rangelands Research is developing techniques in collaboration with appropriate State departments for applying Landsat and AVHRR data in arid lands as a cost-effective tool for improving rangeland management and preventing further degradation. Satellite and other remotely-sensed data are being integrated to produce geographic information systems.



The Division of Geomechanics will work with NASA and Mount Isa Mines to investigate the structure and state of stress of the Bowen Basin, in Queensland. It will apply image processing techniques to digital high wall mapping. The photograph shows a Bowen Basin surface strip mine, with spoil piles, high wall and exposed coal on the mine floor.

A model of the ERS–1, a European satellite for observing the oceans under all weather conditions, due to be launched in 1989. CSIRO is designing and constructing some of the components for the satellite, including the along-track scanning radiometer (ATSR).

The Division of Atmospheric Research worked with The Dindima Group to develop the CSIRO System for Interactive Data Analysis (CSIDA) which receives and processes data from geostationary and polar orbiting meteorological satellites using software developed by CSIRONET. CSIDA allows real-time consolidation of vast quantities of low information content data into small quantities of high information content data. The Division will continue its work in enhancing the market for the AVHRR product, and developing software for extending the use of meteorological data.

The Division of Oceanography is developing techniques for applying AVHRR data in oceanographic studies, using real-time imagery of sea surface temperature to identify currents, upwellings and other phenomena.

The Division of Animal Production is using Landsat data to assess fertilizers, with support from the Australian Wool Corporation and the State departments of agriculture.

Meteorology Spacecraft Systems

The Division of Groundwater Research and the Western Australian Institute of Technology developed an experimental system for AVHRR reception. The Division of Atmospheric Research, in collaboration with PCM Electronics, has developed a commercial reception system to be introduced to the market in mid-1985.

The Division of Oceanography is developing an improved AVHRR receiver, which acquires data with zero errors from horizon to horizon. The Division will use the facility to demonstrate the satellite Search and Rescue System, in addition to investigating its potential for X-band reception.

Experimental Development

The Division of Chemical Physics initiated the design of a spectrograph for the Australian National University STARLAB project, which places it in an advantageous position to perform optical design of spectroscopic equipment for astronomy and remote sensing space projects.

The Division of Applied Physics completed a project in collaboration with Dr L Dintenfass, of Kanematsu Memorial Institute, which involved designing and producing a shuttle-borne experiment for measuring blood viscosity. The Division produced optical surfaces to provide a Fabry Pèrot interferometer for the Sacramento Peak observatory in the USA, which led to a collaborative program with Johns Hopkins

Mr Peter Osman, of the Division of Applied Physics, works the CSIRO instrument carried aboard a NASA space shuttle. It was designed to measure the viscosity of normal and diseased blood under the zero gravity conditions of space. It is hoped the results will lead to a better understanding of blood clotting.

University for developing a similar etalon for solar astronomy. The Division also is involved in research for obtaining accurate time signals from satellites.

Since its inception COSSA has been involved in a number of space science projects, including the commissioning of a consultant firm to study the industrial benefits of the proposed CSIRO space research and development program. COSSA's objective is to contract out about 70% of new space work.

It also was instrumental in achieving significant Australian participation in the UK-provided Along Track Scanning Radiometer (ATSR) to be flown on ERS-1 in 1989. A member of the Division of Atmospheric Research was one of the originators of the concept being tested by ATSR. The digital electronics package for ATSR will be manufactured by an Australian company, subcontracted to its UK parent, and funded by the Department of Industry, Technology and Commerce.

Other principal events involving COSSA during the year under review were:

- An industrial feasibility study for Australian reception of data from the various instruments on ERS-1. The Division of Atmospheric Research is providing substantial input, and coordinating the response of the Australian scientific community. The Division of Radiophysics is participating in studies of the role of VLSI technology in receiving high bit rate data from the satellite.
- Negotiations with NASA for the US-Australia Joint Scanner project. The Division of Mineral Physics is coordinating a range of users, in CSIRO, industry, universities and overseas, for the data from three advanced airborne scanners developed by NASA — the NSOOI scanner (a precursor to the Landsat Thematic Mapper), the TIMS (Thermal Infrared Multispectral Scanner), and the AIS (Airborne Imaging Spectrometer). Data acquired over a number of Australian test sites will provide input into the development of remote sensing hardware and applications.
- Participation in coordinating the sponsorship of the ALS-CSIRO Signal Processing Experiment. Two CSIRO Divisions — Mineral Physics, and Radiophysics — and CSIRONET are involved in this hardware and software development program. A number of Divisions, companies and other organizations are contributing funds to ensure access to the Landsat thematic mapper data obtained over Australia during this experiment.
- An investigation of the setting up of an Australian research satellite, MIRRABOOKA. Based in part on the existing USA reusable satellite, SPARTAN, it would provide Australian industry with substantial space manufacturing experience prior to the letting of contracts for AUSSAT-2. COSSA considers that the MIRRABOOKA program is the best means for Australian industry to achieve significant participation in AUSSAT-2 and is ideally suited for fundamental and applied science experiments such as remote sensing, astronomy, and studying the equatorial ionosphere.
- Cooperation with AUSSAT to coordinate and manage an experimental package for the second generation of AUSSAT satellites.

TABLE 10.1

Industry sector	Space-based Communications	Remote Sensing R&D
Space Sector		
Project Management	1.0	1.5
Spacecraft Structures		1.0
Spacecraft Power Systems		
Spacecraft Digital Processors		1.5
Spacecraft Telemetry/ Command		
Spacecraft Attitude Control		
Spacecraft Instruments		
Electro-optical Scanners		3.0
Spacecraft Communications Exp.	2.0	
Spacecraft Qualification		0.5
Ground Sector		
Reception Systems	4.0	2.0
Data Processing Systems	1.0	4.0
Value Added Products		1.0
Continued R & D	2.0	1.0
Flight Operations	1.0	0.5
Total Expenditure/Project (in Industry)	11.0	16.0
Add. Expenditure/Project (in CSIRO)	2.5	4.5

Proposed CSIRO Space R&D Program — 1985–1989 (1984 $M)*

COSSA Project

ERS-1 Space-craft System	Meteor-ology Space-craft Systems	SPARTAN Space-craft	AUSSAT Science Package	Reception Facilities	Test Facilities	SARSAT Space-craft	Experi-mental Devel-opment	TOTAL
1.0	1.5	1.5	2.0	0.5	1.0	0.3	0.5	10.8
1.0		1.0	3.0	2.5				7.5
			1.0	0.5				1.5
1.5	1.5	2.0	2.0	2.0				9.0
			1.0					1.0
			1.5					1.5
			5.0	3.0				8.0
3.0		4.0		3.0				10.0
				3.0				5.0
0.5		0.5	1.0	1.0		4.0		7.0
								61.3
4.5	1.0	1.0		1.0		0.5		14.0
5.0	3.0	1.0	2.0	1.5		0.5		18.0
1.0	1.0	1.0						3.0
2.0	1.0			1.0			2.5	9.5
1.0	0.5	0.5	1.0	2.5				7.0
								51.5
16.0	15.5	18.5	20.0	6.5	5.0	1.3	3.0	112.8
3.5	4.5	2.5	2.5	0.5			4.5	25.0

* A level of 33 per cent of non-CSIRO expenditure is assumed, which would be derived from Offset contracts, other technology development funding from Government, R & D contributions from 'user' government departments, and industrial collaborative agreements.

11. International Aid

CSIRO has contributed to overseas development assistance and aid-related activities for about 30 years. Major projects have included land-use surveys in Papua New Guinea, training for Colombo Plan Fellows and the setting up of a major centre for animal production research in Indonesia.

CSIRO supported Australia's foreign aid program in the past in response to specific requests from agencies such as the Australian Development Assistance Bureau (ADAB), reflecting the prevailing government policy. A review of CSIRO's international activities and the associated internal arrangements was commissioned by the Executive in 1982. Following the review, the Executive decided that CSIRO should adopt a more active approach, identifying research areas where an expansion of the Organization's normal research programs could significantly contribute to a developing country's progress.

The principal outcome of Executive decisions on the review report was that CSIRO was considered to have a significant part to play in the national policy on international science and technology based on the expertise, skills and experience of its individual scientists and of the Organization as a scientific body.

It was decided that CSIRO's participation in aid programs should be based on criteria such as their relevance to existing research programs, availability of appropriate expertise, staff and resources relative to existing commitments, cost recovery and the existing level of outside funding in relation to Divisional core programs.

The CSIRO Centre for International Research Cooperation (CIRC), which was established in 1978, provides a focus for the Organization's aid and development assistance activities.

CIRC is responsible both for the formulation, for Executive approval, of policy and procedures for the Organization's participation in international activities, and for their implementation as appropriate. It coordinates the Organization's activities in relation to international science and

Small farms at Machakos, Kenya. CSIRO research, funded by the Australian Centre for International Agricultural Research, is based here and aims at improving agriculture in Africa's semi-arid tropics.

technology agreements, and is also the focal point for formal arrangements which CSIRO makes with overseas research institutions and with the United Nations agencies and other international agencies.

CIRC is responsible for coordinating the Organization's efforts to assist developing countries, for evaluating and implementing project proposals, and for training scientists from developing countries.

CSIRO's development assistance activities may be divided into three major categories:

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

Many senior CSIRO scientists also serve on the policy, advisory and management committees of bilateral and multilateral donor agencies such as the Australian Centre for International Agricultural Research (ACIAR); the Consultative Group for International Agriculture Research (CGIAR); and the United Nations agencies, including the Food and Agriculture Organization (FAO) and the World Health Organization (WHO).

Cooperation with agricultural research institutions in developing countries increased significantly following the establishment of ACIAR in 1982. At the Centre's request, project proposals were prepared by CSIRO and other scientists for consideration by the ACIAR Board of Management. CSIRO has accepted responsibility for some 29 projects, thus becoming the major contractor. Further proposals are being prepared by CSIRO for the Board's consideration, but some Divisions may have reached, or may soon reach, their limit for providing development assistance. Additional commitments could create an imbalance between a Division's national and international priorities. Pressure on the few senior scientists supervising these projects is also nearing its limit.

Requests for development assistance from CSIRO's non-agricultural Divisions appear to be increasing and there is considerable potential for further involvement, particularly by Divisions able to contribute to the scientific and economic development of the more advanced countries of South East Asia, such as Singapore, Malaysia, Thailand and Indonesia, which are interested in importing high technology goods, services and industries.

An example of a CSIRO project contributing in this area is the Asia/Pacific Regional Metrology Program, funded by ADAB, and managed by the CSIRO Division of Applied Physics through its

Imbuanda village and lagoon, Papua New Guinea, where CSIRO international aid has assisted in controlling the floating fern, salvinia, through a small weevil. The weevil, which was discovered by CSIRO scientists in Brazil, kills the weed, which sinks to the bottom of the water leaving it clear and unpolluted. The pictures show the lagoon before and after treatment which took about three months.

National Measurement Laboratory, the leading one of its kind in the South East Asian region. The Laboratory undertakes measurement workshops, calibration of national standards, and international intercomparisons of measurements and provides advice and training. The 17 participating countries represent more than half the world's population.

Further indications of the growing interest in secondary industries research are the increasing number of requests received by CSIRO for consultants and training programs from the United Nations Industrial Development Organization (UNIDO).

The setting up of Science and Technology Cooperation Agreements with several ASEAN countries, on the initiative of the Commonwealth Department of Science, should stimulate further collaboration between ASEAN scientific institutions and CSIRO, thereby creating greater opportunities for participation in high technology projects.

Programs on the Management of Research and Development are being implemented by CIRC at the request of the ASEAN Committee on Science and Technology and ADAB under the ASEAN/Australia Economic Cooperation Program. Senior and middle level research managers and managers of training and development participate in seminars and workshops that are designed to increase knowledge and improve skills. ASEAN middle level managers are placed in CSIRO Divisions and other Australian research institutions to study management practices. The first phase of the four-year project was completed successfully in May 1985.

Expenditure on development assistance activities from CSIRO's appropriation funds is limited to part of the salaries and operating costs of CIRC, which totalled $435 000 in 1984/85. During the year $6.82 million were obtained from external sources for the Organization's involvement in aid-related programs. This comprised $6.30 million for projects, $34 000 for consultancies and $180 000 for training activities. CSIRO's commitment to, and involvement in, aid programs has had a twofold benefit — providing much sought-after expertise to developing countries and creating opportunities for CSIRO researchers to accept new challenges.

Administration

12. Management

CSIRO is governed by an Executive of three full-time members and five part-time members. The Chairman, who must be a full-time member, is *ex officio* the Chief Executive of the Organization, responsible to the Executive for its day-to-day operation.

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. The latter are 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 organizational 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 organizational 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 Directors of research Institutes and the heads of the main elements of central administration. The role and responsibilities of the Management Committee were revised as follows:

Role

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 which affect the Organization as a whole. It deals with matters concerning the maintenance of scientific standards and the public standing of CSIRO. It also deals with certain matters which cross Institute boundaries.

The Management Committee is the prime focus of accountability for individual members of the Committee on matters upon which it exercises decision-making powers. Standing sub-committees are formed by the Committee to deal with specialized areas and they also report to it.

Responsibilities

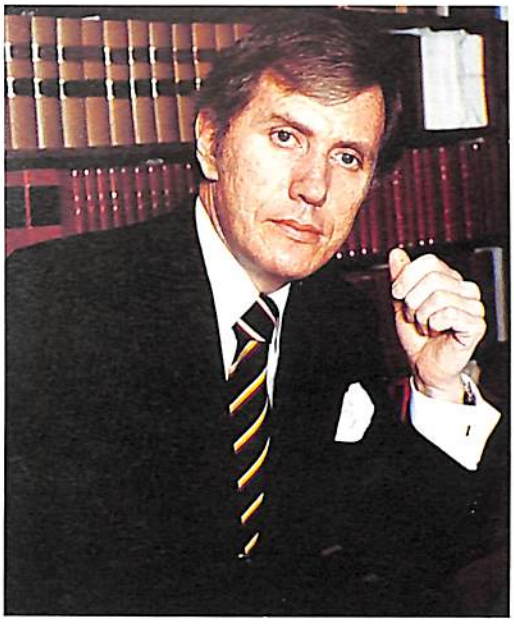
Subject to the over-riding decision-making authority of the Executive, to *decide* the following matters:

- procedures for implementing research policies and strategies determined by the Executive;
- establishment of research reviews, and deciding management actions arising out of reviews (other than issues reserved for the Executive);
- appointment and promotion to Senior Principal Research Scientist and Chief Research Scientist levels;
- formulating and implementing policies and procedures in line with broad personnel objectives determined by the Executive;
- multi-Institute arrangements (such as joint programs and services on a common site); and
- capital expenditure below the level reserved for Executive decision and above the level delegated to Directors.

To *advise* the Executive on:

- broad policies and procedures for the Organization;
- research policies and strategies for the Organization and Institutes;
- corporate plans;
- budget proposals for Institutes, other areas of activity and the Organization as a whole;
- new initiatives to be put to the Government;
- proposed major growth and shrinkage areas for deployment of the Organization's resources;
- appointment and renewal of terms of Chiefs;

Members of the CSIRO Executive: From left (standing) Mr G G Spurling, Prof. D P Craig, Dr K J Foley, Prof. A E Clarke, Mr P D A Wright (seated) Dr N K Boardman, Dr J P Wild, Dr G H Taylor.



Justice M D Kirby, Part-time Member of Executive

Mr S B Myer, Part-time Member of Executive

Directors of Institutes; from left Dr K A Ferguson, Dr N H Fletcher, Dr W I Whitton, Dr M G Pitman.

Dr A F Reid, Director, Institute of Energy & Earth Resources

- public relations and promotion of the Organization; and
- form and content of submissions to Parliament and other external bodies.

Executive and Staff Changes

Executive Changes

The appointments of Dr J P Wild, CBE, as Chairman of the Organization and Dr N K Boardman as a full-time member of the Executive conclude on 24 September 1985. In June 1985 the Minister for Science announced that Dr Boardman had been appointed as Chairman, to succeed Dr Wild on his retirement, for a term of nine months from 25 September 1985.

The appointments of Professor D P Craig, AO, and Mr S B Myer as part-time members of the Executive concluded in June 1985 after having been extended by six months from December 1984.

Dr A E Clarke and Dr K J Foley were appointed as part-time members of the Executive to fill these vacancies. Their terms are for nine months from 23 June 1985.

Mr G G Spurling, a part-time member of the Executive, was reappointed for a term of nine months from 9 September 1985, when his present term ends.

The period of the appointments was set at nine months by the Government to allow scope to review the composition of the Executive in the light of the ASTEC report on CSIRO.

Senior Staff Changes

Following the Minister for Science's announcements of changes in membership of the Executive, which leaves one full-time position vacant from 25 September 1985, the Executive has appointed Dr M G Pitman, OBE, as an associate member of the Executive for a period ending on 30 June 1986.

Dr E F Henzell, AO, Chief of the Division of Tropical Crops and Pastures, was appointed Acting Director of the Institute of Biological Resources while Dr Pitman serves as an associate member of the Executive.

Dr F R Harden Jones, formerly of the Ministry of Agriculture, Fisheries and Food, Lowestoft, United Kingdom, was appointed Chief of the Division of Fisheries Research for a period of seven years from 13 August 1984.

Dr B H Walker, formerly Professor, Department of Botany, and Director, Centre for Research Ecology, University of Witwatersrand, South Africa, was appointed Chief of the Division of Wildlife and Rangelands Research for a term of seven years. He takes up this appointment on 8 July 1985.

Following the decision in May 1984 to establish CSIRONET as an autonomous unit within CSIRO, the Executive appointed Dr P J Claringbold as Chief Executive of CSIRONET for a term commencing on 1 July 1984 and ending on 14 January 1988.

The Executive announced the appointment of Mr D McCullough as Chairman of the Board of Management of CSIRONET. Mr McCullough is a director of several companies and has had extensive national and international experience with PA Management Consultants Pty Ltd.

Dr K G McCracken, formerly Chief of the Division of Mineral Physics, was appointed as Director of COSSA for a period of two and a half years from 20 February 1985.

Mr W A Snowdon was appointed Chief of ANAHL for a period of three years from 14 December 1984.

Mr S Lattimore, Director of the Bureau of Scientific Services, commenced extended leave on 16 January 1985 prior to retirement.

Dr R J Batterham, Chief Research Scientist with the Division of Mineral Engineering, was appointed Chief of that Division for a period of seven years from 15 November 1984.

Dr R D B Fraser, Chief Research Scientist with the Division of Protein Chemistry, was appointed Chief of that Division from 14 February 1985 to 13 August 1989.

Dr D F A Koch, formerly Chief of the Division of Mineral Chemistry, was appointed as Chief of the new Division of Minerals and Geochemistry based at Floreat Park, Perth, from 1 July 1985.

Dr G E Thomas, Director of the Edinburgh Regional Computer Centre, UK, was appointed Chief of the new Division of Information Technology for a term of five years. He takes up his appointment in August 1985.

Dr P J Nestel, Deputy Director, Baker Medical Research Institute, Melbourne, was appointed Chief of the Division of Human Nutrition for a period of seven years from 1 January 1986.

Mr L G Wilson, AO, was appointed Corporate Secretary in the Office of the Chairman following the disbanding of the Office of the Executive on 18 February 1985.

Mr H C Crozier became General Manager (Finance and Administration) and Mr K J Thrift, General Manager (Personnel) under the new arrangements introduced at CSIRO Headquarters from 18 February 1985.

Administrative Reviews

Bureau of Scientific Services and Library and Information Services

The establishment of reviews of the Bureau of Scientific Services and Library and Information Services was reported in the 1983/84 Annual Report.

Decisions on the Library and Information Services review were made in September 1984. The organizational structure of the Central Information, Library and Editorial Section (CILES) was considered in the context of the review of the Bureau of Scientific Services.

The Bureau of Scientific Services comprised:

- Central Information, Library and Editorial Section (CILES)
- Centre for International Research Cooperation (CIRC)
- Commercial Group, and
- Science Communication Unit (SCU).

As a result of the review, CILES and the SCU were combined in a new information and public communication service, and CIRC was made independently responsible to a full-time member of the Executive. Members of the Commercial Group had previously been absorbed into SIROTECH Ltd or transferred to Institutes. The Bureau of Scientific Services effectively ceased to exist in December 1984. Arrangements are proceeding to appoint a Director, Information and Public Communication, to head the new service.

As a result of the review of Library and Information Services the aims and broad responsibilities of CILES relating to library services are:

- to support and help ensure the excellence and relevance of CSIRO's science and technology;
- to support the communication of the results of CSIRO efforts, within CSIRO and externally, to industry, government, academia and the general public;
- to support Australia's national information programs;
- to coordinate, monitor and provide consultative assistance and direct support to all CSIRO units in identifying and solving information problems at local, regional and central levels. This support should cover the entire spectrum of CSIRO information activities, including internal support services as well as external information transfer;
- to maintain statistics and reports on the overall level of information resources, information-related expenditure and information utilization for CILES and for CSIRO as a whole;
- to act as a focal point for coordinating and monitoring all significant CSIRO information programs, no matter where, and by whom, conducted;
- to define and promulgate standards and procedures for collecting, processing, storing and disseminating information for CILES and for CSIRO as a whole to ensure that all CSIRO-generated information meets professional standards of quality and is compatible on an intra- and inter-organizational basis; and
- to encourage and support non-competitive and compatible regional and Divisional library, inquiry and referral, database and

publishing efforts providing they are coordinated with the central information programs.

Strategic Research Planning and Divisional Reviews

Reviews of CSIRO's strategic research planning activities and Divisional reviews were concluded and are reported in Chapter 1.

Executive Secretariat

Policy and administrative support had for several years been provided to the Executive by an Office of the Executive. The Office was disbanded following a review chaired by Dr N K Boardman. It was replaced by an Office of the Chairman and two small personal staffs providing direct support to full-time members of the Executive. The Office of the Chairman provides advice on policy, government, legal and corporate development matters, and covers Ministerial liaison and administrative services required by the Executive.

The change was designed to encourage Institutes to continue to increase the depth and range of research policy matters covered by them.

External Communication Activities

The review of CSIRO's external communication activities described in the 1983/84 Annual Report was completed and a report presented to the Executive. Decisions on the report will be made shortly.

Personnel Branch

A review of the role and operations of the Personnel Branch of headquarters has been established under the chairmanship of Dr M G Pitman.

CSIRO Office of Space Science and Applications (COSSA)

CSIRO played a crucial part in the exploration of space when the Parkes radiotelescope was used to receive the pictures of the Apollo 11 moon landing in 1969. Subsequently, the Division of Radiophysics became increasingly involved in aspects of satellite telecommunications, based on its antenna expertise developed in radio-astronomical research, and has established useful collaboration with industry.

In the early 1970s the Organization recognized the value of remote sensing satellites for resources management across Australia. Several Divisions, which were then known as Mineral Physics, Computing Research, Land Resources Management and Land Use Research, began a substantial research effort into the applications of these satellites, including mineral exploration, water resource management and agriculture and land use monitoring. Their research resulted in considerable user demand, which was largely responsible for the establishment of the Australian Landsat Station in 1980. These Divisions, their successors, and others, are continuing their interaction with the user communities in developing remote sensing techniques and instrumentation for current and future earth resources satellites.

With the launching of satellites designed specifically for meteorological and ocean science applications, the Divisions of Atmospheric Research and Oceanography established research efforts to receive and use the data generated in a manner designed for their user communities.

In March 1984 CSIRO set up a Space Science and Technology Study Group to look at the future development of the CSIRO space research effort. The Study Group, which had substantial representation from space interests outside CSIRO, consulted widely and visited a number of overseas space research establishments. After considering the Study Group's recommendations, the CSIRO Executive established the CSIRO Office of Space Science and Applications (COSSA) in December 1984. It appointed Dr K G McCracken as Director. Dr McCracken was formerly the Chief of the Division of Mineral Physics, and prior to joining CSIRO in 1970 had been closely involved in space research.

SIROTECH

SIROTECH Ltd, CSIRO's technology transfer company, was incorporated in late 1984 and became operational in February 1985. It was launched officially by the Minister for Industry, Technology and Commerce, Senator the Hon. John Button, in Canberra in March 1985.

The impetus for establishing a company, separate from the Organization, was CSIRO's need to have access to strong commercial and business expertise at a time when it was placing new emphasis on transferring its research results to the market place on a sound financial basis.

SIROTECH Ltd, CSIRO's new national technology transfer company, was launched in March 1985, by the Minister for Industry, Technology and Commerce, Senator the Hon. John Button.

SIROTECH's major roles are:

- principal agent and adviser to CSIRO in negotiations on the commercialization of research results
- manager of CSIRO's joint ventures
- head licensee for CSIRO inventions.

By 30 June 1985 SIROTECH had a staff of 24. Many are highly skilled professionals formerly holding senior positions in industry and government, with expertise in marketing, technology communication, finance, law and industrial property. Further appointments are to be made.

One of SIROTECH's first tasks was to carry out a stocktake of CSIRO research which was either ready for commercialization or which would be ready within the next three years. It has made considerable progress towards compiling an inventory and, at the same time, has brought many pre-existing commercial negotiations to a successful conclusion. Extensive market research has been a key element in the process.

The company has established close relationships with CSIRO Divisions and with various areas of industry. It had expected that about a quarter of the Divisions would have immediate need for its services, but in its first few months of operation it dealt with 30 of the 40–plus Divisions, taking on more than 150 projects as potential candidates for commercialization.

Industry's interest in dealing with SIROTECH has been strong, especially from Australia's largest companies and from the new, entrepreneurial science-based companies.

Following discussions with industry and CSIRO, SIROTECH selected for special attention areas which build on the strengths and needs of both parties and have export potential. These are mining and mineral processing; material conversion and energy; primary industry processing; primary industry/advanced materials; food, drugs and biotechnology; and electronics and instrumentation.

An agreement was negotiated with the South Australian Timber Corporation (SATCO) to manufacture SCRIMBER, a new timber product made from pine thinnings and small trees, which provides a cheap, quality alternative to the best natural timber. SIROTECH is now negotiating overseas licences for the product.

Several more negotiations are in the final stages including new insecticide developments with a major chemical company, new human and veterinary vaccines and improved grain treatment mechanisms.

In March, SIROTECH launched Tech-Link Australia, the monthly subscription-based journal of the Tech-Link technology transfer network which now has more than 700 members. The first four issues of Tech-Link covered several Australian science and technology agencies and support schemes, explanations of new technologies, venture capital and various State initiatives.

A technology transfer workshop, held at the Division of Chemical and Wood Technology in June, was attended by key personnel from the Division and seven senior officers from SIROTECH. The workshop identified the main issues concerned with the commercialization and marketing of CSIRO technology and discussed SIROTECH's interaction with the Division's research staff. More workshops and two conferences are planned in 1985/86.

As CSIRO is its principal subscriber and major client, SIROTECH has provided most of its services to the Organization. However, its charter allows it to undertake consultancy work for other organizations. An early contract was with the Victorian Government, which it advised on prospects for commercializing biotechnology. It completed a report on livestock management techniques for the Australian Meat and Livestock Corporation and a technology evaluation for Price Waterhouse. It acts also as a commercial adviser to the Garvan Institute.

The joint CSIRO/manufacturing industry collaborative research program, under which funds have been set aside for new research areas important to the manufacturing sector, is being administered by SIROTECH.

Personnel

SIROTECH's Chairman is Mr L G Cuming, former Chief Executive of Nicholas-Kiwi and a former Chairman of the Board of the World Federation of Proprietary Medicines Manufacturers. He is also a Board member of the Australian Biomedical Corporation, Mercantile and General (Australia) Reinsurance Group and McPherson's Ltd.

The company's Chief Executive and Board member is Mr J J Doyle. Mr Doyle is a lawyer and former trade commissioner in Europe and Africa. He was founding Chief Executive of the Victorian Economic Development Corporation.

Directors:

Mr D Dyer, General Manager, Industry Development, AIDC

Mr G G Spurling, Managing Director, Mitsubishi Motors Australia Ltd, and part-time member, CSIRO Executive

Dr G H Taylor, full-time member, CSIRO Executive

Mr M J Williams, General Manager, The Australian Gas Light Company.

Senior Executives:

Mr B F Gaffney, Marketing Manager

Mr L A Wisbey, Manager, Technology Communication

Mr J M Barrington, Corporate Lawyer and Company Secretary

Mr F Pernat, Manager, Industrial and Intellectual Property.

CSIRONET

Following a review of the Division of Computing Research in 1982/83, the computing service and its associated developmental activities were established as a separate entity known as CSIRONET on 1 January 1985. Research activities not directly related to the computing service formed the embryo of a new Division of Information Technology.

CSIRONET is no longer part of the Institute of Physical Sciences and operates as an autonomous unit within CSIRO, managed by a Board of Management, on a full cost-recovery basis. The Executive has directed the Board to enhance the commercial role of CSIRONET.

CSIRONET's functions are:

- to operate and develop a computing network and services for CSIRO and appropriate external users, including providing scientific computing facilities for CSIRO;
- to conduct other high level development in support of these responsibilities.

The CSIRONET Board sets strategic directions, policies and objectives, critically reviews alternative strategies and proposals developed by management and directs management to pursue specific programs. It also reviews and approves specific management proposals made in the context of the Executive's long-term policies. The Board first met in August 1984.

The Chairman of the Board now has responsibility for approving certain appointments and promotions previously the responsibility of the Director of the Institute of Physical Sciences. The Chairman is assisted in this by a CSIRONET Personnel Advisory Committee.

Members of the Board of Management are:

Chairman, Mr D McCullough

Chief Executive, Dr P J Claringbold, Institute of Physical Sciences, CSIRO

Other Members:

Dr B H G Brady, Chief, Division of Geomechanics, CSIRO

Mr H C Crozier, General Manager (Finance and Administration), CSIRO

Dr N H Fletcher, Director, Institute of Physical Sciences, CSIRO

Mr P P Hanlon, CSIRONET Staff Representative

Mr N J Tanzer, Deputy Director-General, Department of Social Security.

The change in CSIRONET's status has led to a more commercially-oriented management structure. As well as a Chief Executive, it now has a Senior Adviser and three General Managers (Services, Products and Marketing).

New strategies are being developed to meet the requirements of existing and new clients. As part of an overall improvement to user services, a franchising agreement was recently concluded with Intran Australia Pty Ltd for facilities management and marketing in South Australia and Western Australia.

Several user surveys were undertaken during 1984/85 to gauge the potential use of proposed services and to determine the impact of other changes. An independent survey of computing bureau charges in Australia showed overall CSIRONET costs to be substantially lower than those of other bureaux.

Marketing and business development activities have been considerably increased and sales of CSIRONET-developed software have been made

in Australia, Japan and elsewhere. Other activities included:

- an exchange of information agreement, including software marketing rights, which was signed with Century Research Centre Corporation of Japan;
- a multi-million-dollar, five-year contract which was awarded to CSIRONET by Telecom for providing time-sharing and batch processing facilities, to begin 1 October 1985;
- a joint venture which was launched with the Sperry Corporation to make its Mapper service available to CSIRONET clients.

Under its new charter CSIRONET has changed its research emphasis and development work from computing research (including information technology, simulation modelling and VLSI) to areas directly supporting the network and services. These include: supercomputer applications; computer communications, including developing and implementing international standards; work station design, based on the successful CSIRONET micronode; typesetting and electronic demand publishing; and graphics and image processing.

In mid-1985, the Australian Industry Development Corporation (AIDC), acting on behalf of CSIRO, the Department of Industry, Technology and Commerce and itself, engaged a consultant to investigate the financial feasibility of restructuring CSIRONET as a separate commercial entity outside CSIRO. If the first stage of the study demonstrates sufficient potential a second stage will examine the necessary strategy and the organization for CSIRONET to exploit perceived business opportunities. The earliest date at which a separate entity could be formed would be 1 July 1986.

SIROMATH

During 1984/85 the commercial venture SIROMATH Pty Ltd continued to expand the types of skills and volume of services provided to Australian industry, government and commerce. The research staff of CSIRO continued to play a key role in providing this resource.

Turnover increased 50% and SIROMATH registered an income from consulting fees and software sales of more than $1.5 million.

SIROMATH has continued to develop a specialist consulting group for projects in areas where commercial demand either outstrips CSIRO capacity or is outside current CSIRO skills.

SIROMATH continued to expand its skills and services during 1984–85. SIROMATH systems to optimize production in rice milling plants such as this are expected to save Australia's rice growers more than a million dollars a year.

Support staff needed for consulting projects, and a computer group with specialist skills linked into projects with statistical, mathematical and operations-research have been acquired.

A Darwin consultancy has been added to those in Sydney, Melbourne and Perth, and by June 1985 SIROMATH had a staff of about 30 (including SIROMINES).

The biggest interaction with CSIRO was with the Division of Mathematics and Statistics. However, a number of research projects with mathematically-oriented groups in the Division of Building Research and the Division of Water and Land Resources were undertaken. SIROMATH also collaborated with several universities and other research institutions.

Areas of Work

The principal areas of SIROMATH consulting continued to involve statistical analysis, research and design, often in parallel with software development and implementation. Particular growth has come from work in:

- quality assurance and improvement
- forecasting methods
- demographic and social data analyses
- biometrical analysis, especially field trial work
- database design and implementation.

The broad market developed by SIROMATH for statistical, mathematical and computing skills shows no sign of narrowing, and the SIROMATH client list covers more than 200 Australian companies and institutions.

The joint venture, SIROMINES, between SIROMATH and the French School of Mines, more than doubled its turnover in 1984/85, with a total income from consulting and software sales of more than $250 000. In its two years of operation SIROMINES has worked with a significant number of mining companies which are now carrying out in Australia estimations of ore reserves rather than engaging overseas consultants.

Major SIROMATH projects include:

- development and installation of a production optimization system for Ricegrowers Cooperative Mills Ltd, in NSW. The industry expects to recover full costs in 12 months, and to save $1 million a year;
- projects involving industrial experiments for quality improvement. For example, Australian Newsprint Mills Ltd hopes to save millions of dollars by more energy-effective paper-making methods;
- undertaking a major project for evaluating methods of detecting the diversion of nuclear materials for the Australian Program of Assistance to the International Atomic Energy Agency;
- controlling the design, collection and data-analysis in large-scale traffic studies which have considerable social and budgetary impact;
- undertaking for Telecom Research Laboratories an ongoing project for quantifying and understanding the pattern of lightning strikes;
- a detailed analysis of the flow-on effects of investment in different types of accommodation to assist State governments to make maximum use of housing funds;
- evaluating the effects of Medicare on the health status of the Australian community in a joint project with Westmead Hospital;
- contributing research based on biological capture-recapture methods for the NSW Drug and Alcohol Authority to assess the extent of heroin addiction in Sydney.

Looking towards 1985/86

In 1985/86 SIROMATH is looking at a steady consolidation of the achievements of the past five years, placing special emphasis on contributing to Australian industrial improvement through work on quality assurance and quality improvement. It will be working closely with the Division of Mathematics and Statistics in this vital area. SIROMATH aims also to provide an expanded consultancy in market research and demographic research. An improvement in identifying markets should provide greater efficiency for almost all sectors of Australian industry.

Freedom of Information

Requests made to CSIRO between 1 July 1984 and 30 June 1985.

CSIRO received 43 requests during the reporting year and helped other agencies with some of their requests.

Requests were handled as follows:

- access granted in full 14
- access granted in part or with deletions 20
- access deferred 2
- access refused 1
- transferred to other agencies 1
- request withdrawn 5
- awaiting decision 7

Initial decisions on whether or not to grant access were notified as follows:

- 0 — 15 days 9
- 16 — 30 days 6
- 31 — 45 days 11
- 46 — 60 days 6
- over 60 days 6

During the reporting period there was one case before the Administrative Appeals Tribunal which subsequently was withdrawn by the applicant.

Fees received from access charges were $68.

CSIRO has a central FOI Coordination Unit at CSIRO Headquarters to receive requests, identify documents subject to requests, refer to senior officers for decision where appropriate, give or deny access as appropriate and to maintain FOI statistics. All Divisions and Units have FOI contact officers for inquiries, advice and assistance.

13. Personnel

Staff Development and Training

As a result of a comprehensive review a specially commissioned consultant's report evaluating CSIRO staff development and training needs was circulated within the Organization in May 1983. Following that report an Executive review committee prepared detailed recommendations on the future direction and management of staff development and training. This review focused attention on the two most important training areas: management training and retraining. A short study also was made of a sample of some US commercial research and development organizations to assess their policies and practices in these important areas. Reports on these studies, together with an overview assessment by the Human Resources Strategy Working Group, were considered by the Executive in February 1985.

Retraining

CSIRO faces constant pressures to redirect its research work. For permanent staff this can be successfully achieved only by exposure to continuing education and retraining programs. There has always been some continuing education and retraining within CSIRO, but the Executive concluded that a more coordinated, planned approach would maximize the use of the Organization's human resources.

The overseas organizations studied have well-developed policies for appraising performance, developing careers and setting goals. These policies are seen as indispensable to the success of their retraining and continuing education programs. Approaches vary, but the trend is towards scientific staff devoting a minimum period each year to development and training.

US experts suggest that the most successful retraining remains a learning/doing situation where trainees work with other scientists who are already skilled in the new area and sympathetic to their needs. This process can be supplemented by attendance at short - usually external - courses or longer intensive courses of up to 12 months at universities or elsewhere.

The Organization agrees that the retraining needs of professional scientific staff are usually best identified and catered for individually through performance appraisal and career development. The likelihood that CSIRO professional staff will be committed to retraining depends on effective consultation. Staff must have the opportunity to participate in goal setting: to reconcile their wants with the Organization's needs. Success also depends on clear and unequivocal directions from corporate management.

A scientist from the Division of Applied Physics working on the development of a ratio pyrometer for temperature measurement in an aluminium strip rolling mill.

The study confirmed the positive relationships between change and continuing productivity. While coping with change is often difficult for individuals, when successful it is usually associated with continuing high performance and job satisfaction. Consequently, retraining can meet two objectives: it equips staff to transfer to higher priority work; it can remotivate staff whose performance has declined or might otherwise decline through stagnation. To secure these objectives the Executive resolved to increase resources to retraining and continuing education programs.

Executive decisions

The Executive's decisions of February 1985 will lead to increased emphasis on development and training to improve the quality of management at all levels, which will, in turn, ensure effective

retraining programs. The Executive has decided to issue a policy statement expressing a strong commitment to the principles and objectives of staff development and training. This statement will emphasize line management's responsibility to ensure that staff receive appropriate training, relevant to their duties and to the needs of CSIRO. This requires the allocation of adequate staff development and training resources at the Divisional as well as Organizational levels.

Staff development and training will be the subject of strategic planning involving:

- consideration of annual training reports and plans;
- consultation with staff associations;
- identification and resolution of priorities;
- consideration of the distribution of resources according to determined priorities; and
- recommendation of the level of resources to be allocated.

A Staff Development and Training Committee comprising an Institute Director as Chairman, four Chiefs of Division and the General Manager (Personnel) will be responsible for planning. The Committee will decide on programs and courses to be conducted or coordinated by the Staff Development and Training Unit and advise the Management Committee on annual resources required for the programs, including retraining.

As a priority, the Committee will develop a strategy aimed at ensuring that staff counselling, oriented towards discussions on performance and goal setting, is carried out successfully within CSIRO. The Committee will also develop a CSIRO strategy for retraining staff incorporating the following elements:

- staff should be involved through the staff counselling process in deciding on their retraining needs and how they should be met. Training is unlikely to succeed unless staff are personally involved in these decisions;
- retraining programs will usually be tailored to individual needs; and
- retraining will normally be centrally funded, except for retraining in overseas institutions.

Consultations with staff associations on training programs will be arranged through a Consultative Council Sub-committee. The central Staff Development and Training Unit is being re-established as the focus for staff development and training in CSIRO with additional resources to ensure a high level of professional expertise.

The personal counsellors, Acey Choy, Kent Hallett, Maxine Fern, Curt Fisher, Dawn Cumes, Ian Mackie.

Personal Counselling Services

CSIRO first experimented with personal counselling services in 1982, when the Executive, on the advice of Consultative Council, appointed professionally qualified counsellors to Sydney, Melbourne, and Canberra. The objective of these services is to give staff ready access to counselling on personal problems which could affect work performance. In addition to face-to-face counselling, the three counsellors contributed significantly to the Organization's occupational health and staff development programs by developing and conducting courses in stress management and communication skills.

Management and staff in all three centres, as well as staff associations, welcomed the services and, after a trial phase, the Executive concluded that they were most beneficial. A review of the services in October 1983 resulted in similar facilities being extended to staff in Adelaide, Perth and Brisbane. CSIRO now employs seven professional counsellors, including two in Brisbane who work in a job-sharing arrangement. The standard of the service is particularly high and counsellors are encouraged to develop strategies for broadening their contribution to overall occupational health and staff development.

While the Personnel Branch has an administrative responsibility for the personal counselling services, the counsellors provide a confidential service to staff independent of management. The counsellors themselves arrange most publicity for

Table 13.1 PROPORTION OF EXTERNALLY FUNDED STAFF 1978–1985

STAFF GROUPINGS	June 1978	June 1981	June 1983	June 1985
	%	%	%	%
Research Scientist	5.8	7.7	7.1	8.0
Other Professional	9.6	13.5	13.6	14.6
Technical	17.7	23.7	19.4	21.3
Other	7.9	9.6	6.5	5.9
TOTAL	10.6	14.0	11.9	12.6

the service by visiting sites in their region and talking informally to staff at social gatherings. They work from offices on CSIRO sites as this makes them easily accessible to all staff. Care has been taken to ensure privacy for staff visiting the counsellors and back-up facilities, such as answering services, ensure that their telephones are never unattended. The counsellors move around sites to ensure that all staff are conscious of their availability. Staff may meet counsellors away from their designated office whenever this seems preferable.

The services' operations are monitored through anonymous statistical records. These have shown that the services are mostly used by a wide cross-section of staff but the counsellors also see other family members or friends where this seems desirable. The counsellors are consulted on a broad range of problems, particularly those relating to family, relationships, anxiety, stress and career issues. Many supervisors seek advice on managing personnel problems and improving staff communication. The counsellors also are called upon to act as mediators where inter-personnel problems arise; to follow up with staff who have consulted the services; to assist local Equal Employment Opportunity contact persons; to visit staff in hospital; to visit the Organization's remote localities; and to provide information on community services.

In the fields of preventive occupational health and staff development, involvement in the stress management and communication skills courses mentioned above is considered to be of the utmost importance. Courses run by the counsellors are an essential part of the services in that they serve as an educational medium which, in itself, can help people through stressful periods without their having to see the counsellor individually. The courses reach staff who will attend a course with colleagues but who would hesitate about approaching a counsellor personally.

Recognizing Industry Contributions in Promoting Research Scientists

In 1983 the Executive promulgated classification guidelines for research scientists which emphasized the significance of contributions to industry when assessing scientists for promotion. The guidelines recognize the diverse activities of CSIRO scientists who may be engaged in any part of the spectrum of scientific activities ranging from fundamental research to the application of research skills and knowledge in investigating specific industry or community needs. Indications of achievement include the extent of a scientist's contributions to industry through the development of products or processes; the extent of endeavours to follow up research into the development stage; and contributions in collaborating with and advising industry.

As the classification guidelines have been operating for a reasonable period, a preliminary

Table 13.2 PROPORTION OF STAFF ON FIXED TERM APPOINTMENTS 1978–1985

STAFF GROUPINGS	June 1978	June 1981	June 1983	June 1985
	%	%	%	%
Research Scientist	9.9	13.3	13.3	14.4
Other Professional	9.9	16.1	18.4	19.9
Technical	18.3	22.7	27.8	24.8
Other	29.9	25.1	32.0	27.9
TOTAL	19.0	20.3	24.4	22.5

assessment can be made of their effectiveness. For example, in the 1984 round of reclassifications 9 of 19 promotions to Senior Principal Research Scientist and 3 of 6 promotions to Chief Research Scientist depended on industry contributions. These promotions were a consequence of the greater emphasis placed on the contribution to industry provided for in the classification guidelines. As the guidelines are still relatively new in application, the Executive will continue to monitor their effectiveness in providing suitable rewards for scientists' contributions to industry.

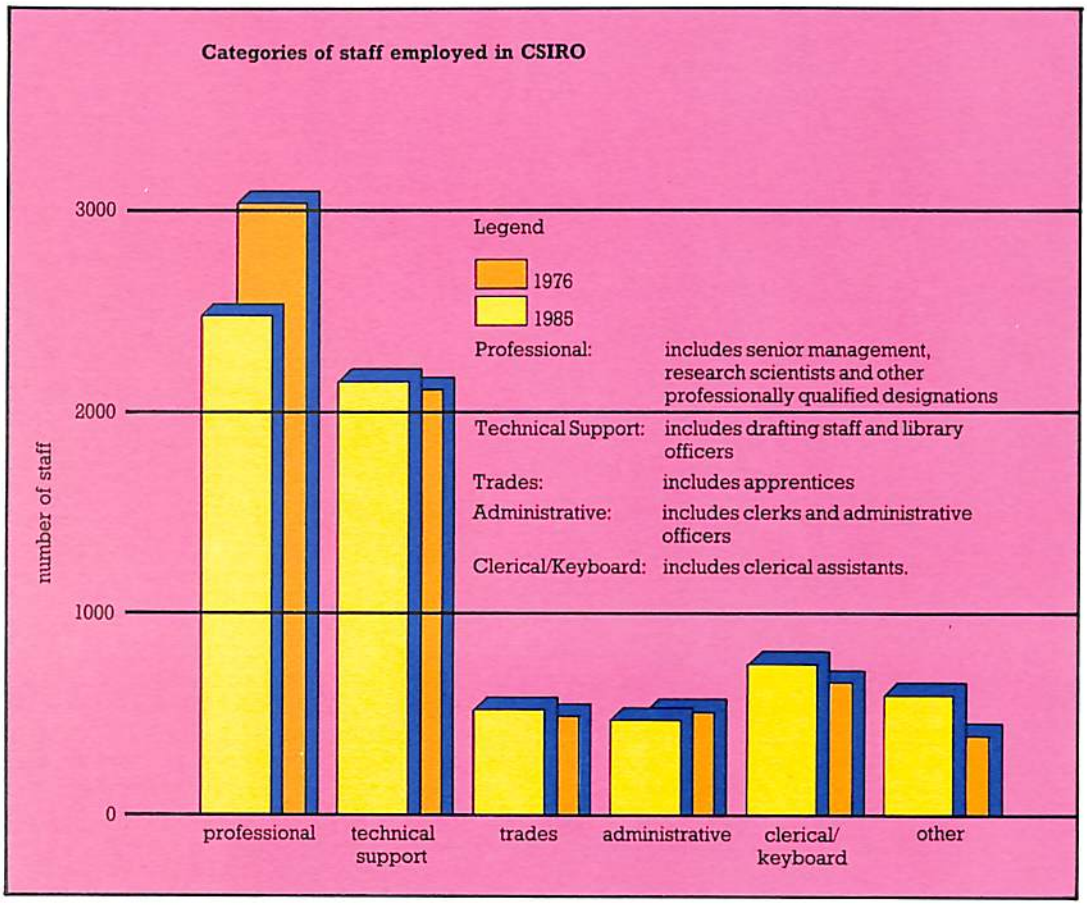
Staff Numbers

On 30 June 1985 CSIRO had a staff of 7195 (excluding 269 staff who were engaged on Government employment and training programs). This figure represents an apparent increase of 2.2% over the figure of 10 years earlier. During the period from 1976 to 1983, the staff total increased slightly from 7041 to 7378, only to fall back to the present level as a consequence of severe budgetary restrictions. However, if the present staff figure is adjusted to take account of transfers from the Defence laboratories and the Australian Atomic Energy Commission that occurred during the decade (involving 147 staff), it is evident that there has been an increase in staff of only 0.1%.

The graph shows the changes in the broad profile of the Organization's staff categories over the 10–year period. In spite of the relatively static staffing picture, the Organization has managed to maintain some growth in its professional staff numbers with slight falls in technical and trades staff categories. This has led, in a number of areas, to there being too few support staff for research programs.

Over a similar period there has been an increase of 18.9% in the proportion of staff employed against external funds. Table 13.1 gives a detailed breakdown of the changes in the proportions of externally funded staff between 1978 and 1985.

The proportion of staff on fixed terms has also increased as Table 13.2 illustrates. This increase is partly attributable to the Executive's fixed term appointments policy (which was first announced in 1977) and partly to the growth in externally funded employment, where the duration of engagement is mainly limited to specific projects.


Categories of staff employed in CSIRO
number of staff
3000
2000
1000
0
Legend
1976
1985
Professional: includes senior management, research scientists and other professionally qualified designations
Technical Support: includes drafting staff and library officers
Trades: includes apprentices
Administrative: includes clerks and administrative officers
Clerical/Keyboard: includes clerical assistants.
professional
technical support
trades
administrative
clerical/ keyboard
other

14. Consultative Council

The CSIRO Consultative Council was established under section 56 of the Science and Industry Research Act 1949, following amendment of the Act in 1978. The Council's functions are 'to consider, and to report to the Executive on any matter affecting, or of general interest to, the officers of the Organization, including any such matter that is referred to the Council by the Executive'.

The Council comprises: a Chairman, Dr N K Boardman, a full-time member of the Executive; seven other members appointed by the Executive; and eight representatives of staff associations covering the various staff groups in CSIRO. Mr E P Wright of the Australian Public Service Association (Fourth Division Officers) succeeded Mr B Cain of the CSIRO Technical Association as Deputy Chairman of Council at the October 1984 meeting.

The Council's thirteenth meeting was held in Canberra in October 1984, the fourteenth meeting at the Marine Laboratories in Hobart in April 1985.

At its thirteenth meeting the Council established an Industrial Democracy Sub-committee to examine existing consultative mechanisms and possible new arrangements for greater staff involvement in decisions affecting their work. The Council discussed also the funds allocated in the 1984/85 budget and recommended to the Executive cost-saving proposals to minimize the budget's effect on staff numbers. Recommendations were made to the Executive on adopting a new internal disciplinary code.

At its fourteenth meeting Council considered the final report of the Technological Change Sub-committee. Most CSIRO staff engaged on research activities expected and accepted changes in duties and work methods as an essential consequence of the nature of research. Nevertheless, the introduction of technological change can have a significant impact on staff in all areas and Council recommended consultative procedures to minimize the negative impacts of change. The procedures involve assessing the effects on staff of proposed change and early advice to, and consultation with, affected staff. Where technological change was regarded as significant, there should be early consultation with the affected staff and the relevant staff association before any final decision was made to adopt the change.

Council proposed revised probation and grievance procedures for adoption within CSIRO. Council then requested the Terms and Conditions of Service Sub-committee to review personnel policies to assess whether they accord with the principles of natural justice. This review will cover existing practices on selection, appointment and promotion, the associated documentation, and related appeal procedures.

The Staffing Sub-committee's final report to Council in April 1985 proposed 28 recommendations concerning appointments, career planning, promotions, mobility, training and retraining, personnel management, retirements and cessations. Council proposed that the Executive endorse the Sub-committee's recommendations that:

- Divisional reviews include an examination of staffing policies and personnel management;
- successful redeployment be recognized in promotions;
- induction programs be improved;
- criteria be developed for appointing staff for specified periods, funded from appropriation sources;

Members of the CSIRO Consultative Council and Council Secretariat.

- priority be given to developing an early separation incentive scheme.

The remaining recommendations of this Sub-committee were referred to a Policy Sub-committee which will review staffing policies in special areas of concern, identify staffing trends and the reasons for them, and reappraise the use of designations and classifications in CSIRO.

The Internal Communications Sub-committee reported on a survey of staff attitudes to internal communications. Communication between management and staff was identified as the major problem, particularly communication from management to staff. The survey concluded that responsibility for internal and external communications should not be separated and the communications responsibilities of managers should be clearly specified. The survey suggested that staff opportunities to initiate communications with management should be increased, particularly through more frequent staff meetings. In addition, Institutes should play a greater role in coordinating communication between Divisions.

During the year the Remote Localities Sub-committee continued to study conditions of service, provision of staff housing, and staff mobility in remote localities. Its recommendations on training opportunities in remote areas were referred to the Executive.

The Equal Employment Opportunity (EEO) Sub-committee discussed implementing the Organization's EEO policies, including the setting up of a contact person network and training in EEO principles. The Organization's EEO management plan will be considered by the Sub-committee.

Following the Executive's adoption of the recommendations of the Committee of Review on Staff Training and Development, Council agreed to the formation of a Staff Development and Training Sub-committee. It will discuss policy and resource matters relating to the Organization's increased staff development and training programs.

15. Finance and Works

CSIRO/Department of Finance Joint Working Party

In October 1984 the then Minister for Finance, the Hon. John Dawkins proposed, and the Executive agreed to, a Joint Working Party (JWP) to examine issues raised by the Department of Finance. The main concerns were:

- interpretation of the Budget allocation to CSIRO in 1984/85
- CSIRO financial management and control
- stability of funding
- allocation of resources in CSIRO.

Following the 1984 Budget there had been significant differences of opinion about how resource allocation should be interpreted. After adjusting CSIRO's budgets in 1983/84 and 1984/85 for items of a non-recurring nature, expenditure for ongoing activities was estimated to increase in 1984/85 by 6.6%.

The JWP noted there were no additional funds in CSIRO's Budget allocation to meet increased operating costs in 1983/84 and 1984/85. In addition, there were insufficient funds to cover the full cost of the government-directed repairs and maintenance and occupational health and safety programs. This meant the Executive had to reduce salary and operating funds for more than two-thirds of the Organization's research programs. These cuts were necessary to enable other higher priority programs to be maintained at their 1983/84 level and to allow a modest increase of effort in selected growth areas.

The JWP examined the CSIRO management information and control systems and concluded that they were appropriate for the proper management and control of the Organization's finances.

CSIRO operates under a global budget. Although this confers a degree of flexibility the Organization contends that it needs its long-term expectations to be more firmly defined to facilitate planning. This is particularly relevant to capital works. The Department of Finance argued that CSIRO realistically could expect that there would be no major changes in its real level of annual funds; however, CSIRO could not be fully insulated against changes in budget priorities directed by governments. The JWP agreed that funds from external sources should not be regarded as replacements for Appropriation funds on a dollar-for-dollar basis.

The JWP agreed that in certain circumstances it was appropriate to allow an increase in the approved gross expenditure for CSIRO (i.e. moneys appropriated by the Parliament, plus other revenue receipts) when an increase in revenue was available. This would apply particularly in the commercialization of research results by Divisions where CSIRO, assisted by SIROTECH, was actively seeking means of improving its performance. The opportunity to retain 'profits' from this process would encourage more Divisional effort to transfer research results to industry.

The ability to rationalize property holdings was seen by the JWP as part of CSIRO's flexibility in reallocating resources. Therefore, the JWP agreed that for the Organization to manage its estate more efficiently it should be free to acquire property for research purposes to the value of property disposed of where the transactions were a result of the rearrangement of research priorities.

The JWP noted that the main objective of CSIRO's research planning was to distribute available resources to research programs with optimal benefits to Australia. While there are continuous changes within Divisions and Institutes, CSIRO places great emphasis on reviews as a means of reorienting its research effort. The purpose of these reviews is to ensure that the Organization's research is always as relevant and effective as possible. This frequently requires CSIRO to redeploy resources between research projects; as projects reach fruition resources are redeployed to new projects. Vacancies provide opportunities for further redeployment to other high priority projects either in the Division concerned or in other Divisions.

The JWP commended the Organization's efforts to develop efficient procedures for allocating and redeploying its resources.

Funding the Operation of National Facilities

An increasing number of national facilities for which CSIRO is the host institution are now being commissioned. ANAHL and the oceanographic research vessel, *Franklin*, are examples. The Australia Telescope is a national facility currently under construction. There are, however, no government-accepted guidelines covering the operation of such national facilities. ASTEC has proposed guidelines. In the meantime, there is the risk that host institutions may be required to fill any operational shortfall. CSIRO shows as separate lines within its budget the cost of these facilities.

CSIRO considers that the Government should adopt the ASTEC guidelines, which recommend

separate financial provisioning of national research facilities. CSIRO will observe these guidelines in submitting estimates requests in the format approved by the Minister for Science, the Hon. Barry O. Jones. However, there is no guarantee that CSIRO will receive these funds unless the Government formalizes the ASTEC guidelines as policy. The Minister for Science has asked CSIRO to implement ASTEC's recommendations in relation to the *Franklin*. Clearly mechanisms need to be established to resolve funding issues associated with operating national research facilities. There should be no inappropriate cost to the host institution and equitable charges for optimal use of the facilities should be formally determined.

Oceanographic Research Vessel

The 55-metre oceanographic research vessel, *Franklin*, was completed and is now in service as a national facility. The vessel was named by Her Excellency, Lady Stephen, wife of the Governor-General, at a formal ceremony in Cairns, Queensland, two months before its handover to CSIRO in March 1985. An interim steering committee, appointed to determine the use of the vessel under national facility guidelines, was confirmed as the Steering Committee during the year.

Australia Telescope

The Minister for Science drove a peg into the ground on 27 September 1985 to mark the start of civil works on the Australia Telescope, at Culgoora, NSW. CSIRO is working in association with engineering consultants, MacDonald Wagner Pty Ltd. Fabrication of the antennas will start during 1985/86, with completion scheduled for the Australian Bicentennial in 1988.

Buildings

Australian National Animal Health Laboratory

During the year the Australian National Animal Health Laboratory (ANAHL) was completed, commissioned and began operating as a microbiologically-secure laboratory. The Laboratory cost $160 million. The building was opened on 1 April 1985 by the Governor-General, Sir Ninian Stephen, at a function attended by parliamentarians and primary industry and state

Expenditure

The year's expenditure from all CSIRO-controlled funds amounted to more than $380.4 million. Of this amount expenditure from funds directly appropriated by Parliament in 1984/85 accounted for 84% ($320 million). A further 11% ($40.7 million) was spent out of funds provided by other contributors. The remaining 5% ($19.7 million) of expenditure came from:

- revenue earned by the Organization
- unspent funds from 1983/84
- receipts from the Department of Primary Industry for its half-share of the operating costs of ANAHL.

This year's salaries and operating expenditure from direct appropriation and revenue funds, amounting to $310.9 million represents a 5.7% increase on 1983/84 after excluding expenditure of $8 million in that year for fees levied by the Department of Housing and Construction which, from 1984/85, are reflected in the capital cost of new buildings and works. Most of the increase was due to funds being made available to meet inescapable salary increases ($12 million) and for other specific purposes. These included:

- operating the oceanographic research vessel ($1.2 million)
- introduction of accrual accounting ($0.9 million)
- increased rate of employer superannuation contributions ($0.7 million).

No additional funds were provided to meet the increased costs of goods and services due to inflation.

Appropriation-funded capital costs during the year included expenditure on:

- construction of laboratories at Clayton, Vic.
- completion of the Marine Laboratories at Hobart and the Australian National Animal Health Laboratory at Geelong
- work on the Australia Telescope
- completion of the oceanographic research vessel, *Franklin*
- acquisition of new premises for the Division of Manufacturing Technology.

This year, expenditure funded by contributions from industry and other sources increased by 16.6% ($5.8 million) mainly for research supported by Rural Industry Research Funds ($1.6 million), the Australian Centre for International Agricultural Research ($2.2 million), and the National Biotechnology Program Research Grants Scheme ($0.4 million).

Table 15.1: Sources 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	310 864 502	28 829 533	339 694 035
Wool Research Trust Fund	11 856 426	467 016	12 323 442
Meat Research Trust Fund	4 309 252	47 944	4 357 196
Wheat Research Trust Account	968 454		968 454
Dairying Research Trust Account	283 343		283 343
Fishing Industry Research Trust Account	1 241 680		1 241 680
Oilseeds Research Trust Account	88 582		88 582
Dried Fruits Research Trust Account	109 339		109 339
Poultry Industry Trust Fund	80 440		80 440
Chicken Meat Research Trust Account	73 031		73 031
Pig Industry Research Trust Account	70 452		70 452
Cotton Research Trust Account	357 987	263 237	621 224
Barley Research Trust Account	27 570		27 570
NERDDC-Coal Research Trust Account	356 105		356 105
NERDDC-Energy Research Trust Account	1 354 727	148 617	1 503 344
Rural Credits Development Fund	526 226		526 226
Other Contributors	17 897 900	219 318	18 117 218
	350 466 016	29 975 665	380 441 681

The Australian National Animal Health Laboratory at Geelong, Victoria.

government organization representatives concerned with the livestock industry.

The Laboratory continues to attract attention, receiving visitors from overseas interested in a high degree of microbiological security in research and experimental facilities. Scientists, engineers and senior administrators from the United States, Canada, Britain, India and China have visited the Laboratory, generally regarded as the finest facility of its kind in the world and regarded as a model by a number of countries with similar requirements.

Marine Laboratories

The Marine Laboratories in Hobart which house the Divisions of Fisheries Research and Oceanography were completed during 1984/85 and opened on 1 May 1985 by the Minister for Science, the Hon. Barry O. Jones. The $13 million complex, occupying an attractive waterfront site adjacent to Castray Esplanade and Salamanca Place, has been designed to achieve harmony with the historic Battery Point region and the Sullivan's Cove Planning Scheme. The Laboratories are now fully operational and all research activities have been transferred from Cronulla, NSW, to Hobart.

Clayton Laboratories

Construction of the Materials Science Laboratory at Clayton, Vic. reached an advanced stage during the year and will be completed in the first half of 1985/86 at a cost of $10 million. The Clayton laboratory for the Division of Applied Organic Chemistry also is well advanced. The cost of this laboratory, due for completion late in 1986, is estimated at $12 million.

Capital Works and Property

During 1984/85 CSIRO disposed of nine properties as part of a rationalization program for property holdings and relocation of research facilities. These were: six houses; a rural research field station at Isis Junction, Qld; a site at Mt Gravatt, Qld previously acquired for laboratory development; and the laboratory site at Cronulla, NSW, transferred by the Commonwealth Government to the NSW Government.

To date the main impact of the rationalization program has been in northern Australia. The Organization is currently disposing of the Kimberley Research Station, Kununurra, in north-west Western Australia back to the Western Australian Government and reducing further its Queensland property holdings.

A Ciba Geigy property at Preston, Vic, was acquired for $1.22 million during the year for the Division of Manufacturing Technology headquarters and research facilities to replace leased premises in Melbourne. Additional land at North Ryde, NSW, for proposed building development was acquired at a cost of $550,000. The Organization also entered into a lease arrangement with the Northern Territory Government to rent housing in Katherine for CSIRO staff transferred from Kununurra to Katherine.

Work has begun on an occupational health and safety project at the Division of Protein Chemistry at Parkville, Vic. The work involves a general upgrade of laboratory facilities to conform to modern safety standards. Refurbishing also is in progress at the new Division of Manufacturing Technology laboratory at Preston. The expenditure on each of the projects will exceed $1 million.

OFFICE OF THE
AUDITOR-GENERAL

G.P.O. Box 707
Canberra A.C.T. 2601
Telephone 48 4711

F85/657

2 December 1985

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 my report its financial statements for the year ended 30 June 1985. These comprise:

- Summary of Receipts and Payments
- Consolidated Statement of Payments
- Statement of Payments — General Research Account
- Statement of Payments — Specific Research Account, and
- Notes to and forming part of the Accounts.

The statements have been prepared in accordance with the policies outlined in Note 1 to the Accounts and are in the form approved by the Minister for Finance. A copy of the financial statements is enclosed for your information.

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 disclosed in Note 15.

Yours sincerely

(Sgd.) J. Monaghan

J.V. Monaghan
Auditor-General

Commonwealth Scientific and Industrial Research Organization
Summary of Receipts and Payments for the year ended 30 June 1985

(Figures in brackets refer to 1983/84 financial year)

	Funds held 1 July 1984 ($)	Receipts ($)	Total Funds available ($)	Payments ($)	Funds Held 30 June 1985 ($)
General Research Account	4 553 016 (3 164 896)	344 595 230* (344 010 554)	349 148 246 (347 175 450)	339 694 035 (342 622 434)	9 454 211 (4 553 016)
Specific Research Account	6 951 648 (4 082 244)	45 326 838** (37 819 433)	52 278 486 (41 901 677)	40 747 646 (34 950 029)	11 530 840 (6 951 648)
Other Moneys†	1 096 966 (587 625)	7 517 317 (5 640 695)	8 614 283 (6 228 320)	7 883 532 (5 131 354)	730 751 (1 096 966)
Total	**12 601 630** **(7 834 765)**	**397 439 385** **(387 470 682)**	**410 041 015** **(395 305 447)**	**388 325 213‡** **(382 703 817)**	**21 715 802††** **(12 601 630)**

N.K. Boardman
(Chairman)

G.I. Batchelor
(Manager, Management Services)

* See Note 2.
** See Note 3.
† See Note 4.
†† See Note 5.
‡ See Note 6.

Commonwealth Scientific and Industrial Research Organization
Consolidated Statement of Payments for the year ended 30 June 1985

1983/84 $		1984/85 $
	Headquarters (including Regional Administrative Offices)	
10 854 590	Salaries and allowances	11 542 427
439 521	Travelling and subsistence	557 154
652 913	Postage, telegrams and telephone	702 248
5 094 577	Other operating expenditure	6 193 573
278 299	Advisory Council	389 350
144 583	State Committees	196 894
17 464 483		19 581 646
	Research Programs	
	Institute of Animal and Food Sciences	
320 679	Institute Headquarters	628 340
7 109 542	Animal Health	7 834 629
12 970 548	Animal Production	12 996 768
11 611 788	Australian National Animal Health Laboratory	7 220 823
9 535 097	Fisheries Research	11 002 904
12 429 872	Food Research	13 000 164
3 463 794	Human Nutrition	3 768 915
3 120 879	Molecular Biology	3 372 890
1 134 258	Project for Animal Research and Development	1 317 419
6 656 310	Tropical Animal Science	7 092 326
793 068	Wheat Research	1 105 412
69 145 835		69 340 590
	Institute of Biological Resources	
445 904	Institute Headquarters	530 140
2 633 306	Centre for Irrigation Research	2 709 511
12 168 325	Entomology	13 625 714
9 908 777	Forest Research	9 118 696
2 948 653	Horticultural Research	3 032 920
15 517 086	Plant Industry	17 061 113
7 860 448	Soils	8 333 006
10 283 631	Tropical Crops and Pastures	10 679 008
5 996 956	Water and Land Resources	6 603 869
7 776 204	Wildlife and Rangelands Research	8 164 495
75 539 290		79 858 472

1983/84 $		1984/85 $
	Institute of Energy and Earth Resources	
443 668	Institute Headquarters	605 917
5 117 687	Energy Chemistry	5 407 504
3 569 577	Energy Technology	3 664 775
7 350 429	Fossil Fuels	6 367 785
3 171 612	Geomechanics	3 641 976
3 092 356	Groundwater Research	3 031 100
5 933 781	Mineral Chemistry	5 972 464
4 859 241	Mineral Engineering	5 177 742
4 880 717	Mineralogy and Geochemistry*	5 055 509
6 815 981	Mineral Physics	6 358 006
45 235 049		45 282 778
	Institute of Industrial Technology	
277 053	Institute Headquarters	257 870
5 386 635	Applied Organic Chemistry	4 433 241
7 316 229	Building Research	7 510 792
7 784 383	Chemical and Wood Technology	8 079 655
4 295 831	Manufacturing Technology	4 983 853
5 278 784	Protein Chemistry	5 734 337
7 538 351	Textile Industry	7 719 383
4 781 324	Textile Physics	4 768 848
42 658 590		43 487 979
	Institute of Physical Sciences	
285 097	Institute Headquarters	618 867
15 153 972	Applied Physics	15 394 467
5 612 060	Atmospheric Research	5 749 691
506 487	Australian Numerical Meteorology Research Centre	315 276
694 940	Australia Telescope	1 323 445
5 224 815	Chemical Physics	5 402 857
1 461 371	Environmental Mechanics	1 503 298
-	Information Technology**	995 143
4 233 049	Materials Science	4 371 842
4 485 887	Mathematics and Statistics	4 540 137
5 262 594	Oceanography	4 589 913
7 221 693	Radiophysics	7 419 574
889 958	Research Aircraft Facility	990 733
50 000	Research Vessel	617 467
51 081 923		53 832 710

	Bureau of Scientific Services	
335 562	Bureau Headquarters	299 490
6 307 847	Central Information, Library and Editorial Section	6 525 836
900 013	Centre for International Research Cooperation	1 181 360
1 637 353	Science Communication Unit	1 891 294
793 402	CSIRO/University Research	856 839
9 974 177		10 754 819

* Formerly known as Mineralogy

** Information Technology was a newly created Division during 1984/85

1983/84 $		1984/85 $
	Other	
10 245 277	CSIRONET*	9 993 343**
830 670	SIROTECH‡	2 010 300
	CSIRO Office of Space Science and Applications†	160 934
818 393	Contributions	872 326
8 268 343	Miscellaneous	8 848 045
313 797 547	Total Research Programs	324 442 296
5 326 210	**Repairs and Maintenance**	6 442 074
	Capital Works and Services	
987 538	Acquisitions of sites and buildings	1 812 251
	Buildings, works, plant and developmental expenditure	
9 273 312	ANAHL	5 113 178
17 884 634	Other	11 648 474
	Major items of laboratory equipment	
155 048	ANAHL	479 240
5 498 527	Other	4 853 290
6 339 233	Construction of research vessel	2 848 676
845 931	Australia Telescope	3 220 556
40 984 223		29 975 665
	Other Moneys	
	Remittance of revenue from investigations financed	
528 643	from Industry Trust Accounts	687 751
4 602 711	Other miscellaneous remittances	7 195 781
5 131 354		7 883 532
382 703 817††	**Total Expenditure**	388 325 213

* Formerly known as Computing Research

** Expenditure for CSIRONET excludes $4,600,000 (1983/84 $4,000,000) which is the value of CSIRONET services provided to CSIRO users. See Note 7.

‡ 1983/84 expenditure is for the operations of the former Commercial Group, the functions of which were assumed by SIROTECH from 15/11/84. See Note 12.

† CSIRO Office of Space Science and Applications was a newly created unit during 1984/85

†† Dissection details of 1983/84 expenditure have been adjusted, to allow comparison with 1984/85 figures.

N.K. Boardman
(Chairman)

G.I. Batchelor
(Manager, Management Services)

Commonwealth Scientific and Industrial Research Organization
Statement of Payments — General Research Account — for the year ended 30 June 1985

1983/84 $		1984/85 $
	Headquarters (including Regional Administrative Offices)	
10 850 319	Salaries and allowances	11 542 427
439 716	Travelling and subsistence	557 154
652 913	Postage, telegrams and telephone	702 248
5 093 700	Other operating expenditure	6 193 573
278 299	Advisory Council	389 350
144 583	State Committees	196 894
17 459 530		19 581 646
	Research Programs	
	Institute of Animal and Food Sciences	
320 679	Institute Headquarters	628 340
6 286 855	Animal Health	6 507 067
8 813 092	Animal Production	8 523 904
11 594 508	Australian National Animal Health Laboratory	7 166 738
8 157 985	Fisheries Research	9 137 310
9 800 474	Food Research	9 941 151
3 301 958	Human Nutrition	3 558 190
2 876 154	Molecular Biology	3 055 613
5 794 484	Tropical Animal Science	6 085 617
509 899	Wheat Research	604 098
57 456 088		55 208 028
	Institute of Biological Resources	
445 904	Institute Headquarters	530 140
2 394 199	Centre for Irrigation Research	2 469 284
9 634 207	Entomology	10 039 326
9 571 550	Forest Research	8 679 147
2 787 527	Horticultural Research	2 825 108
14 357 700	Plant Industry	15 065 077
7 601 099	Soils	8 009 381
9 498 266	Tropical Crops and Pastures	9 386 616
5 157 771	Water and Land Resources	5 473 306
7 214 480	Wildlife and Rangelands Research	7 471 913
68 662 703		69 949 298

1983/84 $		1984/85 $
	Institute of Energy and Earth Resources	
441 991	Institute Headquarters	605 917
4 918 533	Energy Chemistry	5 170 450
3 407 779	Energy Technology	3 546 590
5 935 868	Fossil Fuels	5 654 539
2 883 407	Geomechanics	3 026 480
2 963 907	Groundwater Research	2 904 705
5 219 945	Mineral Chemistry	5 278 893
3 870 173	Mineral Engineering	4 248 563
4 247 476	Mineralogy and Geochemistry*	4 382 007
5 097 122	Mineral Physics	5 222 924
38 986 201		40 041 068
	Institute of Industrial Technology	
277 053	Institute Headquarters	257 870
5 264 388	Applied Organic Chemistry	4 345 784
7 027 391	Building Research	7 233 694
7 204 373	Chemical and Wood Technology	7 375 691
4 217 449	Manufacturing Technology	4 885 492
5 203 470	Protein Chemistry	5 519 625
2 971 046	Textile Industry	3 065 598
2 557 290	Textile Physics	2 810 185
34 722 460		35 493 939
	Institute of Physical Sciences	
285 097	Institute Headquarters	618 867
15 034 037	Applied Physics	15 160 026
5 425 331	Atmospheric Research	5 561 679
505 487	Australian Numerical Meteorology Research Centre	315 276
694 940	Australia Telescope	1 323 445
5 196 899	Chemical Physics	5 381 648
1 461 371	Environmental Mechanics	1 468 884
-	Information Technology**	979 960
3 942 942	Materials Science	4 061 495
4 405 347	Mathematics and Statistics	4 539 044
5 252 889	Oceanography	4 512 787
6 984 010	Radiophysics	7 233 628
889 958	Research Aircraft Facility	990 733
50 000	Research Vessel	617 467
50 128 308		52 764 939

	Bureau of Scientific Services	
335 562	Bureau Headquarters	299 490
5 920 896	Central Information, Library and Editorial Section	6 093 548
900 013	Centre for International Research Cooperation	951 819
1 559 571	Science Communication Unit	1 805 022
793 402	CSIRO/University Research	856 839
9 509 444		10 006 718

* Formerly known as Mineralogy

** Information Technology was a newly created Division during 1984/85

1983/84 $		1984/85 $
	Other	
9 861 600	CSIRONET*	9 485 372**
830 670	SIROTECH‡	2 010 300
-	CSIRO Office of Space Science and Applications†	160 934
818 393	Contributions	872 326
8 258 571	Miscellaneous	8 847 860
279 234 438	Total Research Programs	284 840 782
5 326 210	**Repairs and Maintenance**	6 442 074
	Capital Works and Services	
987 538	Acquisitions of sites and buildings	1 812 251
	Buildings, works, plant and developmental expenditure	
9 273 312	ANAHL	5 113 178
17 823 021	Other	11 480 832
	Major items of laboratory equipment	
155 048	ANAHL	479 240
5 178 173	Other	3 874 800
6 339 233	Construction of research vessel	2 848 676
845 931	Australia Telescope	3 220 556
40 602 256		28 829 533
342 622 434††	Total Expenditure	339 694 035

* Formerly known as Computing Research

** Expenditure for CSIRONET excludes $4,600,000 (1983/84 $4,000,000) which is the value of CSIRONET services provided to CSIRO users. See Note 7.

‡ 1983/84 expenditure is for the operations of the former Commercial Group, the functions of which were assumed by SIROTECH from 15/11/84. See Note 12.

† CSIRO Office of Space Science and Applications was a newly created unit during 1984/85

†† Dissection details of 1983/84 expenditure have been adjusted, to allow comparison with 1984/85 figures.

N.K. Boardman
(Chairman)

G.I. Batchelor
(Manager, Management Services)

Commonwealth Scientific and Industrial Research Organization
Statement of Payments — Specific Research Account — for the year ended 30 June 1985

1983/84 $		1984/85 $
	Headquarters (including Regional Administrative Offices)	
877	Incidental and other expenditure	-
4 271	Salaries and allowances	-
(195)	Travelling and subsistence	-
4 953		-
	Research Programs	
	Institute of Animal and Food Sciences	
822 687	Animal Health	1 327 562
4 157 456	Animal Production	4 472 864
17 280	Australian National Animal Health Laboratory	54 085
1 377 112	Fisheries Research	1 865 594
2 629 398	Food Research	3 059 013
161 836	Human Nutrition	210 725
244 725	Molecular Biology	317 277
1 134 258	Project for Animal Research and Development	1 317 419
861 826	Tropical Animal Science	1 006 709
283 169	Wheat Research	501 314
11 689 747		14 132 562
	Institute of Biological Resources	
239 107	Centre for Irrigation Research	240 227
2 534 118	Entomology	3 586 389
337 227	Forest Research	439 550
161 126	Horticultural Research	207 812
1 159 386	Plant Industry	1 996 036
259 349	Soils	323 624
785 365	Tropical Crops and Pastures	1 292 391
839 185	Water and Land Resources	1 130 563
561 724	Wildlife and Rangelands Research	692 582
6 876 587		9 909 174

1983/84 $		1984/85 $
	Institute of Energy and Earth Resources	
1 677	Institute Headquarters	-
199 154	Energy Chemistry	237 054
161 798	Energy Technology	118 185
1 414 561	Fossil Fuels	713 245
288 205	Geomechanics	615 496
128 449	Groundwater Research	126 395
713 836	Mineral Chemistry	693 570
989 068	Mineral Engineering	929 180
633 241	Mineralogy and Geochemistry*	673 502
1 718 859	Mineral Physics	1 135 083
6 248 848		5 241 710
	Institute of Industrial Technology	
122 247	Applied Organic Chemistry	87 457
288 838	Building Research	277 098
580 010	Chemical and Wood Technology	703 964
78 382	Manufacturing Technology	98 361
75 314	Protein Chemistry	214 712
4 567 305	Textile Industry	4 653 785
2 224 034	Textile Physics	1 958 663
7 936 130		7 994 040
	Institute of Physical Sciences	
119 935	Applied Physics	234 441
186 729	Atmospheric Research	188 012
1 000	Australian Numerical Meteorology Research Centre	-
27 916	Chemical Physics	21 209
-	Environmental Mechanics	34 414
-	Information Technology**	15 183
290 107	Materials Science	310 347
80 540	Mathematics and Statistics	1 093
9 705	Oceanography	77 126
237 683	Radiophysics	185 946
953 615		1 067 771
	Bureau of Scientific Services	
386 951	Central Information, Library and Editorial Section	432 288
-	Centre for International Research Cooperation	229 541
77 782	Science Communication Unit	86 272
464 733		748 101

* Formerly known as Mineralogy

** Information Technology was a newly created Division during 1984/85

1983/84 $		1984/85 $
	Other	
383 677	CSIRONET	507 971
9 772	Miscellaneous	185
34 563 109	Total Research Programs	39 601 514
	Capital Works and Services	
61 613	Building, works, plant and developmental expenditure	167 642
320 354	Major items of laboratory equipment	978 490
381 967		1 146 132
34 950 029*	Total Expenditure	40 747 646

N.K. Boardman
(Chairman)

G.I. Batchelor
(Manager, Management Services)

* Dissection details of 1983/84 expenditure have been adjusted to allow comparison with 1984/85 figures.

Commonwealth Scientific and Industrial Research Organization
Notes to and forming part of the Accounts for the Year ended 30 June 1985

1. Statement of Accounting Policies

The Financial Statements are in a form approved by the Minister of Finance under sub-section 57(1) of the Science and Industry Research Act 1949. However, this form does not accord with all the requirements of 'The Guidelines for the Form and Standard of Financial Statements of Commonwealth Undertakings' issued by the Department of Finance. From 1986/87 the Organization plans to change its accounting from a cash basis to an accrual basis to comply with these guidelines.

2. Receipts to the General Research Account comprise:

	1983/84 $	1984/85 $
Appropriations — Consolidated Revenue Fund		
Operational	290 854 300	291 494 000*
Capital	40 760 900	33 228 000
	331 615 200	324 722 000

* excludes $190,000 that was appropriated but not received until 1 July 1985.

Revenue and Other Receipts		
General Operations		
Sale of publications	657 544	758 320
Receipts in respect of expenditure in former years	630 126	3 248 481**
Sale of produce, including livestock	466 567	569 216
Royalties from patents	183 325	452 056
Fees for tests and other services	450 900	503 070
Interest on investments	480 514	1 163 938
International consultancies	650 671	520 786
Department of Primary Industry contribution to cost of ANAHL operations	–	3 858 000
Miscellaneous receipts	459 438	483 742
	3 979 085	11 557 609
CSIRONET Operations		
Computing service charges	8 364 682	8 300 555
Receipts in respect of expenditure in former years	39 776	9 527
Miscellaneous receipts	11 811	5 539
	8 416 269	8 315 621
	12 395 354	19 873 230
Total Receipts	344 010 554	344 595 230

** of this amount $2 545 975 relates to the disposal of CSIRO owned properties (see also Note 15).

3. Receipts to the Specific Research Account comprise:

	1983/84 $	1984/85 $
Rural Industry Research Trust Funds (Department of Primary Industry)	20 175 100	22 090 538
National Energy Research Development and Demonstration Program (Department of Resources and Energy)	2 417 376	1 979 342
Other Contributory Funds (Government Departments and Agencies, Private Industry and other sources)	15 226 957	21 256 958
	37 819 433	45 326 838

4. Other Moneys

Other Moneys Account includes funds made available from the Community Employment Program, Special Youth Employment Training Program and National Strategy for Aboriginals (administered by the Department of Employment and Industrial Relations) and other sources.

5. Funds held at 30 June 1985

	1983/84 $	1984/85 $
Cash at Bank	8 601 630	4 204 628
Investments*	4 000 000	17 500 000
Advances to Departments	–	11 174
	12 601 630	21 715 802**

* Investments (at cost) in Reserve Bank of Australia Interest Bearing Deposits.

** Of the $9 454 211 funds held in the General Research Account, $4 742 167 (1983/84 $158 644) represents funds which had been appropriated to CSIRO but which were not expended in 1984/85.

In addition to funds in CSIRO's main bank accounts, $200 877 (1983/84 $215 848) was held in various Divisional Imprest Accounts. These funds were expensed when the advances were established.

6. Payments

Total expenditure comprises

	1983/84 $	1984/85 $
Salaries*	232 502 414	247 860 596
Travel	10 165 194	11 290 462
Equipment	17 214 258	20 647 297
Other Operating	82 649 348	81 747 474
Capital	40 172 602	26 779 304
	382 703 816	388 325 213

* 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 $34 565 679 (1983/84 $31 846 572) on the employer's share of superannuation. Following a recent review undertaken by the Australian Government Actuary, the Organization increased its contribution rate from 20·0% to 20.5% effective 1 July 1984.

7. CSIRONET Computer Services

Receipts and payments relating to the provision of CSIRONET Computer Services are as follows:

	1983/84 $	1984/85 $
Receipts		
CSIRO users	4 000 000	4 600 000
Other users	8 364 682	8 300 555
Receipts in respect of expenditure in former years	39 776	9 527
Miscellaneous receipts	11 811	5 539
	12 416 269	12 915 621
Payments		
Operational expenditure	13 861 600*	13 685 372
Capital expenditure	415 861	110 766
	14 277 461	13 796 138

*Of the operational expenditure recorded for CISORNET the former Division of Computing Research's research activities were funded by CSIRO Appropriation to the Division of $2,341,200.

8. Moneys held in Trust

Summary of receipts and payments for the year ended 30 June 1985.

	1984/85 $
Funds on hand 1 July 1984	566 566
add receipts	284 442
	851 008
less payments	59 993
Funds on hand 30 June 1985 held as:	791 015

	1983/84 $	1984/85 $
Investments		
Commonwealth Inscribed Stock	50 000	50 000
State Electricity Commission of Victoria	12 200	12 200
Primary Industry Bank of Australia	96 000	96 000
Civic Permanent Building Society Ltd	385 674	584 622
Reserve Bank of Australia Interest Bearing Deposits	9 000	–
	552 874	742 822
Cash at Bank	13 692	48 193
	566 566	791 015 *

* The components of the funds on hand as at 30/6/85 were:

William McIlrath Trust Fund	103 182	100 000
David Rivett Memorial Lecture Fund	70 710	58 200
F D McMaster Bequest **	385 674	602 615
Sir Ian Mclennan Achievement for Industry Award †	–	27 700
Other	7 000	2 500
	566 566	791 015

** The F D McMaster Bequest consists of $1 050 000 of which $425 000 has been received, the balance will be paid in 9 consecutive annual instalments.

† Set up by the CSIRO Advisory Council. The award has been established to encourage active interaction between CSIRO Scientists and Australian Industry.

9. Auditors Remuneration

The total amount paid to the Auditor-General for the audit of the Organization amounted to $145 200 (31 March 1984 $193 400). This represents fees in respect of the period ended 31 March 1985. No other benefits were received by The Auditor-General.

10. Fees paid to the Department of Housing and Construction $2 415 636 (1983/84 $8 500 000).

Represents interdepartmental charges levied on the Organization by the Department of Housing and Construction for design, development, construction supervision and management costs of CSIRO's 1984/85 Capital Works and Repairs and Maintenance Programs. The 1983/84 fee was appropriated and charged to various research programs.

11. SIROMATH Pty Ltd

CSIRO holds a one-third equity shareholding in SIROMATH Pty Limited, a private company established to provide a high level of mathematical consultancy services, primarily to Australian industry. As at 30/6/85 CSIRO has subscribed a total of $100 001 to the Share Capital of SIROMATH Pty Limited.

12. SIROTECH Limited

SIROTECH Limited is a non-profit company, limited by a guarantee and governed by a board comprising nominees of CSIRO and its partners. The Company was incorporated on 15/11/84. 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 1984/85 SIROTECH's retainer, including payments made by CSIRO on behalf of SIROTECH was $1 484 764, whilst $525 536 was expended in respect of the former Commercial Group.

13. Investments

Shares (at cost)

	1983/84 $	1984/85 $
Griffith Producers Co-operative Co Ltd	5 373	5 373
Griffith Co-operative Society Ltd	40	40
Primac Holdings Ltd	89	133
SIROMATH Pty Ltd	50 001	100 001
Bioquip Ltd	82	82
	55 585	105 629
Austek Microsystems Pty Ltd	US 130 000	US 130 000
Unsecured Notes		
CSBP and Farmers Ltd	380	380
	55 965	106 009
Total	+ US 130 000	+US 130 000

14. 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:

	1983/84 $	1984/85 $
Full time members of the Executive	205 857	223 267
Other members	30 157	35 083
	236 014	258 350

These rates are in accordance with determinations of the Remuneration Tribunal.

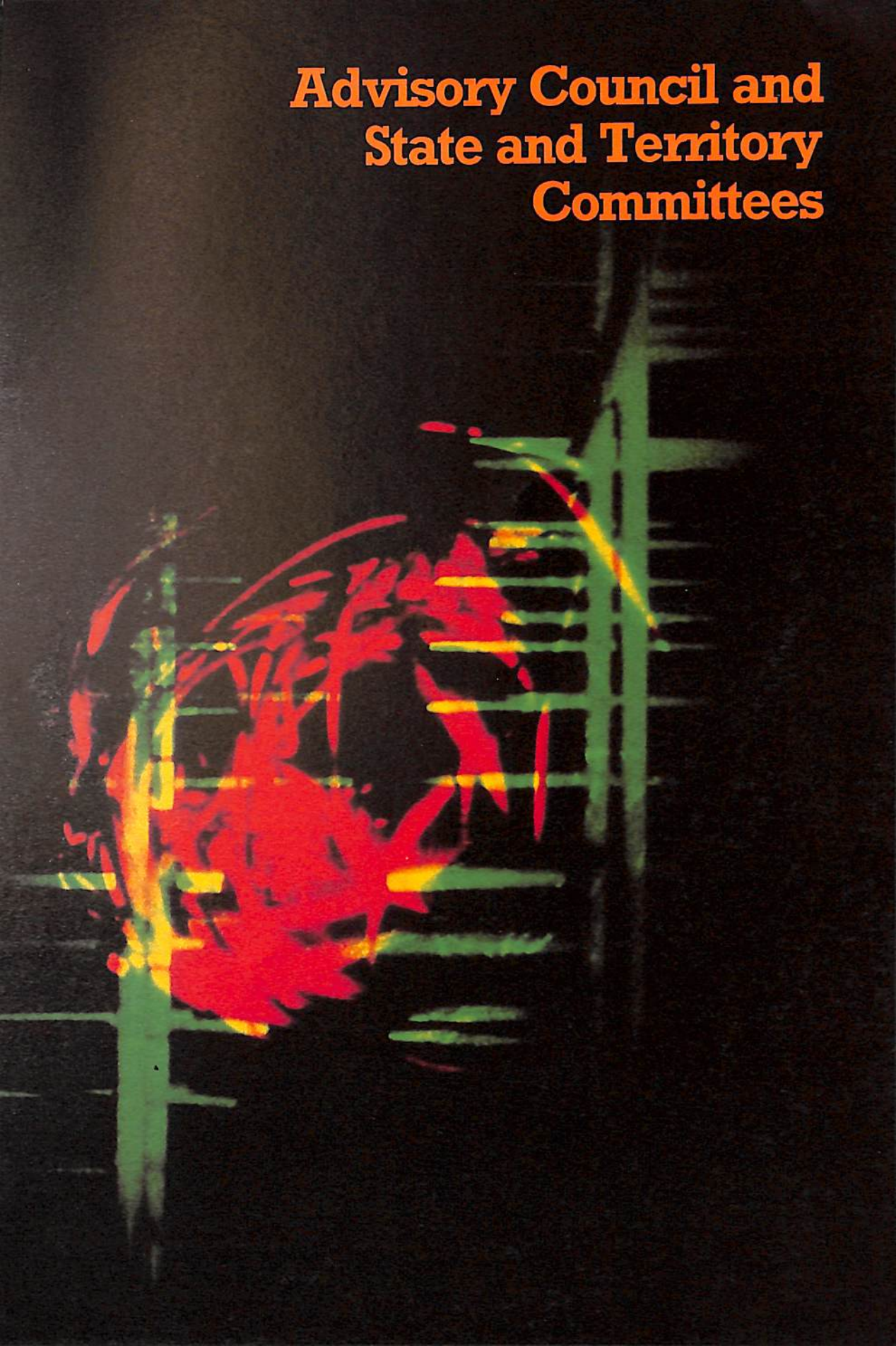
15. Disposal of Properties

Under Section 50 of the Science and Industry Research Act 1949, CSIRO is required to obtain the approval of the Minister to enter into a contract involving the receipt of an amount exceeding $100 000. Formal ministerial approval in accordance with Section 50 was not obtained on two occasions for the disposal of properties to the value of $1 325 976. Ministerial approval has subsequently been obtained.

N.K. Boardman
(Chairman)

G. I. Batchelor
(Manager, Management Services)

Advisory Council and State and Territory Committees



16. 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. There were eight meetings of Council's Standing Committees and four of the Chairpersons of the Standing Committees. The Standing Committees of Council are:

- Information and Social Impact Standing Committee
- Manufacturing Industries Standing Committee
- Mineral, Energy, Water Resources and Soils Standing Committee
- Natural Environment, Renewable Natural Resources Standing Committee
- Rural Industries Standing Committee.

Council's meeting in February 1985 was held in Hobart for the first time since Council was reconstituted in 1979. The opportunity was taken to visit the new CSIRO Marine Laboratories, where the Chiefs and staff of the Division of Fisheries Research and the Division of Oceanography discussed aspects of their work. Council also saw the facilities for the new CSIRO oceanographic research vessel, *Franklin*, due to arrive shortly after the visit.

Changes in Membership

Representatives of Parliament from the two major political parties are appointed to Council for the life of the current Parliament. During the year Mr P R Staples, MP, Member for Diamond Valley, represented the Labor Party until December 1984 and, as Member for Jagajaga following electorate changes, from March 1985. Dr H R Edwards, MP, Member for Berowra, represented the Liberal Party until December 1984. The Hon. M J R MacKellar, MP, Member for Warringah, represented the Liberal Party from March 1985.

Full lists of members are set out in the next chapter.

Dr E N Cain was appointed as the Council's Secretary on 30 July, joining CSIRO from the Department of Communications.

Council Advice

Many matters were brought to Council's attention through correspondence from the Chairman and Members of the Executive of CSIRO or raised with Council in correspondence or through informal discussions with Institute Directors, particularly during meetings of the Standing Committees. Some of these subjects are included in this section and give an indication of the wide range of topics covered during the year.

CSIRO's Budget Appropriation 1984/85

Council commended the Executive's action to accommodate the difficult financial situation faced by the Organization following economies in the Budget. Council also expressed concern to see that reorientation to priority and growth areas through internal reallocations and further concentration of resources into programs of national priority was not arrested by the rigidity of the 1984/85 Budget allocation.

CSIRO's Growth Areas

Council supported the Executive's list of first priority growth areas (indicated in Chapter 2 of this report) with a reservation about the allocation of resources to space science and technology research pending the completion and consideration of an independent Government enquiry.

Review of CSIRO's Strategic Research Planning Activities

Throughout the year Council has been strongly supportive of the Executive's initiatives in reviewing the Organization's planning activities and developing subsequently a corporate strategy for the years 1985-1990. Council made a major submission to the Review of Strategic Research Planning Activities in which it emphasized the need to strengthen mechanisms that would allow resources to be redirected from low priority areas and to ensure that current

programs continued to be relevant and adequately supported. Council stressed the need to establish criteria for priority setting. It also proposed a strengthening of the top-down element in research planning and stressed the critical role of the Institute Directors in the planning process, as the links between the policy-making Executive and the managers of research in Divisions and Units. Council proposed that the Central Planning Unit should have a stronger role than had been envisaged by the Review Committee.

Council provided substantial comment on the subsequent CSIRO discussion paper 'A Strategy for CSIRO, 1985-1990' with strong support for the concepts put forward by the Executive for discussion and evaluation.

CSIRO's External Communication Activities

Council has taken considerable interest in two-way communication between CSIRO and the wider community and the recently completed Report of the Review of CSIRO's External Communication Activities was supported by Council. While Council recognized that a reorientation as proposed in the Report would require an increase in funds, there were some reservations about the increased level of funding (to 5-10% of total CSIRO expenditure) favoured by the Review Committee in its Report.

Science Education Centres

The expansion of the network of science education centres to all States/Territories has been a special interest of Council, its Standing Committees and State and Territory Committees. There has been active lobbying of State authorities for support, including staffing support, for science education centres in all capital cities.

CSIRO Reviews and Review Committees

Council suggested that CSIRO Divisional reviews should be chaired by a non-CSIRO member of the committee appointed by the Executive. It is pleasing to note that this recommendation has been adopted for future reviews. A streamlining of the review process and greater involvement of staff in the committees' investigations and conclusions is another result endorsed by Council.

Council has provided comments during the year on the establishment of the CSIRO Office of Space Science and Applications (COSSA); CSIRO's contribution to the Government's National Technology Strategy discussion paper; and library and information services in CSIRO and their relationship with national facilities for science information services.

Committees of Council provided informal comments to CSIRO during reviews of the CSIRO Divisions of Food Research; Applied Physics; Environmental Mechanics; Plant Industry; Tropical Crops and Pastures; Horticultural Research; and of calibration services of the Division of Applied Physics. Council also assisted the former CSIRO Planning and Evaluation Advisory Unit (PEAU) in its work on planning documents concerned with CSIRO's forest research and with minerals and metals industries research in CSIRO.

ASTEC Review of Public Investment in Research and Development in Australia

As at 30 June Council was completing the preparation of a substantial paper, incorporating its views and those of State and Territory Committees, for submission to the ASTEC Review of Public Investment in Research and Development in Australia.

The Council sees the Review as one of great national importance, since the future role and operational guidelines for CSIRO will have a profound influence on Australia's preparedness for the 21st century.

Sir Ian McLennan Achievement for Industry Award

During the year an important new award and a public trust fund were established by the Advisory Council in honour of Sir Ian McLennan's encouragement, throughout his working career, for technological innovation in Australian industry. The award, which has Sir Ian's full support, is to stimulate, encourage and recognize practical achievement by any CSIRO scientist working individually, or as a member of a team, in any field of CSIRO's endeavour. Achievements will be judged in terms of established economic and/or technological impact on primary, secondary or tertiary industry. In this regard, the award differs from the many existing awards which are made each year in Australia for scientific achievement.

The first award is to be made in December 1985. Further details will be given in the next annual report.

State and Territory Committees

New South Wales

The Committee met four times during the year. These included a joint meeting with the Victorian State Committee at Albury/Wodonga, and visits to local industries. Senior CSIRO research staff and the Chairman of SIROTECH were the principal speakers at a manufacturing industry seminar arranged in conjunction with the Albury/Wodonga Development Board.

The Committee worked closely with the Hunter Development Board to improve communication and create a greater awareness of CSIRO in the Newcastle area by industry and the community. A State Committee proposal to establish a regional information office in Newcastle was shelved because of insufficient resources.

The Committee made submissions to the reviews of the Divisions of Food Research, External Communications Activities, and the Review of Divisional Reviews, and commented on the CSIRO planning document about research for the Australian mineral and primary metals industries.

An unsuccessful approach was made by the Committee to the Director-General, NSW Department of Education, to provide a science teacher to staff a proposed CSIRO Science Education Centre.

Visits were made to the Divisions of Fossil Fuels, Food Research, Applied Physics and the NSW Department of Industrial Development and Decentralization.

In response to a request from the Division of Building Research, the Committee alerted wide sectors of the building industry to the Division's mathematical models to assist in management planning.

Members of the Committee obtained industry support for the Sir Ian McLennan Achievement for Industry Award established by the Advisory Council this year.

Northern Territory

The Committee met in July, November, April and June in Darwin, Katherine and Alice Springs. At a function organized by the Committee in Darwin in July the Chairman of CSIRO Dr Paul Wild and Executive member Dr G H Taylor met government and community representatives and presented the booklet called 'CSIRO 1978-83: Years of Change', a review of CSIRO, attracting public and media interest which reflected the community's desire for CSIRO to assume a higher public profile. The Committee also attended the Manbulloo Field Day, organized in June by the Division of Tropical Crops and Pastures.

The Committee has continued to develop the concept of an increased and more holistic effort by CSIRO into tropical research. It expects to discuss later in 1985 a list of priorities and to present a master plan to the Advisory Council.

Queensland

The Committee met six times during the year. The meeting in Townsville coincided with the Davies Laboratory Open Days. Discussions were held with scientists of the Divisions of Tropical Animal Science and Tropical Crops and Pastures, located at this Laboratory, and Committee members saw examples of the Divisions' research work. Visits and demonstrations arranged by the Australian Institute of Marine Science and the James Cook University highlighted the degree of research cooperation in the region.

Dr M R J Dack addressed the January meeting on CSIRO Science Education Centres (CSIROSEC). In November Mr J J Doyle outlined the structure of SIROTECH and its aims, and Dr J J Lowke, Chief of the Division of Applied Physics, spoke of the research activities of the Division, emphasizing its Applied Physics Industrial Program. Dr D F Mahoney, Chief of the Division of Tropical Animal Science, and Dr R J Jones, Acting Chief of the Division of Tropical Crops and Pastures, addressed the May meeting on the effects of current budget restrictions, on their Divisional research.

The Chairman of CSIRO, Dr Paul Wild, with the Chairman of the CSIRO Advisory Council, Sir Peter Derham. (Photo courtesy of the Hobart Mercury).

The Director of the Institute of Energy and Earth Resources Dr Alan Reid (centre), with the current and former Chairmen of the Western Australian State Committee, (from left) Dr John de Laeter; Emeritus Professor Sir Noel Bayliss; Sir Laurence Brodie-Hall and Mr Dennis Horgan.

The Committee's interest in the possibility of assisting Queensland local government authorities in research relevant to local government problem areas has continued. Financial support has come from the Local Government Association of Queensland and it is expected that the Division of Building Research will begin investigations during 1985/86 on methods of waste disposal.

The activities of the Standing Committees of the Advisory Council have been actively supported by the Committee. It has contributed to many of the Organization's current reviews.

Victoria

The Committee held five meetings during the year and visited the Divisions of Chemical and Wood Technology, Geomechanics, and Animal Health, accompanied by invited guests whose research interests were relevant to the Division concerned. These activities enabled contact with representatives of manufacturing industry and agriculture, semi-government and government authorities, and community leaders.

On 9 and 10 July the Victorian and New South Wales State Committees met in Albury/Wodonga to demonstrate how CSIRO could assist local industry. Visits were arranged to Australasian Training Aids Pty Ltd, Australian Newsprint Mills Ltd, Borg Warner (Aust.) Ltd and Shorko Australia Ltd. The local business community attended a public forum addressed by CSIRO Chiefs and the Chairman of SIROTECH Ltd.

The Committee made submissions to the Advisory Council and supplied comments on many issues including the National Technology Strategy, the Strategic Research Planning Review, the Review of Divisional Reviews, the Review of CSIRO's External Communication Activities, questions on the Organization's strategy from the Chairman of CSIRO and the ASTEC Review of Public Investment in Research and Development in Australia.

In November Mr J H S Heussler, Chairman of the Council's Rural Industries Standing Committee, visited agricultural research centres in Melbourne, Werribee and Geelong, enabling him to talk to senior CSIRO officers, representatives of the Victorian Department of Agriculture and members of the Victorian Farmers and Graziers Association.

Committee members actively sought support from industry for the recently established Sir Ian McLennan Achievement for Industry Award.

South Australia

The Committee held six meetings during 1984/85. Following each meeting, members of the Committee and invited guests from industry met staff, heard of current work, and acquainted themselves with the work of different Divisions including Soils, Human Nutrition, Horticultural Research and Mathematics and Statistics. Interstate speakers from SIROTECH and SIROMATH addressed separate functions. These opportunities were greatly appreciated by, and of significant interest to, industry guests. The

Committee held one meeting at Technology Park, Adelaide (TPA) and subsequently discussed the role and facilities of TPA.

Functions of this kind provide general awareness of CSIRO to many people from industry, government, the media and political parties. Bringing representative groups together has resulted in new contacts between individuals and has led to specific activities such as, for example, a radio program on a CSIRO activity and a new collaboration between a food processing company and SIROMATH. The Committee intends to encourage joint functions and the benefits from them.

The Committee actively supports Divisions represented in South Australia, and is concerned to bring the work and expertise of other Divisions, relevant to large sectors of South Australian industry, to the State. This attitude was reflected in special interest seminars involving inter-State Divisions scheduled for the second half of the year.

Tasmania

The Committee was particularly active early and late in the year. It was, however, handicapped in mid-year by a lack of a State Secretary in full-time CSIRO employment and a reduced complement of members. The new Secretary position, combining the functions of State Committee Secretary and CSIRO Technical Information and Liaison Officer, was filled in late January.

The terms of six Committee members expired in December and replacement arrangements continued into 1985. In mid-May 1985 the Committee comprised ten members, five of them newly appointed; two vacancies are still to be filled.

The Committee held four formal meetings in 1984/85. Members also came together for the Advisory Council meeting in Hobart on 19 February 1985, the opening of the Marine Laboratories on 1 May and the North-West seminar and visit from 13-15 May 1985. Sub-committees met as business required.

The Committee endorsed the comments of its appropriate sub-committees on the Planning and Evaluation Advisory Unit (PEAU) planning documents relating to fisheries research, forest research, and knowledge and management of the natural environment, and forwarded them to the Advisory Council. The full Committee also made a submission to the Advisory Council on the Executive's paper dealing with the Review of Divisional Reviews.

The setting up of a Tasmanian Science Education Centre was discussed at two committee meetings and referred to the Information and Social Impact Sub-committee of the Advisory Council. At the end of the year several possible arrangements were being pursued.

Four CSIRO speakers addressed the North-West Regional Seminar at Burnie on 13 May. They discussed research relevant to industry on the North-West and West coast of Tasmania. There was an encouraging public and media response to the seminar. On the two following days Committee members visited Tasmanian industry.

Western Australia

The Committee met formally on six occasions, including a special meeting with senior officers of the Institute of Energy and Earth Resources. An informal meeting was held with Dr N H Fletcher, Director of the Institute of Physical Sciences.

The program of periodic special meetings, addressed by senior CSIRO officers, continued throughout the year. These included addresses by Dr J J Lowke, Chief of the Division of Applied Physics; Dr H Martel, Division of Manufacturing Technology; Dr W J Peacock, Chief of the Division of Plant Industry; Mr J J Doyle, Managing Director of SIROTECH Ltd, and Sir Peter Derham, Chairman of the Advisory Council. Groups of community leaders visited the Floreat Park Laboratories on several occasions throughout the year.

Submissions were made to the Review of the Division of Food Research, the CSIRO Forest Research Planning Document and the National Technology Strategy. A working party, which included representatives of the WA Government, prepared a document on Information Technology.

The Committee inspected the water treatment plant at the Western Australian Water Authority. This plant utilizes the SIROFLOC process, and treats a significant percentage of Perth's water supply.

A submission was made to the Parliamentary Public Works Committee supporting the proposed building program at Floreat Park and the State Committee Chairman later will present evidence to the Committee.

Other activities during the year included a meeting with representatives of the ASTEC Committee reviewing Public Investment in Research and Development in Australia, and assistance with the presentation of the Rivett

Memorial Lecture, given by Dr L Branscomb.

Senior officers of the Institute of Energy and Earth Resources visited Western Australia for a week during March, meeting members of State Government Departments, and industry representatives.

During the visit, Director of the Institute of Energy and Earth Resources, Dr A F Reid, presented the inaugural Brodie-Hall address. This address honours the contribution of Sir Laurence Brodie-Hall to the State Committee's work during his membership of 20 years and as its Chairman from 1971-1981.

17. 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, BVSc, MSc, PhD, FACVSc, Director-General, Queensland Department of Primary Industries (*Queensland*).

R A Footner, AM, retired in April 1985 as 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, WA 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*).

Members

S C Bambrick, OBE, BEcon, PhD, Dean of Students, Australian National University.

V A Brown, MSc, PhD, Director, Health Promotion Branch, A.C.T. Health Authority.

L P Duthie, BCom, Secretary, Department of Primary Industry.

H R Edwards, BA, DPhil (Oxon), FAIM, FASSA, MP, Member for Berowra (until December 1984).

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, Chairman, Hartley Computers Australia Pty Ltd.

J H S Heussler, Grazier.

D J Ives, BSc, BEcon, 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 (from March 1985).

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.

Professor R O Slatyer, AO, FAA, FRS, Chairman, Australian Science and Technology Council.

J P Wild, CBE, ScD, FTS, FAA, FRS, Chairman, CSIRO.

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, NSW Electricity Commission.

D R Dunk, Assistant Secretary, Health & Research Employees' Association.

K P Farthing, ASTC, Executive Director, Manufacturing, Metal Manufactures Ltd (until March 1985).

S C Hayes, BA, PhD, Senior Lecturer, Department of Behavioural Sciences, University of Sydney (from April 1985).

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.

G R Peart, MRurSc, Agricultural Consultant (until March 1985).

K P Sheridan, BAgrSc, MSc, PhD, Member, NSW Public Service Board (from April 1985).

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.

W J Fisher, Mining Consultant (until March 1985).

P L Garton, Insurance Loss Adjuster.

B K James, BA, Research Officer.

G A Letts, CBE, DVSc, former Director, Conservation Commission of NT.

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

M J Tilley, Company Director and Farmer (until December 1984).

R J Tormey, BEc, AASA, Manager, Secondary Industry, NT Development Corporation.

W J Waudby, Pastoralist.

M G Ridpath, BSc, PhD, (Secretary), Officer-in-Charge, CSIRO Darwin Laboratories.

Queensland

G I Alexander, BVSc, MSc, PhD, FACVSc (Chairman), Director-General, Queensland Department of Primary Industries.

V B Aldrich, BSc, Regional Manager, Queensland, CSR Limited (from March 1985).

J A Allen, PhD, FTS, former Chairman, Board of Advanced Education (until March 1985).

A J Allingham, Grazier.

G L Baker, MSc, Assistant Director (Industry), Department of Commercial and 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 Qld Electricity Board.

J Sheridan, Family Day Care Coordinator for Queensland.

D M Traves, OBE, BSc, Consultant, Peat, Marwick & 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.

South Australia

R A Footner, AM (Chairman), retired in April 1985 as 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 Bouwer, Small Farms Adviser, SA Dept of Agriculture.

J C Killick, BE, ME, Manager, Water Resources, SA Dept of Engineering & Water Supply.

I J Kowalick, BSc, BEc, Executive Officer, SAMIC Limited.

J K Lesses, Secretary, United Trades & Labor Council of SA.

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.

P M South, BSc, DipFor, Director, Woods and Forests Department, South Australia (until March 1985).

G K Wilkinson, BSc, MSc, Senior Dietician, Modbury Hospital.

R Woodall, AO, BSc, MSc, Director of Exploration, Western Mining Corporation Ltd (until January 1985).

V W Westwood, BAgrSc (Secretary), CILES Information Officer, Division of Manufacturing Technology, Adelaide Laboratory.

Tasmania

Professor P Scott, OBE, PhD, LLD (Chairman), former Pro-Vice-Chancellor, University of Tasmania.

J R Ashton, BCivilEng, Commissioner, Hydro-Electric Commission, Tasmania (until May 1985).

R D Barker, DipMetallurgy, DipChemEng, General Manager, Electrolytic Zinc Co (until December 1984).

E C Best, BSc, BE, Manufacturing Manager, Cadbury Schweppes Ltd.

J S S Burns, Editor, 'The Mercury'.

M C P Courtney, Editor, Launceston 'Examiner' (until December 1984).

T M Cunningham, BSc, BFor, PhD, former Commissioner (Management), Tasmanian Forestry Commission.

R J Downie, Grazier (until December 1984).

A T Dunbabin, BAgrSc, Grazier (from April 1985).

P J Fountain, BSc, Director, Tasmanian Department of Agriculture (until 1 December 1984).

B F Gibson, BScF, BA, Managing Director, Australian Newsprint Mills Ltd (from April 1985).

Professor F P Larkins, BSc, DipEd, MSc, PhD (Oxon), Department of Chemistry, University of Tasmania.

H Murchie, BSc, DRTC Director of Mines (from April 1985).

J Simmonds, BA, Secretary, Hospital Employees' Federation.

G R Stackhouse, President, Tasmanian Branch, Australian Fishing Industry Council (from April 1985).

Captain D M Waters, MSc, Principal, Australian Maritime College (until December 1984).

G B Laffer, BSc, MSc, BA (Secretary) CILES Information Officer, 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, 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 of Agriculture.

H M Mitchell, OBE, Vice President, Victorian Farmers' and Graziers' Association.

R D E Parry-Okeden, BE, 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, CSIRO.

Western Australia

J R de Laeter, PhD, FTS (Chairman), Associate Director, Division of Engineering and Science, WA Institute of Technology.

D S Balfour, BSc, DipEd, Science Lecturer (from April 1985).

E R Gorham, BE, Co-ordinator of Industrial Development, Department of Industrial Development (until December 1984).

N J Halse, MAgrSc, FAIAS, Director, Department of Agriculture.

A Heine, Vice President, Teachers' Union (until March 1985).

R M Hillman, BEng, Chairman, Water Authority of Western Australia.

D R Hull, BCom, PhD, Director, WA Govt Technology Directorate.

P V Hurse, OBE, MB, BS, Medical Practitioner.

J B Kirkwood, FInstEngsA, FTS, Commissioner, State Energy Commission (until December 1984).

S L G Morgan, BE, Managing Director, Westintech Innovation Corporation Ltd.

J R H Ross, BSc, PhD, Manager, Diamond Exploration, Western Mining Corporation (from April 1985).

D W Saunders, BE, BEc, Assistant Commissioner (Policy and Planning) State Energy Commission.

S R Shea, BSc, MSc, PhD, Scientific Adviser on Forests and the Environment.

J Shepherd, BSc, Farmer and Agricultural Scientist.

Professor R Street, DSc, FAA, Vice-Chancellor, University of Western Australia.

J P Brophy, MBE (Secretary), Regional Administrative Officer, CSIRO, Perth.

Appendices

Appendix I Science and Industry Endowment Fund

Eleven applications for grants were received during the year by the Science and Industry Endowment Fund (SIEF). Ten grants valued at $16 710 were approved and details are given in the table below.

A total of $18 645 was disbursed. This included $16 710 for new 1984/85 grants, and $1935 for grants approved in 1983/84 for which full payment was not made until 1984/85.

At 30 June 1985 the Fund had $13 526 available. Income during 1985/86 is expected to provide an additional $29 065.

The Fund was established under the Science and Industry Endowment Act 1926 to assist people engaged in, and for training students in, scientific research.

The members of the CSIRO Executive are Trustees of the Fund, which comprises the original capital of £100 000 appropriated by the Act and the income derived from investment of that amount. An extensive report of the Fund's history appeared in the 1982/83 Annual Report.

Key features of the year's operations included:

- continuation of grants as in previous years
- consideration of a review of the Fund (mentioned in earlier reports)
- implementation of revised guidelines for administering the Fund.

The report on the review of the Fund's activities was considered by the Trustees in September 1984. Among aspects of the Fund examined were previous reviews, investment policy, legislation, operational mechanisms and success in meeting its objectives. The Trustees concluded that the Fund was a worthwhile source of assistance for small projects but administrative arrangements needed revising.

The main revisions were to advertise the availability of grants, and to provide for awarding the grants, for the most part, on a competitive annual basis.

A national newspaper advertisement inviting applications advised that the Fund would make about five grants in 1985/86, each of up to $3000. The applications will be processed early in the next financial year.

Table — Grant Disbursements — 1984/85

Applicant	Project	Amount $
Mr N Draper	Travel expenses to Kangaroo Island for archaeological research on prehistoric Kartan culture	931
Dr L Dintenfass	Research on aggregation of red blood cells for testing on NASA space shuttle — offsetting of salaries and equipment costs	4 000
National Science Summer School	Travel costs in bringing students to Canberra for 1985 NSSS	750
Mr D Herald	Travel expenses to Papua New Guinea to observe total solar eclipse	2 346
Mr G Robertson	Travel and field equipment costs associated with participation in Antarctic expedition to study gentoo penguin	958
Rev. R O Evans	Purchase of Meade DS16 Newtonian telescope and accessories to study supernovae	3 959

Table — Grant Disbursements — 1984/85 (cont)

Applicant	Project	Amount $
Mr R C Kershaw	Travel expenses for field trips and museum visits for research on Tasmanian molluscan fauna plus additional equipment for Wild microscope	1 216
Science Teachers' Assoc. of ACT	1985 Science Fair — contribution towards awards	400
Mr M Dunning	Travel expenses to attend the first workshop and symposium of the Cephalopod International Advisory Council in France	1 950
Science Teachers' Assoc. of Vic.	1985 Science Talent Search — contribution towards awards and bursaries	200
Total		**16 710**

Appendix II CSIRO Submissions to Parliamentary and Official Inquiries

CSIRO made submissions during 1984/85 to two official inquiries with implications for the Organization's activities in scientific and industrial research:

Inquiry into Australia's Relations with Papua New Guinea

The Organization's involvement in Papua New Guinea (PNG) began after World War II with a long-term land resources study to determine the nation's agricultural potential. In its submission to the Senate Standing Committee on Foreign Affairs and Defence, CSIRO described recent and ongoing research which was contributing to the economic development of PNG. These investigations are concerned mainly with agriculture, forestry, fisheries and mining. Much of this work has depended on the active cooperation of PNG Government agencies, with financial support from aid agencies, the PNG Government, CSIRO's own appropriation funds, and in the case of minerals research, the mining sector. The submission made general comments on how research might be applied more effectively to increase agricultural production in PNG.

Review of Government Offsets Policy and Program

The CSIRO submission drew attention to the benefits of conducting research and development to discharge offsets obligations and recommended that such arrangements be encouraged to facilitate the transfer of overseas technology. Another important aspect raised by CSIRO relates to the offsets orders placed with Australian manufacturers where overseas contractors have required measurement standards to be traceable to overseas laboratories. As most of these standards are available at the National Measurement Laboratory, the submission recommended that they should be made traceable within Australia to facilitate Australian companies accepting such orders.

In addition to formal submissions to these inquiries the Organization has had, at the request of the committees involved, a continuing input into many of the inquiries listed as having received CSIRO submissions in the 1983/84 Annual Report.

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 15
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 16.
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 1, 4 and 5-11.
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 15.

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 1985 CSIRO had a total staff of 7195.

Terms of office of Executive members are as follows:

Chairman and Chief Executive
J P Wild, 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
D P Craig, DSc, FAA, FRS
26.3.83-22.12.84
23.12.84-22.6.85
M D Kirby, CMG, VA, LLM, BEc
11.8.83-10.8.86
S B Myer, MA
14.12.81-13.12.84
21.12.84-20.6.85
G G Spurling, BTech, MAE, ED
9.9.82-8.9.85
P D A Wright
4.2.83-3.2.86
K J Foley, MCom, PhD
23.6.85-22.3.86
A E Clarke, BSc(HGNS), PhD
23.6.85-22.3.86

Information about CSIRO may be obtained from the sources listed below.

Scientific and technical inquiries:

Central Information Service, CSIRO,
P.O. Box 89, East Melbourne, Vic. 3002
Tel. (03) 418 7333

The Librarian, CSIRO,
P.O. Box 225,
Dickson, A.C.T. 2602
Tel. (062) 48 4228

Regional Information Office, CSIRO,
P.O. Box 218, Lindfield, N.S.W. 2070
Tel. (02) 467 6211

	Regional Information Office, CSIRO, P.O. Box 374, West Perth, W.A. 6005 Tel. (09) 322 2111
	Freedom of Information inquiries:
	Freedom of Information Unit, CSIRO, P.O. Box 225, Dickson, A.C.T. 2602 Tel. (062) 48 4123
	Media inquiries:
	Media Office, CSIRO, P.O. Box 225, Dickson, A.C.T. 2602 Tel. (062) 48 4484
Financial statements	See Chapter 15
Activities and reports	See Chapters 1-15. CSIRO maintains relations with a wide range of Commonwealth, State and local government organizations 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: Central Information, Library and Editorial Section, CSIRO P.O. Box 89, East Melbourne, Vic. 3002 Tel. (03) 418 7333
Operational problems	See Chapters 1-15
Subsidiaries	Under section 9AA(b) of the Science and Industry Research Act 1949, CSIRO has joined in the formation of two companies, SIROTECH Ltd and Siromath Pty Ltd. These companies are reported on in Chapter 12.

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Commonwealth Scientific and Industrial Research Organization, Australia