CSIRO
1991-1992
ANNUAL
1991-1992
REPORT

CSIRO
AUSTRALIA

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The Hon Ross Free MP
Minister for Science and Technology
Parliament House
CANBERRA ACT 2600

We have pleasure in submitting to you, for presentation to Parliament, the forty-fourth annual report of the Commonwealth Scientific and Industrial Research Organisation.

Highlights for the year included the release of a number of cost-benefit studies showing that CSIRO delivered returns of up to $14 for every dollar invested in a wide range of our research. Our Strategic Plan for 1991–96 reveals how we have planned to deliver benefits to Australia in the future.

The establishment of eleven more multi-Divisional programs this year will enable us to focus more effectively on important national issues by bringing teams swiftly together from across traditional scientific and administrative boundaries.

We commend the Organisation's achievements to you.

Adrienne E. Clarke
(Chairman of the Board)

John W. Stocker
(Chief Executive)

November 1992

Contents

Chairman's Foreword

Professor Adrienne Clarke

We live in extraordinary times, times of rapid change, times in which great challenges and opportunities are presented to us. Australia is a small community in the global context. We are buffered by distance from political upheavals in Europe and natural disasters in Africa, but we are buffeted by movements in the major economies of the world.

One of the truly global forces which we can influence to a certain extent is modern science and technology. This powerful force is driving all societies in similar directions. In Australia, we are in the fortunate position of having a relatively strong scientific capability, mainly in CSIRO, the universities and the research institutes.

Within CSIRO our focus is to use our science and technology resources to achieve a better standard of living and quality of life in Australia. In planning for this goal, we address major questions such as management of our environment and our natural resources, as well as how best to help both existing and new industries achieve and maintain international competitiveness.

CSIRO's vision is expressed in our priority setting and strategic planning processes. In the past year, CSIRO has continued to tackle the issue of directing and concentrating resources in order to best help Australia solve problems and develop opportunities. We are doing this in close co-operation with research users and beneficiaries.

This year we published our five-year Strategic Plan. This plan sets out our broad goals and strategies and highlights some of the expected outcomes and benefits of programs. It identifies milestones by which the Organisation is prepared to be judged.

CSIRO's contribution to Australia's drive for competitiveness became more focused in 1991–92 and our range of skills better integrated. Our approach has balanced development and environmental values and

we have made a major contribution to the broadly participative examination of ecologically sustainable development.

Genuine forward-looking strategies are central to CSIRO's success and overseeing their development is one of the Board's key responsibilities. To this end the Board will soon be analysing the major challenges and opportunities facing Australia and the ways CSIRO can contribute to an effective response.

My predecessor, Mr Neville Wran, presided over a period of major restructuring and cultural change in CSIRO. These changes have enhanced its reputation as an extremely effective, world-class research organisation. In paying tribute to Mr Wran's leadership during this period, I also acknowledge the work of other outgoing Board Members, Sir Roderick Carnegie and Dr Kevin Foley, who made major contributions to the Board program and through this, to the Organisation and the nation. It was a great privilege for me to have worked with these outstanding Australians during the past five years.

In a small nation such as Australia, we can only succeed by focusing our energies and co-operating to reach our goals. Too often in the past, for a host of reasons, our energies have been diffused by an unwillingness of major bodies and organisations to co-operate. We are slowly overcoming our past history and recognising the strength in pulling together rather than apart.

The recent review of CSIRO's rural research effort highlighted the need for co-operation in rural research and in its first recommendation suggested the production of a unifying strategy for successful research and application in collaboration with other research agencies.

Co-operation with State authorities and agencies is important to optimise our overall effort. The past year has seen several co-operative agreements with State agencies; for example, agreements with the Sydney Water Board and Melbourne Water, co-operative development of mineral research facilities with the Queensland and Western Australian governments, air pollution work with the NSW Environment Protection Authority, and increased funding for pharmaceutical research through the Biomolecular Research Institute in Victoria.

CSIRO is also a partner in 29 of the 35 Co-operative Research Centres so far established. We strongly support this program and believe it offers the potential for formation of synergistic links between research performers in CSIRO, the universities and other research institutions, as well as the users of the knowledge generated.

Internal co-operation within CSIRO has also been emphasised recently. We are ensuring that all levels of CSIRO contribute to planning and priority setting, in each case consulting with potential users. Planning includes new programs in human resource management, career planning, and training and redeployment strategies to complement changes in research programs. With the strongest support from the Board, management is working towards better and more co-operative staff retraining and redeployment. The CSIRO Consultative Council has set up a task force to develop processes which fully reflect the conviction that CSIRO's greatest resource is its skilled staff.

Another successful development in co-operation, crucial to the full realisation of CSIRO's potential, is the extension of multi-Divisional, multi-disciplinary teams to

tackle big problems and big opportunities. These co-operative programs within CSIRO are already leading to practical outcomes in areas such as waste management, land and water care, greenhouse research and genetic engineering. This year we launched CSIRO's Coastal Zone Project, another cross-Divisional effort to help manage our fragile coastal zones. This project also involves extensive collaboration with other bodies throughout Australia, reflecting the diversity and complexity of use of coastal areas.

There were other major research and research management advances during the year, many of them outlined elsewhere in this Annual Report, together illustrating the range and potential of CSIRO's work. Two particularly exciting projects are the development of the world's largest magnesite deposit in Queensland and an on-line system for analysis of coal — Coalscan.

The magnesite deposit is being developed as a co-operative venture involving CSIRO, the Australian and Queensland governments, Queensland Metals Corporation Ltd and Mount Isa Mines Ltd, with UBE Industries of Japan as a minority shareholder. CSIRO's role is to develop the technology for production of metal from the mineral deposit. This is an exciting opportunity for 'value-added' activity in Australia.

The Coalscan team was awarded this year's Australia Prize for their achievements. In particular, they developed a series of analytical instruments which have already achieved $50 million in sales.

CSIRO has also contributed to many community activities. Education and skills development have been enhanced through the CSIRO Science Education Centres, the burgeoning Double Helix Club and postgraduate awards. CSIRO has also continued to build awareness of science through media activities and displays, including 'Will Pigs Fly?' — a travelling exhibition exploring some of the facts and fictions of genetic engineering. These are a very important part of our commitment to Australia's future.

A vision for Australia's future, a drive to ensure science and technology plays its full part and a willingness to adopt a co-operative approach are all part of CSIRO's contribution to building a competitive Australian economy and maintaining our environmental assets. The Board is confident that CSIRO, under the strong and inspired leadership of Dr John Stocker and his management team, has worked very effectively toward these outcomes in 1991–92 and that the momentum will gather strength in the coming year.

Adrienne E Clarke

Chief Executive's Review

In a year of restraint for government and industry, CSIRO has again delivered very real benefits for the nation's economy and community.

The proof of CSIRO's value to the nation is perhaps most strikingly apparent in a series of cost-benefit analyses of our work completed this year. The studies, outlined in this Report, show an impressive return on investment in CSIRO R&D of up to $14 for every dollar invested.

This measure of our output is, I believe, the best indicator of our effectiveness, better than the more commonly used input measure of the level of industry funding of our research. However, on this latter score too, we have performed well — our funding from non-Government appropriation sources grew this year to 28.7 per cent, a healthy increase in a year of national belt-tightening.

We have been active in efforts to raise this figure to 30 per cent: we have issued new guidelines for pricing and commercialising our research; we have established new policies for setting external funding targets; we are soon to trial a range of indicators of our effectiveness in interacting with the users of our research.

We designated March 'Manufacturing Month'. A series of business breakfasts — many of them in partnership with the business magazine *Business Review Weekly* — and a number of industry seminars were held to raise the profile of CSIRO research for manufacturing industry. The response was so positive that we plan to run a similar venture next year.

Our discussions with company boards have increased and our interactions at senior executive level with the Australian Industry Research Group and the Committee for the Economic Development of Australia further demonstrate our determination to work more effectively with the private sector.

Of course, none of this would be possible without first-class R&D to work with. From

Dr Stocker inspects a variety of transgenic plants at the Division of Plant Industry in Canberra

the 'mini-shears' extension of gene shears technology to the Australia Prize-winning creation and marketing of instruments for the coal and mineral industries; from launches of the Australian Magnesium Research and Development Corporation and the Australian Automotive Technology Centre to the signing of a major agreement with the Sydney Water Board; from the commercialisation of active packaging technology to the creation of a consortium to develop a solid oxide fuel cell — these achievements highlight the quality of CSIRO's work in both the 'R' and 'D' components of research and development, and beyond to their commercialisation.

Elsewhere, through the Co-operative Research Centres Program, CSIRO continues to support innovation through collaboration. Increasing private sector support — up to a proposed 28 per cent for the third round of applications — is essential for the Program to fulfil its goal of contributing to the future competitiveness of Australian industry.

CSIRO again this year identified its research priorities and gave them expression in a major document — the CSIRO Strategic Plan for 1991 to 1996. We have matched what we do best with what Australia needs most, and funded it accordingly with $4.6 million raised from a 1.5 per cent levy across the Organisation. It has been pleasing that many government agencies in Australia and overseas have shown interest in our approach to priority-setting; we hope that a more uniform system might be useful in comparing research outcomes.

During the year the government made the welcome decision to allocate an additional $20.72 million to CSIRO as the major part of a package to support capital infrastructure in the science agencies. Of this amount, $10.72 million will be spent immediately on four major projects, with others to follow. The 53-year-old Division of Biomolecular Engineering site at Parkville will be redeveloped, and temporary buildings at the Division of Mineral and Process Engineering in Clayton and the Division of Atmospheric Research in Aspendale will be replaced. Obsolete facilities at the Division of Tropical Crops and Pastures site in St Lucia, Brisbane will be replaced. Also, a loan agreement between CSIRO and the Government will accelerate the development of the North Ryde site in Sydney.

The Government also agreed to pay for the full costs to CSIRO — some $14.78 million — arising from a recent award restructuring, and fulfilled its promise to make triennium funding permanent for us. These measures will help ensure we attract high quality staff and will give us the funding stability that strategic and long-term scientific research desperately needs.

Stability of funding is still the key issue for CSIRO as it looks to the future. We are hopeful that, as foreshadowed in the August 1992 White Paper on Science and Technology, we can make progress towards a long-term resource agreement with the Government. A decision by the Government to maintain the 150 per cent tax concession for industry investment in research will be welcome.

CSIRO continued this year to take an active part in public life through the media, and we have made frequent contributions to government policy development, especially through the deliberations of the Prime Minister's Science Council. I addressed the National Press Club and presented to the Primary Industries and Energy Research Council and the Standing Committee on

Agriculture a paper aimed at improving collaboration in rural research. As part of its strategic planning the Board commissioned an external review of our own research for the rural industries. CSIRO was represented on all nine of the Ecologically Sustainable Development working groups set up by the Government. The Organisation continues to play a key role in the process of responding to the groups' reports.

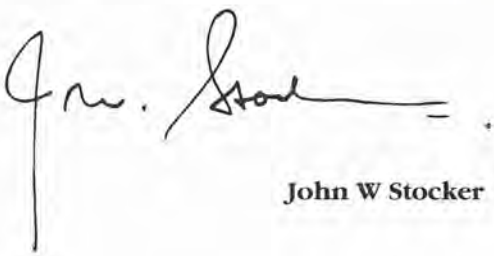
Within our own ranks, we have concentrated on the development of Multi-Divisional Programs (MDPs) to tackle important national issues with multi-disciplinary teams that transcend traditional scientific boundaries. This year, 11 MDPs were set up (making 17 in all) ranging from the Coastal Zone Program to programs working on vaccine technologies and energy storage.

In the public education arena, too, we have taken the initiative. Recognising the impact that genetic engineering will have on our society, we assembled a high-tech interactive travelling exhibition to travel the country to raise the level of awareness and debate on the issue. Demand throughout the country and from across the Tasman has encouraged us to plan for a similar exhibition on the minerals industry.

CSIRO has long been at the forefront of science and careers education. Expansions in the numbers of CSIRO Science Education Centres and Double Helix Science Club members will help to raise the popularity of science in our schools and universities.

The successes of the year have not been achieved without cost. Changing priorities, greater rewards for excellent staff and imposts like the efficiency dividend mean that some staff positions cannot be maintained. CSIRO management and staff, through the CSIRO Consultative Council, have been working to devise ways of redeploying and retraining affected staff members.

CSIRO is a rapidly changing organisation. This Report details ways in which it is becoming more focused, better linked to its research users, at once more proactive and more responsive. The results we have achieved this year cement my conviction that CSIRO has a key role to play in creating the innovation Australia needs to regain its economic vitality.



John W Stocker

Charter, functions and powers

CSIRO is an independent statutory authority constituted and operating under the provisions of the *Science and Industry Research Act* 1949.

A number of changes relevant to CSIRO have recently been made to the *Act*. These are detailed on p. 66 of this Report.

From 1 July 1991 to 30 June 1992 the Minister responsible for CSIRO was Mr Ross Free (Minister for Science and Technology, Minister Assisting the Prime Minister).

Functions

CSIRO's primary functions are:

- to carry out scientific research
  – to assist Australian industry and to further the interests of the Australian community;
  – to contribute to national and international objectives and responsibilities of the Commonwealth Government;
- to encourage or facilitate the application and use of the results of its own or any other scientific research.

Its secondary functions include international scientific liaison, training of research workers, publication of research results, and dissemination of information about science and technology.

Powers

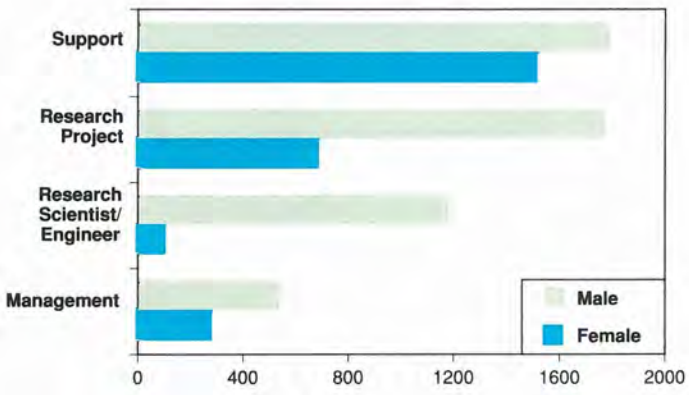
The organisation has power to do whatever is necessary for the best performance of its functions.

In particular it may:

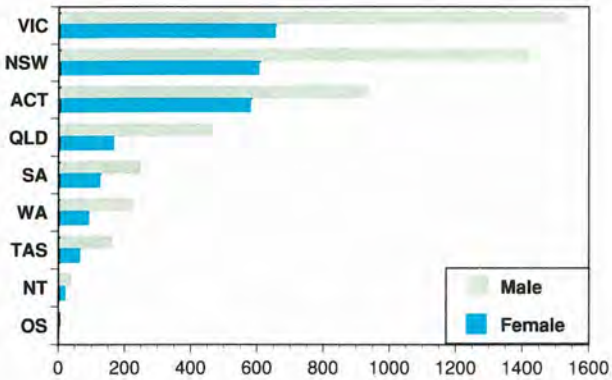
- arrange for research and other work to be undertaken outside CSIRO;
- form partnerships or companies;
- make its discoveries and inventions available for fees, royalties or other considerations;
- pay bonuses to staff for discoveries or inventions;
- charge fees for research, facilities or services provided to others.

A full description of CSIRO's functions and powers can be found in Appendix 2.

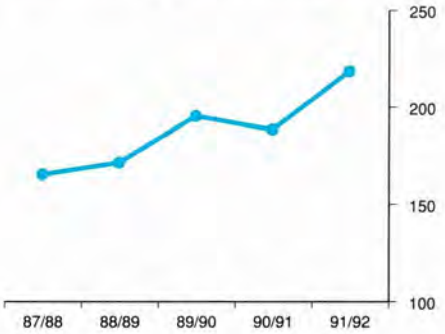
Distribution of staff by gender and state



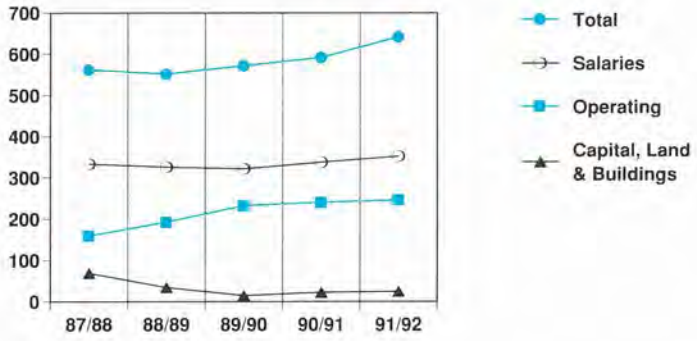
Distribution of staff by gender and function



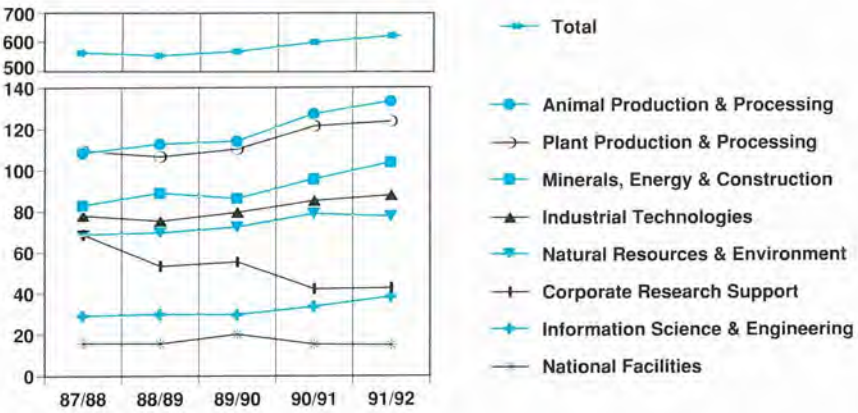
Numbers of provisional patent applications



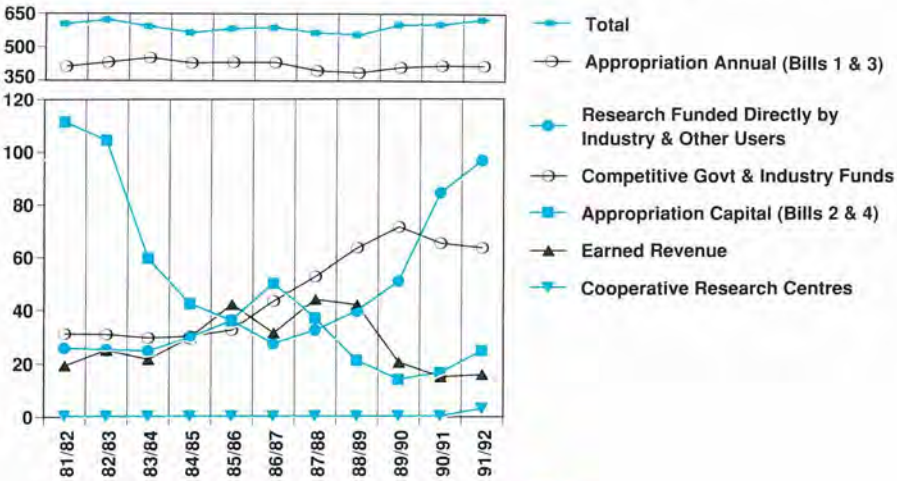
CSIRO cash expenditure by category in 1992 dollars



CSIRO cash expenditure by Institute in 1992 dollars



CSIRO cash expenditure by source of funds in 1992 dollars



Structure, management and staff

CSIRO's current structure was established by the *Science and Industry Research Amendment Act* 1986. This established a ten-member Board responsible for determining policy and ensuring the efficient functioning of CSIRO. The Chief Executive, who is a member of the Board, is responsible for the Organisation's activities.

The Chief Executive, the six Institute Directors and the Director of Corporate Services form the Executive Committee, which assists the Chief Executive in managing the activities of the Organisation.

Research is performed in 35 Divisions and research units, grouped into six Institutes. Each Institute has its own management committee, which consists of the Director and Divisional Chiefs. The Institute Committee provides a forum for setting the strategic direction for the Institute and assisting in the formulation and implementation of corporate and Institute policies for research and management.

A Corporate Centre provides central services to support managers and staff in the development and implementation of policies, and to provide services such as payrolling that are best performed at the corporate level.

Divisions and Institutes are located all over Australia, with many Divisions having more than one site. CSIRO also maintains a small number of field stations overseas, mainly concerned with biological studies that could benefit Australia.

CSIRO staff are employed under section 32 of the *Science and Industry Research Act* 1949. At 30 June 1992 CSIRO had a total staff of 7,316, which has an equivalent full-time value of 6,893 units. The distributions of staff by gender, function and location are shown in the charts p. 10.

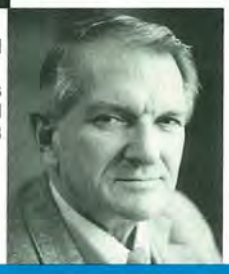
THE BOARD

Chairman
The Hon Neville Wran AC QC
Chairman, Turnbull & Partners
5 Dec 86—4 Dec 91

Chairman
Professor Adrienne Clarke AO BSc PhD FAA FTS
Director,
Plant Cell Biology Research Centre,
University of Melbourne
5 Dec 91—4 Dec 96

(Above)
Dr John Stocker MB BS PhD FRACP FTS
Chief Executive of CSIRO
5 Mar 90—4 Mar 95

Mr Laurie Carmichael
Chairman
Employment and Skills Formation Council
13 Mar 89—12 Mar 93



Sir Roderick Carnegie BSc MA(Oxon) MBA FTS
Company Director
5 Dec 86—4 Dec 91

Professor John de Laeter AO FTS FInstP FAIP
Deputy Vice-Chancellor (Research and Development)
Curtin University of Technology
5 Dec 91—4 Dec 95

Dr Kevin Foley MComm PhD
Managing Director,
Kevin Foley & Associates Pty Ltd
5 Dec 89—4 Dec 91

Dr Tony Gregson PhD DSc FRACI
Primary producer,
Director, Grains R&D Corporation
5 Dec 90—4 Dec 92
(reappointment)

(Below)
Professor Sir Gustav Nossal AC CBE MB BS BSc PhD FTS FAA FRS
Director of the Walter and Eliza Hall Institute of Medical Research
5 Dec 91—4 Dec 93
(reappointment)

Dr Max Richards BSc PhD FAIMM
Managing Director
Aberfoyle Limited
5 Dec 91—4 Dec 95

Mr Doug Shears
Executive Chairman,
ICM Australia Pty Ltd
5 Dec 91—4 Dec 96

Mr Ralph Ward-Ambler AM BMechE
Company Director
6 Feb 89—7 Feb 93

Mr Nigel Stokes BEc BA
Adviser to Bankers Trust Aust Ltd
24 Sept 91—31 Aug 94

Organisation chart
as at 30 June 1992

THE BOARD
Professor Adrienne E. Clarke

Dr J. W. Stocker
Mr L.N.R. Carmichael
Prof. J. R. de Laeter
Dr A.K. Gregson
Prof. Sir Gustav Nossal
Dr S.M. Richards
Mr D.S. Shears
Mr N.C. Stokes
Mr C.R. Ward-Ambler

INSTITUTE OF INFORMATION SCIENCE AND ENGINEERING

Director
Dr R. H. Frater

Divisions

- Information Technology
- Mathematics & Statistics
- Radiophysics
- Australia Telescope National Facility
- COSSA

INSTITUTE OF INDUSTRIAL TECHNOLOGIES

Director
Dr C. M. Adam

Divisions

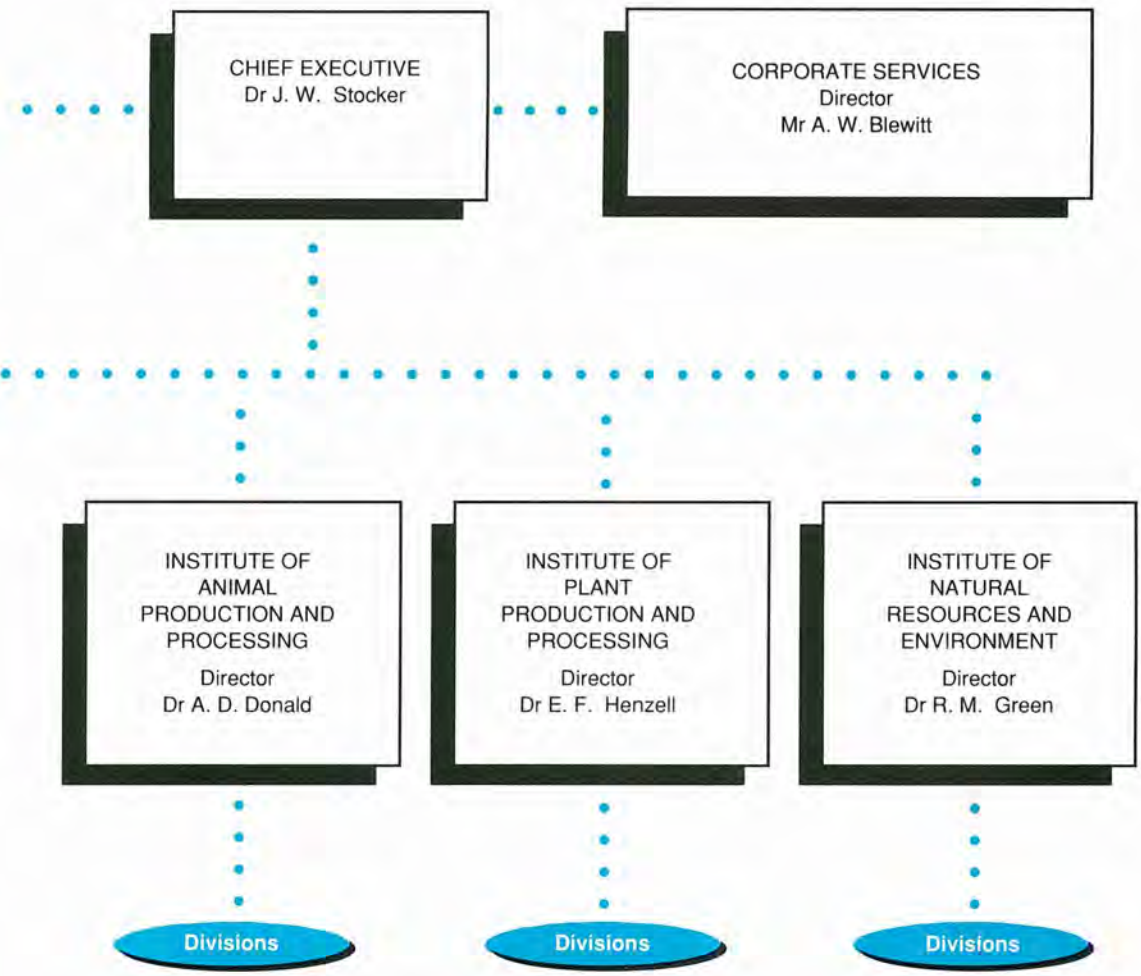
- Applied Physics
- Biomolecular Engineering
- Chemicals & Polymers
- Manufacturing Technology
- Materials Science & Technology

INSTITUTE OF MINERALS, ENERGY AND CONSTRUCTION

Director
Dr A. F. Reid

Divisions

- Building Construction & Engineering
- Exploration Geoscience
- Geomechanics
- Mineral & Process Engineering
- Mineral Products
- Coal and Energy Technology



- Animal Health
- Animal Production
- Tropical Animal Production
- Food Processing
- Human Nutrition
- Wool Technology

- Entomology
- Forestry
- Forest Products
- Horticulture
- Plant Industry
- Tropical Crops & Pastures
- Soils

- Atmospheric Research
- Fisheries
- Oceanography
- Water Resources
- Wildlife & Ecology
- Centre for Environmental Mechanics

Senior staff and addresses

Corporate Centre

Limestone Avenue Campbell ACT 2601
Tel: (06) 276 6766

Chief Executive
Dr J.W. Stocker

Director, Corporate Services
Mr A.W. Blewitt

Board and Executive Committee Secretary
Dr E.N. Cain

Principal Secretary
Dr T.E. Heyde

Corporate Planner
Dr D. MacRae

Manager, Public Affairs
Mr L.R. Bevege

SIROTECH Ltd

Chief Executive: Dr D.C. Gibson
580 Church Street
RICHMOND VIC 3121
Tel: (03) 428 0466

Institute of Information Science and Engineering

Director: Dr R.H. Frater
105 Delhi Road
NORTH RYDE NSW 2113
Tel: (02) 887 8220

Divisions and Chiefs

Information Technology
Chief: Dr J.F. O'Callaghan
ANUTECH Court
ANU Campus
Cnr North and Daley Roads
Acton ACT 2601
Tel: (06) 275 0901

Mathematics and Statistics
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Gate 4, 105 Delhi Road
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Tel: (02) 887 8103

Radiophysics
Chief: Dr D.N. Cooper
Cnr Vimiera and Pembroke Roads
MARSFIELD NSW 2121
Tel: (02) 868 0200

The Australia Telescope—National Facility
Director: Dr R.D. Ekers
Cnr Vimiera and Pembroke Roads
MARSFIELD NSW 2121
Tel: (02) 868 0222

CSIRO Office of Space Science and Applications (COSSA)
Director: Dr G.P. Harris
Cnr North and Daley Roads
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ACTON ACT 2601
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Institute of Industrial Technologies

Director: Dr C.M. Adam
Normanby Road
CLAYTON VIC 3168
Tel: (03) 542 2898

Divisions and Chiefs

Applied Physics
Chief: Dr W.R. Blevin
Bradfield Road
LINDFIELD NSW 2070
Tel: (02) 413 7211

Biomolecular Engineering
Chief: Dr P.M. Colman
343 Royal Parade
PARKVILLE VIC 3052
Tel: (03) 342 4211

Chemicals and Polymers
Chief: Dr T.H. Spurling
Bayview Avenue
CLAYTON VIC 3168
Tel: (03) 542 2244

Manufacturing Technology
Chief: Dr P.M. Robinson
Cnr Raglan and Albert Streets
PRESTON VIC 3072
Tel: (03) 487 9211

Materials Science and Technology
Chief: Dr M.J. Murray
Normanby Road
CLAYTON VIC 3168
Tel: (03) 542 2777

Institute of Minerals, Energy and Construction

Director: Dr A.F. Reid
105 Delhi Road
NORTH RYDE NSW 2113
Tel: (02) 887 8222

Divisions and Chiefs

Building, Construction and Engineering
Chief: Mr K. Martin
Graham Road
HIGHETT VIC 3190
Tel: (03) 252 6114

Exploration Geoscience
Chief: Dr B. Hobbs
Delhi Road
NORTH RYDE NSW 2113
Tel: (02) 887 8630

Coal and Energy Technology
Chief: Dr P.G. Alfredson
51 Delhi Road
NORTH RYDE NSW 2113
Tel: (02) 887 8610

Geomechanics
Chief (acting): Dr G. Price
Kinnoull Grove
SYNDAL VIC 3149
Tel: (03) 881 1285

Mineral and Process Engineering
Chief: Dr R. La Nauze
Bayview Avenue
CLAYTON VIC 3168
Tel: (03) 541 1222

Mineral Products
Chief: Dr T. Biegler
Floreat Park Laboratories
Underwood Avenue
Floreat Park WA 6014
Tel: (09) 387 9200

Institute of Animal Production and Processing

Director: Dr A.D. Donald
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NORTH RYDE NSW 2113
Tel: (02) 887 8222

Divisions and Chiefs

Animal Health
Chief: Dr M. Rickard
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PARKVILLE VIC 3052
Tel: (03) 342 9700

Animal Production
Chief: Dr O. Mayo
Clunies Ross Street
PROSPECT NSW 2149
Tel: (02) 688 0833

Food Processing
Chief: Dr D.J. Walker
39-51 Delhi Road
NORTH RYDE NSW 2113
Tel: (02) 887 8333

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Chief: Dr P.J. Nestel
Gate 13, Kintore Avenue
ADELAIDE SA 5000
Tel: (08) 224 1800

Tropical Animal Production
Chief: Dr D.F. Mahoney
120 Meiers Road
INDOOROOPILLY QLD 4068
Tel: (07) 377 0711

Wool Technology
Chief: Dr K.J. Whiteley
Princes Highway
BELMONT VIC 3216
Tel: (052) 47 2611

Institute of Plant Production and Processing

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Limestone Avenue
CAMPBELL ACT 2601
Tel: (06) 276 6613

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Entomology
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Clunies Ross Street
BLACK MOUNTAIN ACT 2601
Tel: (06) 246 4025

Forest Products
Chief: Dr W. Hewertson
Bayview Avenue
CLAYTON VIC 3168
Tel: (03) 542 2244

Forestry
Chief: Dr G.A. Kile
Banks Street
YARRALUMLA ACT 2600
Tel: (06) 281 8314

Horticulture
Chief (acting): Dr R. Walker
Hartley Grove
URRBRAE SA 5001
Tel: (08) 274 9244

Plant Industry
Chief: Dr W.J. Peacock
Clunies Ross Street
BLACK MOUNTAIN ACT 2601
Tel: (06) 246 4911

Soils
Chief: Dr D.E. Smiles
Clunies Ross Street
BLACK MOUNTAIN ACT 2601
Tel: (06) 246 5937

Tropical Crops and Pastures
Chief: Dr R.J. Clements
306 Carmody Road
ST LUCIA QLD 4067
Tel: (07) 377 0209

Institute of Natural Resources and Environment

Director: Dr R.M. Green
Limestone Avenue
CAMPBELL ACT 2601
Tel: (06) 276 6614

Divisions and Chiefs

Atmospheric Research
Chief: Dr G.B. Tucker
Station Street
ASPENDALE VIC 3195
Tel: (03) 586 7666

Fisheries
Chief: Dr P.C. Young
Castray Esplanade
HOBART TAS 7000
Tel: (002) 20 6222

Oceanography
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Castray Esplanade
HOBART TAS 7000
Tel: (002) 20 6222

Water Resources
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FLOREAT PARK WA 6014
Tel: (09) 387 0200

Wildlife and Ecology
Chief: Dr B.H. Walker
Barton Highway
GUNGAHLIN ACT 2912
Tel: (06) 242 1742

Centre for Environmental Mechanics
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CSIRO's mission

CSIRO's ethos will affirm, above all, the qualities of service and excellence — service to all the Australian people through scientific excellence.

CSIRO seeks to contribute to Australia's quest for enhanced economic performance, living standards, environmental quality and community understanding of science and technology, through excellence, leadership and teamwork in research.

Corporate goals

Research

Plant production and primary products
Improve the international competitiveness and sustainability of rural production systems.

Animal production and primary products
Improve the international competitiveness and sustainability of rural production systems.

Rural-based manufacturing
Improve the competitive position of Australian rural-based manufacturing industries, and add value to plant and animal primary products used as inputs.

Minerals industry
Enhance the international competitiveness, productivity, safety and environmental sustainability of Australia's mineral industry over the next decade.

Energy resources and supply
Increase the efficiency, productivity and safety of Australia's coal, oil and gas exploration and extraction industries to improve their international competitiveness.

Manufacturing industries
Increase the international competitiveness, efficiency and scope of Australian manufacturing industry through R&D with companies able to exploit technological opportunities and enter international markets.

Information and communications industries
Provide leverage for Australian enterprises that add value to goods and services through innovative use of information technology and telecommunications, or that contribute to reducing the trade deficit of the information and communications industries.

Economic development — environmental aspects
Achieve sustainable development in production systems and develop technologies to minimise environmental damage from economic development.

Environment
Develop ecologically sound management principles and practices for the use and conservation of Australia's natural resources.

Infrastructure and services
Enhance productivity and effectiveness in provision of infrastructure and services with particular emphasis on public health, construction and commercial services.

Advancement of knowledge
In undertaking research to advance knowledge, CSIRO will provide a standard for research and teaching, and seek to maintain the currency of the Organisation's intellectual capital base.

Research support

- Further strengthen mechanisms for determining and assessing research priorities and resources allocation across the Organisation.
- Facilitate funding the Organisation's research, provide adequate and cost-effective research accommodation and facilities, develop and maintain efficient computer-based information services, provide legal support services and provide the focus for international relations in CSIRO.
- Maximise CSIRO's capacity to attract and retain an innovative, productive, creative and committed workforce in order to produce the best possible research and development for Australia.
- Increase recognition by government, industry and the general public that CSIRO
  – generates an exceptional return on funds allocated to it by government or invested in it by the private sector;
  – provides authoritative, independent and useable scientific advice on matters of national importance;
  – conducts collaborative research in line with the best international practice.
- Improve Australia's ability to interpret and disseminate scientific and technical knowledge for the economic benefit of our industries.

Research highlights

Planning and reporting of CSIRO research follows the system adopted last year for classifying the purpose of the research.

The system is a modified version of the national research classification used by the Australian Bureau of Statistics. CSIRO has selected sub-divisions that are relevant to science and technology and re-organised them into a form more meaningful to CSIRO. The result is a set of 17 research purposes whose principal objectives are economic development, national welfare or national security. Projects can contribute to more than one research purpose. CSIRO's work in radioastronomy is classified separately under 'advancement of knowledge'.

Purely for ease of reading in this section of the Report, the 16 research purposes and radioastronomy have been grouped into six related sections as follows.

Rural industries

Plant production and primary products: field crops, horticultural crops, forestry, primary products from plants.

Animal production and primary products: livestock, fishing, primary products from animals.

Minerals and energy industries

Minerals industry: exploration, mining and extraction, processed minerals, basic metal products.

Energy resource industries and *Energy supply industries:*, exploration, mining and extraction, preparation and supply, energy transformation, energy distribution, conservation and efficiency.

Manufacturing industries

Rural-based manufacturing: processed food products and beverages, fibre processing and textiles, wood products and furniture, other (processed skins, leather and leather products).

Manufacturing industries: fabricated metal products, transport equipment, machinery and industrial equipment, instrumentation, chemical, pharmaceutical and veterinary products, manufacturing services, ceramics and other industrial products.

Information and communications industries

Information and communications industries: computer hardware and electronic equipment, communications equipment, computer software and services, communications services, and other information services.

Environment

Environment: climate, natural ecosystems, oceans, land use, atmosphere, water resources, environmental impact and protection, other environment.

Economic development — environmental aspects: rural production, minerals, energy resources and supply, manufacturing, construction, transport, commercial services, other.

Infrastructure, services and advancement of knowledge

Construction; Transport; Commercial services; Health ; Social development; Defence; Radioastronomy

Research Achievements & Activities

The selection of achievements and developments described in this section demonstrates how CSIRO is achieving its corporate goals and research objectives. A complete report of the year's activities in all 1,000-plus projects in more than 200 Programs would quadruple the size of this Report. However, a list of Program titles is contained in Appendix 3 of this Report. The list includes the titles of the 17 Multi-Divisional Programs (MDPs) operating this year. Increasingly, CSIRO is looking to assemble multi-disciplinary teams from across the boundaries of its management structure to respond to research problems and opportunities.

A comprehensive account of the whole range of CSIRO's activities can be found in the annual *CSIRO Directory of Research Programs*, which is available both electronically (on the AUSTRALIS database) and as a book (obtainable from the CSIRO Bookshop, 314 Albert Street, East Melbourne, Vic. 3002).

Contents

Manufacturing Industries

Achievements

Developments

Information and Communications

Achievements

Developments

Environment

Achievements

Developments

Infrastructure, Services, Advancement of Knowledge

Achievements

Developments

Rural industries

Achievements

New sheep breed for prime lamb industry

CSIRO has developed a new meat sheep breed with greatly increased reproductive potential.

The work has been carried out over twelve years by the Division of Animal Production, with major funding support from the Meat Research Corporation. The aim of the project was to reduce the costs of prime lamb production by using the high reproduction rates of Booroola sheep.

The Booroola is a strain of Merino sheep in which the Division's scientists discovered the major gene that causes increased ovulation rates. The gene can be transferred into any sheep breed to increase its reproductive rate permanently.

The new sheep breed is mostly Border Leicester with two copies of the Booroola gene. It has been endorsed by the Australian Society of Breeders of British Sheep Ltd as a new breed.

Results obtained in collaboration with the South Australian Department of Agriculture show that the new breed can increase reproductive performance by up to 30 per cent depending on management and season. On current prices, this extra lamb production could be worth millions to the industry. Alternatively, production costs can be reduced by producing the same number of lambs from fewer ewes.

Parasite control in sheep

Internal parasites, such as worms, are a major cost to Australian sheep producers. Current control strategies rely heavily on drugs, but increasing reports of resistance of worms to these drugs, and environmental concerns about chemical residues, make this option less viable.

The Divisions of Animal Production and Animal Health have been studying genetic selection to increase the resistance of sheep to the parasites. Results at the Armidale laboratory are showing that selective

This new sheep breed can increase reproductive performance by up to 30 per cent

breeding to control internal parasites may be a successful long-term control strategy.

Young sheep identified as resistant to one worm species have shown enhanced resistance to a range of other species. This superiority persists into adulthood and is largely inherited in the ensuing generations. So far, the parasites have been unable to adapt to these changes in the host animals.

The Division of Animal Production is now working on methods to help commercial ram breeders to incorporate parasite resistance into their breeding programs.

New test for genetic disorder in cattle

Scientists from the Division of Tropical Animal Production have developed a DNA-based test that, if applied systematically, will lead to the elimination of a serious genetic disorder of cattle.

The disorder, known as Pompe's Disease, is inherited and found mainly in Brahman-based breeds of cattle. Affected animals are unable to metabolise glycogen effectively, so they die soon after weaning. Symptoms include loss of co-ordination, muscular atrophy and cardio-respiratory failure. Carrier animals show no symptoms, making it difficult to reduce or eliminate the disease within herds.

The new test can detect carriers of the disorder from a minute sample of whole blood, semen or skin in less than six hours. Development of the test was made possible after CSIRO scientists isolated the bovine gene responsible for the condition. They were then able to use its DNA information to devise and then evaluate the test in collaboration with the Queensland Department of Primary Industries.

The research work has financial support from the Meat Research Corporation and the Australian Brahman Breeders' Association.

Salmonella-based vaccines

The Division of Animal Health has developed several live vaccines to protect livestock from the notorious Salmonella infection. Apart from causing deterioration in the animals themselves, the Salmonella virus can cause serious illness in humans who eat infected meat.

Tests have shown that the protection given to sheep and cattle by these live, attenuated vaccines is much greater than that given by their non-living counterparts. In sheep, protection lasted for up to six months without any booster shots being needed.

The new vaccines, which are only experimental at present, are non-virulent mutants of Salmonella. They were produced by deleting one or more key genes from the normal Salmonella organism.

The scientists also believe that these new vaccines can be used as a delivery method for other protective agents, such as antigens to kill internal parasites. This is because the live vaccines are able to induce cells to produce immune responses. This idea has yet to be tested but, if it works, could reduce the need to use chemicals in parasite control programs for worms in sheep.

Better predictions for prawn industry

The Division of Fisheries has just completed a six year study of the Northern Prawn Fishery, one of Australia's major fisheries.

The results of this study have increased CSIRO's ability to predict catches and understand the environmental factors that cause fluctuations in numbers of prawns. These predictions are used by industry to aid in fleet deployment, minimise operational costs and maximise export revenue.

Two species of prawn were studied: the banana prawn, *Penaeus merguiensis* and the grooved tiger prawn, *Penaeus semisulcatus*.

Monthly sampling at Albatross Bay in the northeastern Gulf of Carpentaria provided valuable information about numbers of prawns at each stage of their life cycle (eggs, larvae, juveniles and adults), changes in their surrounding environment, levels of fish predation on juveniles and adults, and size and composition of commercial catches.

CSIRO is now in a unique position to use this information to distinguish between environmental factors affecting prawn mortality and those caused by commercial fishing. Managers and industry will be able to identify key habitats for protection and establish long-term sustainable yields against a background of environmental variation and change.

These predictions are the centrepiece of the annual pre-season workshop organised by the Division. These workshops have been cited by the Industry Commission in its report 'Cost Recovery for Managing Fisheries' as a model for liaison between science, industry and management.

Field trials of genetically engineered plants

In mid 1991, CSIRO brought Australia's first genetically engineered plants out of the laboratory into the field for tests. Further trials will be conducted towards the end of 1992 and 1993.

The tests were conducted by the Division of Plant Industry in collaboration with the Queensland Department of Primary Industries. The genetically engineered plants were two potato varieties with a gene for resistance to potato leaf roll virus — a disease transmitted by aphids that dramatically reduces productivity.

Other field trials to be conducted by the Division will include insect and herbicide resistant cotton. Researchers have produced cotton plants with a resistance to the Heliothis caterpillar or bollworm; an insecticidal gene in the leaves of the plants kills the bollworm within 24 hours of feeding. These plants are expected to reach the marketplace within five years. However, insects have the potential to develop resistance to the toxic product of this gene, so much of the Division's genetic engineering research is now directed towards developing additional types of insect tolerance.

Cotton is extremely sensitive to a range of herbicides. Plants have been known to react adversely to the drift of chemicals, such as 2,4-D, sprayed on grain crops up to 60 kilometres away. To combat this problem, the Division has worked with Cotton Seed Distributors Pty Ltd to develop cotton plants tolerant of normal rates of 2,4-D that drift from nearby crops. However, further research is needed to produce varieties that can tolerate 2,4-D being sprayed on troublesome weeds in the cotton crop itself.

All CSIRO fields trials are carried out under conditions specified by the Commonwealth Government's Genetic Manipulation Advisory Committee and the relevant State Departments.

Sunset mandarin

The Division of Horticulture and the Victorian Department of Food and Agriculture have jointly developed a new variety of mandarin. It is the first citrus variety to be granted full protection under Australia's plant variety rights legislation.

The new variety will help the Australian

The Sunset mandarin has both grower and consumer appeal

citrus industry in its quest for greater diversity and increasing emphasis on fresh fruit and fresh juice production.

Sunset mandarin, a hybrid between Imperial mandarin and Ellendale tangor, is an early-to-mid season variety that reaches maturity after Imperial and before Ellendale. It thus usefully fills a gap in the growing season. Sunset's rind has an attractive orange-red colour, hence its name, and is easy to peel so that the fruit can be eaten without making fingers messy. The fruit is very juicy with a mild flavour and few seeds.

These characteristics give the Sunset mandarin consumer appeal; its ability to be snapped rather than clipped from the tree, thus reducing harvest costs, gives it grower appeal as well.

Sunset mandarin will be released to industry in 1993.

Developments

Commercialisation of Linola

Seedex Pty Ltd has become a commercial partner with the Division of Plant Industry in producing and marketing Linola, an edible oil derived from linseed. The development of Linola was described in last year's Annual Report. Seedex will be responsible for all production stages, including growing, crushing and marketing. CSIRO will receive royalties on the oil produced.

Bluetongue test wins world recognition

A CSIRO test to detect bluetongue virus in sheep and cattle has been accepted as a reference procedure by the International Office for Epizootics. The successful development of this genetically engineered test by the Division of Animal Health's Australian Animal Health Laboratory was described in last year's Annual Report.

New sheep and wool laboratory

A $5.8 million Sheep and Wool Research Laboratory was opened in Armidale in February 1992 by the Minister for Science and Technology, Mr Ross Free. It will house 60 scientists and technical staff from the Divisions of Animal Health and Animal

Production. The new Laboratory is a joint venture of the Wool Research and Development Corporation, which provided the money on behalf of wool growers, and CSIRO, which will provide the research skills.

FAO Collaborating Centre

The Division of Animal Health has been designated an FAO (Food and Agriculture Organisation of the UN) Collaborating Centre on helminthology, epidemiology and control, and anthelmintic resistance. The Collaborating Centres form part of a network set up by the FAO to support its international program on animal health by providing information, services, research and training.

Moves in Tropical Animal Production

Following a recommendation made by a review of CSIRO's tropical animal production research, the Tropical Cattle Research Centre in Rockhampton, Queensland, is being upgraded. It will become a major research and extension facility involving units from CSIRO, the Queensland Department of Primary Industries, the University of Central Queensland and possibly other research organisations.

The Division has moved its Molecular Genetics Group from Rockhampton to a new site at the University of Queensland in Brisbane. The move will allow the 12-person unit to liaise more effectively with scientists performing similar work at the University and the Queensland Department of Primary Industries.

Wagga effluent project

The Wagga Wagga Effluent Plantation Project was officially launched in October 1991. Run by the Division of Forestry, the project's aim is to study the effect of treated sewage effluent on plantations of radiata pines and eucalypts. The Division hopes to develop a technology that combines efficient effluent disposal with improved wood production.

The Insects of Australia

A two-volume second edition of *The Insects of Australia*, covering over 85,000 species, was published in November 1991. The book, produced mainly by entomologists in CSIRO's Australian National Insect Collection, describes many new insect families and is the most comprehensive work of its kind in the world.

Minerals and energy industries

Achievements

Industrial refractories

CSIRO's strategic alliance with Queensland Metals Corporation in the exploitation of its massive magnesite resource at Kunwarara, near Rockhampton, is helping to create new industrial and export opportunities for Australia.

The Division of Mineral Products has helped the company and its joint venturers establish one such opportunity, worth an estimated $100 million a year in exports. This is a new plant to produce dead burnt and electrofused magnesia, which is mainly used to make a range of refractory materials that are used to line furnaces and industrial chimneys where resistance to heat is needed. The plant, in Rockhampton, will produce 150,000 tonnes a year. It is owned by Queensland Magnesia Pty Ltd (QMAG), a joint venture between Queensland Metals Corporation, Pancontinental Mining and Radex Austria AG.

After Radex provided the basic technology for the process of preparing refractory grade magnesia from magnesite, CSIRO research with QMAG is now contributing significantly to the optimisation process, particularly in adapting it to the Australian feedstock.

The Division of Mineral Products advised QMAG on the establishment of its laboratory and associated equipment. The Division has developed new sophisticated methods of analysis, such as automated determination of the microscopic crystallite size and grain-boundary phase abundance in dead burnt magnesia. It has also contributed methods of strategic sampling and statistical process control in the plant to improve quality and cut costs.

Exploring for nickel

Australian exports of nickel are worth over $750 million a year. Many of the most productive finds were made in the mid 1960s and during the 'nickel boom' of the early 1970s; exploration since then has continued but with less success.

Research by the Division of Exploration Geoscience has helped to halt this decline in discoveries and has highlighted the potential for finding new nickel deposits in Western Australia, which possesses all of the significant known Australian reserves.

The Division's research has focussed on developing a better understanding of the properties and history of the volcanic rocks that contain nickel and using this knowledge to devise better exploration strategies. The use of these strategies in the Agnew-Wiluna Greenstone Belt has already resulted in new nickel deposits being found in a region previously subjected to nearly 20 years of continuous exploration.

The discovery of nickel deposits in the Mt Keith region of Western Australia by Australian Consolidated Minerals in 1990 can be attributed to a two-year research collaboration with the Division. It is estimated that the Mt Keith region is destined to supply 4.5 per cent of the world nickel market.

Dominion Resources Ltd acknowledges the pivotal role of CSIRO in developing the potential of the Agnew-Wiluna Belt in Western Australia. This area could produce up to 10 per cent of world nickel supply over the next ten years.

Mine planning and visualisation

CSIRO research into mine planning is aimed at more efficient and safer excavations and methods of ore extraction. In particular, user-friendly mine software is being developed to help companies decide precisely how to shape their mines and follow ore contours for optimal extraction and safety.

When underground or open cut mines are being planned, companies set out to extract the maximum amount of ore possible without endangering workers or diluting the ore with the enclosing waste rock. If they can predict the stability of various types of excavation before work is started, a lot of time and possibly lives may be saved.

The mining industry is therefore increasing its use of computer-aided modelling techniques to simulate the behaviour of rock while excavations are being made. The Division of Geomechanics has developed graphics software to help industry make the best use of these models, feed data and interpret results. Two of these programs (FEMCAD and FEMVUE) are now in use at Mount Isa Mines and PASMINCO Broken Hill mines in Australia as well as in Chile, Canada and South Africa.

Research groups aim to incorporate many of the Division's programs into integrated mine design and modelling packages in the near future. These will encompass the display of three-dimensional information like geometry, excavations and rock mass conditions, such as high stress and damage. Visualisation techniques include stereoscopic methods and animated displays including walk-through and virtual reality methods.

In collaboration with other CSIRO Divisions and some private groups, the Division of Geomechanics is also developing a new generation of geological data handling, modelling and visualisation systems.

SIROSIZE

An important factor in the economics of many mining operations is the size of rock fragments produced during the excavation and ore treatment processes. Inadequate blasting produces rocks that are too big to handle easily and require excessive crushing and size reduction. Inefficient overblasting wastes energy and can reduce recovery of the valuable ore.

The Division of Geomechanics has developed a laser-based image processing system that quickly and automatically determines the three-dimensional shape and size of rock fragments on muck piles and fast-moving conveyor belts.

This system will allow better feedback on the quality and effectiveness of mine blasting, tighter control of material processing circuits, and effective and more economical evaluation of the size distribution of rock fragments.

The system is based on a technique known as 'active stereo image analysis'. This involves an inclined planar beam of laser light being projected onto the pile of rock fragments and the resulting distorted light stripe being captured on a video camera. The degree of distortion of the light stripes can be used to calculate the three-dimensional coordinates of illuminated points across the surface of the rock fragments, allowing their sizes to be determined.

The SIROSIZE system is being tested at a number of coal, iron ore and bauxite mines around Australia. It is also being used in an integrated study with an Australian rock crusher in a quarry near Perth, Western

Australia, to help evaluate its prospects for commercialisation.

Helping industry explore for oil

New CSIRO developments will help industry reduce costs and increase the efficiency of its exploration efforts in the hunt for oil.

With the gradual depletion of the giant Bass Strait oilfields, the North West Shelf is poised to become the most important petroleum province in Australia. However, the financial risk involved in drilling off-shore wells in deep water is so great that exploration companies must be confident that their target source rocks have been heated under conditions that have allowed hydrocarbons to be released from buried organic matter (i.e. that the rock strata are thermally mature).

Unfortunately, when traditional methods for determining thermal maturity are applied to North West Shelf sediments, the results are unsatisfactory, with different methods, or even different workers using the same method, giving different estimates.

The root of the problem seems to be the widespread occurrence in North West Shelf sediments of vitrinite (a type of organic matter with considerable ability to generate petroleum) containing an unusually high proportion of hydrogen.

Scientists in the Division of Exploration Geoscience have recently discovered a new way of assessing the thermal maturity of this unusual organic matter by using a laser Raman microprobe to measure its fluorescence properties.

The new technique has now reached the demonstration stage, with twelve Australian petroleum exploration companies supporting pilot studies on North West Shelf wells. It is likely that areas previously classified as non-prospective on the basis of earlier determinations of maturity may be shown to have significant petroleum-generating potential.

In another development, the Division of Mathematics and Statistics has collaborated with a Melbourne company, Geotrack International, to develop a new indicator to help the oil industry select areas for exploration.

When petroleum is created from decayed organic matter it seeps through the surrounding rock, which is often quite porous, until it reaches a barrier that will trap it. The new indicator describes the thermal history of the hydrocarbon source rocks, information that geologists can use to determine when the petroleum was generated. If the indicator shows that petroleum was formed before any traps, then it is likely it has all dissipated and the company may decide to discontinue drilling in that area. However, if the petroleum has been formed later than the traps, continued drilling may be warranted even if previously drilled boreholes have been dry.

The method uses fission tracks in apatite, a widespread but minor component of sedimentary rocks. These tracks are tiny linear regions of damage formed when uranium atoms, an impurity present in most apatites, spontaneously undergo fission. Heat partially repairs the damage, shortening the tracks to an extent that depends on the maximum temperature. Because fission tracks accumulate over time, the track lengths reveal the whole thermal history of the rock.

CSIRO has built a mathematical model of the fission track repair process and used this as the basis of a method of automatically reconstructing the thermal history from the data. Fission tracks are generated in a random three dimensional process so their

reconstruction is not straightforward. CSIRO's statistical input has been crucial to the success of this new technique.

Developments

Coalbed methane

CSIRO and MIM Holdings Ltd have entered into a $10 million, three year research program aimed at developing coalbed methane gas as a new energy source. The Division of Geomechanics/MIM team is studying the factors controlling commercial production of gas from coal seams and will be drilling experimental wells to demonstrate the potential of the energy resource.

It is estimated that Australia has ten times more coalbed methane than conventional natural gas. If coal, oil and other hydrocarbons were extensively replaced by coalbed methane, Australia could reduce significantly its emissions of greenhouse gas, and provide commercial natural gas sources in regions currently remote from conventional deposits.

Magnesium metal project agreement

A $50 million R&D agreement involving the Australian and Queensland governments, Ube Industries (Japan), Mt Isa Mines, Queensland Metals Corporation and CSIRO was signed in June. The agreement launched the Australian Magnesium Research and Development Corporation, which aims to develop the world's lowest cost technology for the production of magnesium metal. Light, strong and recyclable, magnesium could eventually parallel the aluminium industry as a major export earner for Australia.

Senator John Button, Minister for Industry, Technology and Commerce, and Mr Nakahigashi, President of Ube Industries, Japan, test the weight of an engine block built from magnesium, the lightest of all structural metals, at the signing ceremony for a Japanese–Australian joint project funding CSIRO research into the metal

COALTROL commercialised

The Division of Mineral and Process Engineering, working with BHP Engineering and the Australian Minerals Industries Research Association (AMIRA), has commercialised COALTROL, an advanced process control system for coal preparation plants. By using signals from COALSCAN (another CSIRO system for analysing ash content in coal), the COALTROL system makes adjustments in plant equipment to ensure the plant produces coal with the specified ash content. Short-term variations in quality are minimised and plant yield is increased.

Solid oxide fuel cell consortium

A consortium, Ceramic Fuel Cell Limited, has been established to develop a solid oxide fuel cell for the generation of electricity from fossil fuels. The technology is potentially highly efficient and environmentally sound and is well suited to distributed power generation in remote locations. Key research is being conducted by the Division of Materials Science and Technology, where a single cell that uses hydrogen as the fuel has been successfully demonstrated.

Manufacturing Industries

Achievements

Magmotor

The Division of Applied Physics has been developing technology to enable Australian manufacturers to produce supermagnets — high-energy permanent magnets made of neodymium, iron and boron. A local company, AMT (Australian Magnet Technology) has been set up to undertake the commercial manufacture of this material.

Supermagnets have led to significant increases in power and efficiency in electric motors. Also, motors that use supermagnets can be made much smaller for the same power output obtained from conventional motors.

The Division is also involved in a consortium with the School of Electrical Engineering in the University of Technology, Sydney. Known as SEMCOR—Sydney Electrical Machines and Cooperative Research — the venture aims to help Australian industry exploit the commercial potential of supermagnets.

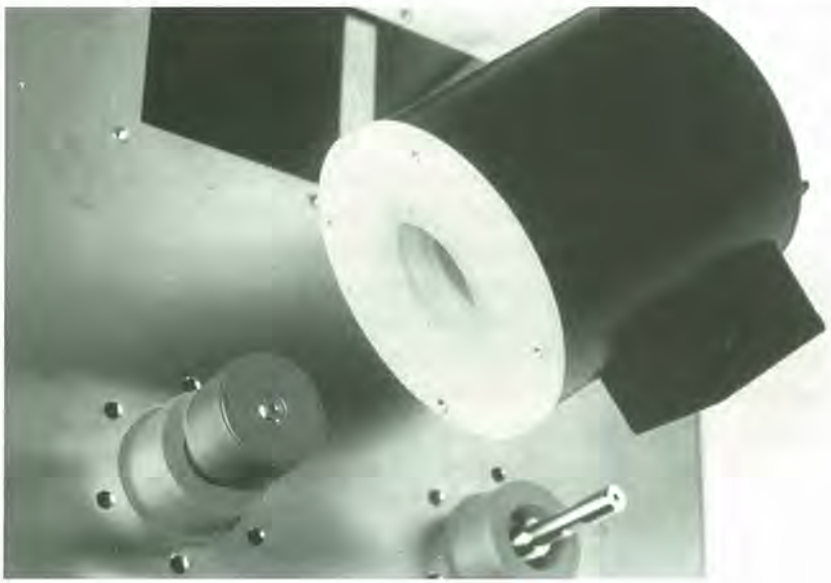
Recently SEMCOR, in collaboration with Filmlab Engineering Pty Ltd in Sydney, developed the Magmotor, a motor that is a major advance in large-scale film processing equipment.

Filmlab has already received an export order for a $1 million machine from a Canadian company that is the third biggest processing laboratory in the world. It has good prospects for further sales and upgrades of existing processing equipment.

High technology structural materials

One outcome of CSIRO materials research for the aircraft industry has been the discovery of new chemicals and polymers with a wide variety of industrial uses.

The aerospace industry is increasingly replacing metals in construction with very strong, lightweight materials made from a combination of polymers and carbon fibres. These advanced composites are generally



A rare-earth permanent magnet motor developed for use in a film processing machine

made by building up layers of carbon fibre cloth, impregnated with a reactive polymer resin, and then curing the assembly in a mould to a strong, stiff but light aircraft part.

The high reactivity of the polymers makes the carbon cloth materials hard to import into Australia, as they must always be kept at minus 20°C.

To overcome this problem, CSIRO scientists, as part of as joint research effort with the Boeing Commercial Aircraft Company, have been developing new polymers and the technologies to impregnate carbon cloths with them. They aim to develop cheaper, tougher and easier to use materials that could help Australian manufacturers of aircraft parts, such as Hawker de Havilland and Aerospace Technologies of Australia, in their production.

During this research, scientists from the Division of Chemicals and Polymers have discovered and patented a range of new chemicals that can be used in a much wider variety of general polymers. New formulations of these products are being developed for composites ranging from those suitable for very high temperature uses in engine parts and mining equipment to those suitable for ambient temperature, high strength use in boats, sporting goods and car parts.

Commercialisation of these discoveries is now under way, with technology being transferred to Australian and overseas companies.

From Gene Shears to Mini-Shears

Researchers from the Division of Biomolecular Engineering have modified the design of the Gene Shears molecule to create a smaller, tougher version dubbed 'Mini-Shears'.

The principle of the Gene Shears approach to inhibiting gene function is the use of a small RNA molecule that interacts with and destroys other RNA molecules that act as messengers in the cell. In diseases such as viral disease and cancer, there are unwanted messages that disrupt the normal processes of information flow in cells. The use of engineered molecules like Gene Shears, that can seek and destroy molecules containing the unwanted messages, provides for exciting new therapeutic possibilities.

The original Gene Shears approach was best suited to introducing a synthetic gene into a cell that encodes a Gene Shears molecule into cells. Reproduction of the gene enables the ongoing production and action of the Gene Shears molecule within the cell.

The researchers involved in the Mini-Shears development hope that its reduced size and toughness will enable it to function when introduced as a 'drug' rather than when manufactured inside a living cell. Mini-Shears can be regarded as a prototype for a range of molecules that could form the basis of new pharmaceuticals.

SAFE-T-CAM

The first field trials of a new CSIRO system to help make Australian roads safer began in New South Wales in April 1992.

A vision technology system, called SAFE-T-CAM, uses infra-red sensor technology to monitor heavy vehicle movement amongst ordinary traffic on multi-lane highways. The unique dual-camera system has been developed by the Division of Manufacturing Technology in collaboration with Telecom Australia and local software developer Iconix.

The SAFE-T-CAM system has been specially designed for 24 hour automatic operation in all road conditions. The system

can be relocated, it emits no radar signals and needs no human interference, unlike current traffic monitoring systems that activate only when sensors or radars are triggered and often require road modification. Its advanced technology enables it to process images in the time taken for a vehicle to move in and out of the camera's sight.

The field tests are being conducted as part of a NSW Road Traffic Authority program aimed at improving road safety.

New timber preservative

A new timber preservative developed by CSIRO and industry reached the market during the year.

It was developed by the Division of Forest Products in collaboration with the company Koppers-Hickson and is being sold as Tanalith Gold timber treatment. The product combines the excellent preserving capacity of the well known copper-chrome-arsenic (CCA) preservative with the weather resistance conferred by oils. It is ideally suited to the treatment of plantation softwoods.

The preservative is known as PROCCA: an emulsion of CCA and a light process oil that has performed well in both pilot and scale-up trials. The treatment is very clean with neither sludging nor efflorescence of salts on the treated timber, effects that occurred in previous attempts to develop such a product. The stability of the emulsion in transport, storage and application is the major factor in the efficacy of PROCCA.

Laboratory tests have shown that the CCA part of PROCCA continues to function against decay fungi and termites, and the oil reduces the effects of weathering, particularly swelling changes and 'checking' caused by uptake of water. Leaching tests have shown that the loss of CCA elements from PROCCA-treated pine is even lower than the very low levels encountered in normal CCA-treated pine.

The market for preservative-treated radiata pine for outdoor use is expected to increase by about 52 per cent by the mid 1990s. The PROCCA emulsion is well placed to secure a substantial share.

Improved wood adhesives

Australia produces more than one million square metres of wood-based panel products a year, and these use over 50,000 tonnes of adhesives.

The Division of Forest Products, in collaboration with Chemplex Australia Ltd, has developed improved fast curing adhesive systems for use in making plywood and panels from pine species. Factory trials have confirmed there is a reduction in press time of at least one-third compared with the time taken to cure conventional adhesives in panels of up to 21 mm thick.

The new adhesive formulation is expected to be used in a wide range of panel products. The Division has already successfully introduced to industry a similar adhesive for use in finger jointing and laminating. Commercial products using this adhesive are showing improved performance.

Developments

Australian Automotive Technology Centre

The Australian Automotive Technology Centre was formally launched at the 1991 meeting of the Federation of Automotive Parts Manufacturers. It has been established

by CSIRO, through its Division of Manufacturing Technology, to co-ordinate and manage collaborative R&D programs for the industry. It will assist in the future development and application of new products, processes and systems, providing Australian manufacturers with competitive advantages in selected local and overseas markets.

Die casting training facility

Australia's first industrial die casting training facility was opened in March 1992. The facility forms a key part of the new die casting technician training program jointly developed by CSIRO, the Australian Die Casting Association and the Royal Melbourne Institute of Technology. The Victorian Education Foundation and the Victorian Department of Manufacturing and Industry Development are providing financial assistance. The facility is at the Preston, Melbourne, laboratory of the Division of Manufacturing Technology.

Active packaging goes commercial

The development of several varieties of 'active' packaging materials was described in last year's Annual Report. This new packaging can extend the shelf-life of many horticultural products, including fruit, vegetables and flowers.

The Industry Research and Development Board has awarded over $500,000 to a CSIRO/industry team for a two year program to develop the technology for the export of horticultural products. Partners in the commercial development are CSIRO's Divisions of Food Processing, Horticulture, and Materials Science and Technology, ANL Ltd, ICI Australia, the Horticulture R&D Corporation and the Flower Export Council of Australia.

Cholesterol reduction

A collaborative development and licensing agreement has been executed with Queensco–Unity Dairy Foods covering cholesterol reduction in dairy products. In addition, AMRAD Corporation has signed an option agreement for the evaluation of treatment of hypercholesterolaemia using CSIRO's cholesterol reduction technology.

Plasma cutting grant

A grant of $581,000 has been awarded by the Industry Research and Development Board to a team from the CSIRO Division of Manufacturing Technology, Farley Cutting Systems Australia Ltd and US equipment manufacturer, Hypertherm Incorporated. The team aims to develop advanced plasma technologies that will provide high quality cutting through improved design and procedures. It also aims to strengthen domestic and emerging international markets. It builds on work by CSIRO in plasma technologies, such as the PLASCON waste destruction system and the CDT-Synchropulse welder.

SIROCLEAR a market success

SIROCLEAR devices have sold in thousands since their release to the world market in Hannover in 1991. SIROCLEAR (described in the 1989–90 Annual Report) is a device that detects dark or stained wool fibres in white wool yarns before they reach the fabric stage. SIROCLEAR gives an estimated cost saving of 90 per cent when compared to current methods of removing faults from fabrics.

Opal cutting robot launched

The world's first opal cutting robot was launched in Melbourne in September 1991. Developed by Sydney opal exporter

Andrew Cody and the CSIRO Division of Manufacturing Technology, the robot should earn Australia millions of dollars annually in processed opal exports now lost to overseas operators. The robot uses cameras and computers to superimpose a design over the image of the rough opal. Data are stored against a bar code number, which is translated by the control computer into precise cutting instructions. Each stone takes a little over a minute to cut compared with ten minutes for hand cutting.

Information and communications

Achievements

New amplifier design

A co-operative research effort between CSIRO and the Defence Science and Technology Organisation (DSTO) has resulted in the successful fabrication of a range of wideband amplifier integrated circuits. These have potential application in military systems and could also have commercial and industrial uses.

The amplifiers have been developed using MMIC technology (Monolithic Microwave Integrated Circuits), which means the complete circuit is built on a single small gallium arsenide semiconductor chip. They provide a gain of about eight decibels between frequencies of one and twenty-five Gigahertz.

The collaborative partners were the CSIRO Radiophysics Division and the DSTO Electronic Warfare Division.

The joint program aimed to give DSTO the opportunity to be involved in the MMIC design process and to obtain experience in using MMIC's in system design.

The designs are based on the Division of Radiophysics' HEMT (high electron mobility transistor) process, which produces individual transistors capable of operating up to 100 Gigahertz.

In separate work, the Division of Radiophysics has designed ten different MMICs that cover frequencies from six to one hundred Gigahertz. Major emphasis is now being placed on developing applications for millimetre wavelengths, an area expected to show significant growth in future electronic communication systems.

Intellitext

The Division of Information Technology is creating a software toolkit for developing 'active' electronic documents capable of integrating text, graphics, video, animation, sound and software programs.

As its first test, the Division has produced an electronic version of the book, *The Knowledge Dictionary*, which will be commercialised as *Intellitext* by Academic Press (UK) Ltd.

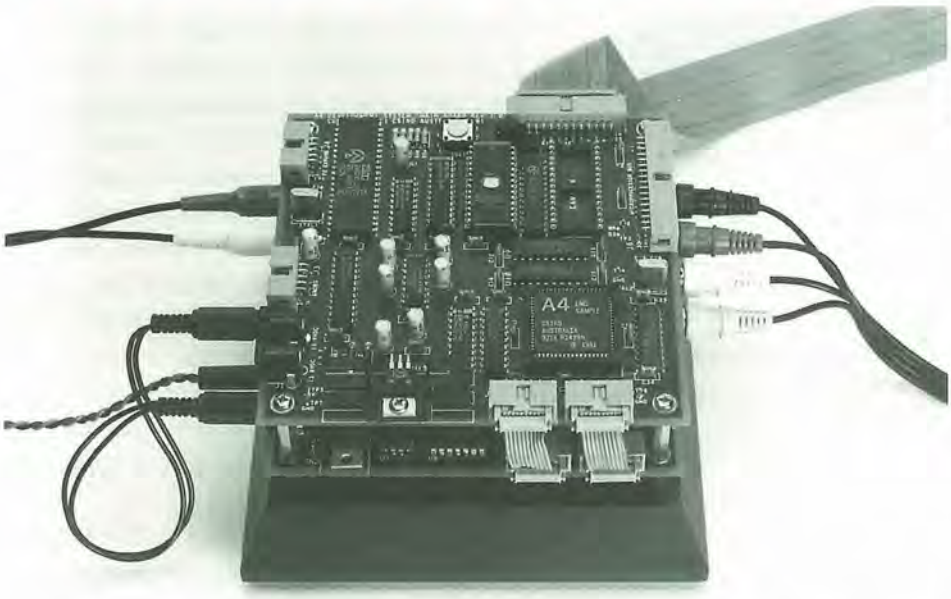
An *Intellitext* reader can interact with the document, read it in various ways, add information or flag desired pathways for gathering information. For example, the reader may view graphs in various ways or explore their underlying numeric data as tables.

Intellitext is based on new information technologies such as hypertext and multi-media, the integration of text, sound and graphics. Unlike a hypertext document, which provides unlimited and therefore often confusing ways of accessing information, an 'active' book like *Intellitext* offers multiple, but defined pathways. Readers may also change the information or pathways to meet personal preferences.

A4 chip

The Division of Radiophysics has designed a low-cost microchip that produces high quality sound in car audio systems. It is negotiating with several Australian companies for commercial production of the chip and design of products.

The microchip, known as the A4, provides acoustic equalisation for car interiors as well as generating spatial effects that simulate conditions in other environments such as concert halls. This VLSI (Very Large Scale Integrated) chip is based on digital signal processing technology pioneered by CSIRO in this country.



The A4 microchip produces high quality sound in car audio systems

The potential world market for A4 chips in the car audio industry alone is over $60 million a year and, at present, there is no known competing product. Alternative systems providing equivalent performance to the A4 have to contain a number of expensive, digital signal processing chips.

The A4 is a powerful adaptive processor that has many other possible uses in telecommunications and other areas that use general digital signal processing.

Developments

Mobilesat antenna technology developed

Last year's Annual Report described the development, by the Division of Radiophysics, of a low cost antenna for users of the Mobilesat service to attach to their vehicles. This year, a three-year collaborative research and licence agreement was signed with MITEC Ltd for the development of antennas for application in the Optus, Inmarsat and American Mobile Satellite Corporation LMSS systems. The Australian Space Office is providing financial support, and another Australian company, CODAN Pty Ltd, will be involved in international marketing activities.

CSIRO and ARC CADCENTRE partnership

ARC CADCENTRE and CSIRO, through the Division of Information Technology, have signed a technology partnership agreement expected to consolidate Australian leadership in spatial information systems. The agreement gives ARC CADCENTRE access to CSIRO's expertise to help integrate their object-oriented spatial information systems.

Interscan sold to China

Interscan, the microwave aircraft landing system originally developed by the Division of Radiophysics in the early 1970s, has been sold to China in a deal worth $2 million. Interscan International, the development and marketing company, has also sold the system to several private airports in the US and Spain and has a contract to develop Interscan for Australian airports.

Environment

Achievements

Monitoring sewage

The treatment and management of sewage is a problem that concerns many of our fast growing cities. CSIRO is conducting several research projects aimed at providing new techniques to help water and sewage agencies overcome difficulties. This year, two developments have emerged that will provide essential information to authorities much more quickly than has been possible before.

The first is SEWER SENTINEL, a waste water monitoring system that will allow sewage authorities to monitor and manage the quality of discharges more effectively.

The unlicensed disposal of toxic waste materials into the sewer networks of cities is a recurring problem. Toxic materials, such as poisonous organic chemicals and heavy metals, can harm staff working in sewer operations. They can also temporarily disable treatment plants, accumulate within the plant itself and contaminate the environment at the discharge point. Corrosive wastes can accelerate the degradation of the concrete infrastructure of the sewer network.

The Division of Materials Science and Technology, in collaboration with the Division of Chemicals and Polymers, has developed the new monitoring system to help alert sewage treatment authorities to discharges of such materials. The research was funded by a grant from the Urban Water Research Association of Australia and Melbourne Water.

The SEWER SENTINEL continuously samples sewage from a wet well or treatment plant and measures such water quality features as temperature and acidity. If any large discharge from an industrial source occurs, the SEWER SENTINEL compares it with the normal background flow pattern, sounding the alarm if an unusual flow is present. Samples can then be taken, which can help trade waste officers trace the offending company through chemical analysis.

The SEWER SENTINEL has been extensively tested in Melbourne and is currently being licensed for manufacture by an Australian company.

In the second development, scientists from the Division of Coal and Energy Technology have developed a simple, rapid 'early warning' test for detecting sewage pollution in seawater.

The pollution of bathing waters by sewage is a serious problem in many areas of Australia and needs to be monitored by authorities. A big problem with monitoring is that the laboratory procedures for measuring pollution, by growing and counting faecal coliform bacteria in samples, can take more than 24 hours. This is not very helpful when bathers want to know whether it is safe to swim that day.

The new CSIRO method takes only 60 minutes. It operates by detecting an enzyme that is found in coliform bacteria but not in marine bacteria.

The test is at present undergoing detailed trials in collaboration with the Sydney Water Board and the New South Wales Environment Protection Authority.

The eventual aim is to develop a portable kit so that the test can be carried out close to the beach, ideally in the back of a car. Apart from its use in Australia, the new test has great potential for export to other countries where coastal sewage pollution is a problem.

Rabbit and fox control

Rabbits and foxes have seriously depleted numbers of native animals in Australia through altering their habitats and by preying on them.

Conventional means of controlling rabbits and foxes are designed to increase mortality rates by spreading poison, ripping warrens and causing damaging or fatal diseases.

CSIRO is now investigating an entirely new way of control that reduces fertility by using a virus to spread a contraceptive agent through the pest populations. This new method has been made possible by recent scientific advances in understanding mammalian reproduction and in the development of recombinant viruses.

The essence of this approach is to provoke an immune reaction in the host mammal to proteins that are essential to fertilisation in that particular species. As the virus spreads among the population, infected animals will become infertile but still continue to occupy territory and prevent others from breeding.

The initial research for this has been carried out by the Division of Wildlife and Ecology, financially supported by the Wool Research and Development Corporation and the Australian National Parks and Wildlife Services. Support for the program has recently been considerably enhanced by the establishment of the Cooperative Research Centre for Biological Control of Vertebrate Pest Populations. This CRC involves the Australian National University, the Agriculture Protection Board of Western Australia, the Western Australian Department of Conservation and Land Management, and CSIRO (Division of Wildlife and Ecology).

Greenhouse gas release from agriculture

Scientists at the Division of Atmospheric Research have completed a study of greenhouse gas emissions from soil in a project partly funded by the Victorian Government Greenhouse Unit. The preliminary results are being used to indicate how agricultural activities affect gas emissions from soil and to estimate Australia's greenhouse gas budgets.

Two sites in the semi-arid Mallee region of Victoria were selected. At one site the land is in a natural, untouched state, covered with eucalypts and spinifex. A few kilometres away, the other site has been intensively farmed for sixty years. Recently, wheat has been grown and fertilised with superphosphate and weeds have been controlled with herbicides. The soil type at both places was the same.

The scientists monitored the movement into and out of the soil of the greenhouse gases carbon dioxide, nitrous oxide and methane as well as carbon monoxide and oxides of nitrogen. They found that in autumn and winter, gas movement through soil was higher in the untouched area than at the farmed site. However, seasonal changes made much more difference to gas movement than any differences between locations. Rainfall also increased the rate of gas emission because of increased microbial activity in the soil.

Methane is absorbed by soil and then oxidised. Measurements showed that the amount of methane being consumed by natural processes in soils is considerable — about the same amount as the methane produced by livestock in Australia.

Nitrous oxide, on the other hand, is emitted from the soil. Emission rates from the two sites were low but the sheer amount of semi-arid land on earth is so large that it is probable emissions from such areas make a substantial contribution to the global nitrous oxide balance.

Monitoring greenhouse gas emissions from soil in a wheatfield in the Mallee region of Victoria

The Centre for Environmental Mechanics is exploring ways of measuring methane emissions from rice fields, using new techniques pioneered by the Centre.

These methods rely on free-standing instruments that give an accurate reading for the whole field environment, instead of the former method of taking measurements from inside small box chambers which tend to interfere with the local microclimate.

The measurements, the first such in the world, have given emission rates in the lower end of the range reported for Asian rice paddies. They confirm previous estimates that rice cultivation contributes only a very small proportion of Australia's man-made methane emissions, probably less than 20 per cent.

Acid drainage from estuarine soils

A research team from the CSIRO's Centre for Environmental Mechanics and the University of New South Wales is studying the process of acid drainage in canefields in the Tweed River area.

Six years ago, professional fishermen in northern New South Wales encountered a carpet of dead and dying fish along the upper two-thirds of the Tweed River's tidal reaches. The cause was unknown but suspicion fell on run-off from local mines and quarries, overflow from the Murwillumbah sewage works, or pesticide run-off from canefields. The phenomenon recurred two months later and similar fish kills were reported in other northern rivers.

The cause, however, was discovered to be natural and not man made. It stemmed from a period of global warming six thousand years ago. Seas rose, marine sediments inundated coastal mangroves and biological activity in the protected tidal flats resulted in the gradual build up of iron sulfide (commonly called iron pyrite) in the soil.

Early surveys by the research team indicated the presence of 500,000 tonnes of pyrite in the Tweed Valley alone; later tests have shown this may be an underestimate. The pyrite is normally cut off from air by

water, but when human activity such as tourist development, agriculture or mining exposes the soil to air, the pyrite reacts to form sulfuric acid. The acid frees aluminium locked in the soil and heavy rainfall washes the acid and concentrated aluminium out into rivers and estuaries, where it clogs the gills of fish and kills them.

CSIRO believes simple solutions to the problem can be achieved through changes in land use. If water tables are maintained so that the pyritic soil is not exposed to air and land surfaces are engineered to remove surface water quickly, there should be fewer fish kills.

The Southern Ocean and climate

Scientists from the CSIRO Division of Oceanography, with significant support from the Antarctic Division (Department of Arts, Sport, Environment and Territories) have completed a major marine science cruise to the Southern Ocean.

Tests have shown that acid drainage in canefields in the Tweed River area had a natural cause

This is part of a seven year World Ocean Circulation Experiment to help oceanographers and marine chemists understand the impact of the Southern Ocean on the planet's climate. Collaborators in this experiment include Japan, Canada, France, China and the USA.

Several milestones were achieved. The first end-of-winter cruise between Australia and Antarctica, using modern oceanographic instruments, was completed. This was an achievement in itself.

Oceanographers made the first CFC measurements in waters south of Australia. These measurements will indicate the origin and age of the southern waters, revealing how ocean heat is transported from one part of the Earth to another.

Other achievements included the measurement of the rate of absorption of carbon dioxide into the Southern Ocean, and how this varies seasonally; and the amount of heat and carbon dioxide flowing between the Indian and Pacific Oceans.

Further research on the Southern Ocean will be carried out by the Division of Oceanography in conjunction with its partners from the recently opened Antarctic Cooperative Research Centre at the University of Tasmania.

Developments

$3M boost for toxic algal blooms

CSIRO is boosting its research effort into preventing and treating toxic algal blooms by $3 million over the next three years.

This will double the amount CSIRO spends each year directly on the problem.

The presence of toxic algal blooms in Australia's waterways came to prominence in late 1991, when many rivers and lakes in throughout the country were found to be severely affected.

Although toxic algal blooms are not new — infestations were reported last century — the extent and frequency of the 1991 occurrences concerned water supply authorities.

CSIRO scientists will now be spending a total of $6 million over the next three years to investigate long and short-term solutions to the toxic algae threat. The extra research effort involves the Divisions of Water Resources and Fisheries, and the Centre for Environmental Mechanics.

Eight agency representatives were involved in advising CSIRO on priorities for this new research. Agreed priorities include:

- strategies and new techniques for monitoring algal blooms;
- nutrient cycling, including sources of phosphorus and sediment-water interactions;
- flow management and release of water from dams;
- toxicity, toxicology and water treatment to remove toxins.

The new research is aimed at understanding, preventing and treating algal blooms and will complement work already being carried out in CSIRO and within State water authorities and agencies.

SIROFLOC pilot plant in UK

A contract has been let by Yorkshire Water in the United Kingdom to build a 75 megalitres a day **SIROFLOC** plant at Rivelin, near Sheffield. This turnkey plant for potable water is to be built under licence by Davy John Brown and will be the largest of its kind in the world when completed in 1994. The **SIROFLOC** process for purifying drinking water was developed by the CSIRO Division of Chemicals and Polymers.

Agreement with the Sydney Water Board

CSIRO and the Sydney Water Board have negotiated a five-year $10 million Memorandum of Understanding to conduct joint research. One top priority will be further studies into the action of ocean currents off the New South Wales coast. Other research will focus on areas such as stormwater and sewage movement and treatment; catchment behaviour; and the allocation, reticulation, recycling and re-use of water.

Toxic waste destruction trials begin

The first PLASCON waste destruction unit was commissioned in March 1992 at Nufarm Limited's Laverton North plant in Victoria. The PLASCON process, developed by the Division of Manufacturing Technology, uses an electric arc to generate very high temperatures that break down toxic industrial wastes into safer compounds that can be recycled or disposed of safely. The pilot plant at Nufarm is undergoing a series of industrial trials, supervised by technicians from Nufarm and CSIRO.

Jervis Bay study concludes

An environmental study of Jervis Bay, south of Sydney, New South Wales, led by the Division of Fisheries, has provided the scientific information needed to manage and monitor the area. (This study was reported in the 1988–89 Annual Report).

The southern parts of the Bay have recently been nominated for National Park status. Other parts of the Bay and nearby areas will include an armaments depot for the Navy, and commercial and local government developments. The monitoring program is

designed to be adaptive to the needs of environmental managers, and will be available for use by the Department of Defence and the Australian Parks and Wildlife Service, the two major managers of the Bay.

CLEVER CLOVER

CSIRO's CLEVER CLOVER kits , designed for backyard gardens, have been one of the most publicised projects of the year. Over 11,000 kits have been bought and much prominence given in the media to the topic of soil degradation.

CLEVER CLOVER is a new approach to remedying soil degradation. It uses a clover and lucerne mulch crop to reduce the amount of digging — and hence soil degradation — in vegetable gardens. The roots of CLEVER CLOVER create small tunnels that allow water and air to circulate freely in the soil. The clover increases the nitrogen content of the soil, and the mulch that results when the clover crop dies off protects the soil from the elements. It was developed by the Centre for Environmental Mechanics, the Division of Plant Industry and Sydney University's Department of Crop Science.

Coastal zone studies

CSIRO has established a multi-Divisional program to study the areas of Australia possibly under the greatest environmental pressure of all — the coastal zone. The program aims to quantify the effects of human impacts on catchment-estuary systems, to produce tools to manage the problems that ensue, to provide these tools to users and to produce a coherent information base for future management of the Australian coastal zone.

Land Cover Change Project

1992 is being celebrated as International Space Year. One of its themes is 'Mission to Planet Earth', aimed at demonstrating the practical and constructive benefits of space exploration.

As part of this effort, CSIRO is co-leading the Global Consequences of Land Cover Change Project with cooperating organisations in France and the Commonwealth of Independent States. The Australian work, conducted by the Division of Wildlife and Ecology, will culminate in November 1992 in the production of a book, video and compact disk showing how earth observation satellite data of Australia can be used in land management and environmental protection.

Catchment planning

A CSIRO decision support system to improve catchment management has been used by the South Australian Engineering and Water Supply Department to evaluate policies developed in response to a water quality problem in Adelaide. The Sydney Water Board is now interested in using this system to assess the impact of further urban growth on the Hawkesbury/Nepean catchment area.

Award for farm software

The Division of Water Resources has developed a PC-based program to help agencies and farmers make the best use of water and land in irrigated areas. The program, SWAGMAN-WHATIF, shows the consequences of various irrigation practices on groundwater levels, rates of soil salinisation and crop yields. SWAGMAN-WHATIF won first prize in the NSW Royal Agricultural Society Farm Software Competition at the 1992 Royal Easter Show.

Infrastructure, services, advancement of knowledge

Achievements

Better transport planning

Planning of rail and road routes has been improved by new CSIRO computer software that selects and evaluates many possible alternatives.

Constructing a road or railway is expensive, partly because so many factors can have an impact on the best alignment of the route. Planners and designers need to consider the terrain and geology of the proposed route, the location of features such as rivers and existing roads, zones that require special treatment for environmental or social reasons, and geometric standards for construction.

The ALIGN 3D design package has been developed by the Division of Building, Construction and Engineering to integrate all these factors and propose the best selection of alternatives. It automatically explores the proposed transport corridor and optimises the alignment of a route more thoroughly than is possible by using a conventional design package interactively. It presents the user with a selection of low cost routes that meet all the objective criteria. The user can then use any design package to modify the selection made by ALIGN 3D to satisfy their assessment of what constitutes the proper balance between cost and a 'good' design.

ALIGN 3D can produce a set of twenty or more alternative alignments in a matter of hours compared with the days or weeks needed for each alignment made using conventional methods. It can achieve savings in construction costs of up to 30 per cent or more, depending on the terrain.

ALIGN 3D has been used on projects as diverse as sections of the proposed Very Fast Train route between Sydney and Melbourne, and ore haulage roads in the rugged Pilbara country of Western Australia.

Protecting telecommunications services

AOTC (formerly Telecom Australia) aims to provide a cost effective and reliable telecommunications network for the whole of Australia. The company has chosen optical fibre cable as the best means to provide this service. However, this technology introduces a problem of its own: cable performance can be dependent on the stability of the soil in which it is buried.

Australia has extensive areas of soils that are not stable, so Telecom asked for help from the CSIRO Division of Soils in identifying soils that might damage optical fibre cables.

Scientists have been able to provide specific advice on selecting alternative routes to avoid shrink-swell clay soils. They have also outlined methods of stabilising highly swelling clay soils along existing and proposed optical fibre cable routes.

Continuing research aims to develop a model to predict the combined influences of soils, vegetation and climate on these types of cables.

Cholesterol differences in men and women

Research by the Division of Human Nutrition has shown that men are poor at coping with a typical Western diet rich in fat and cholesterol, while women have developed some defence against it.

Cholesterol in the blood is found attached to two main particles — low density

A team using the Parkes radio-telescope discovered ten new fast 'millisecond' pulsars. Pictured is *Tucanae*, the globular cluster in which they were found

lipoproteins (LDL), which promote heart disease, and high density lipoproteins (HDL), which protect against it.

In women with a high fat, high cholesterol diet, a rise in harmful LDL levels is accompanied by an equal rise in protective HDL levels. Men on the same diet show a greater rise in harmful LDL and a far smaller rise in HDL. Older and heavier men had the worst response but women could age and put on weight without losing their advantage.

However, in both men and women, if blood cholesterol was already high, then a high fat, high cholesterol diet produced even further rises in LDL.

This study was performed in Adelaide on healthy volunteers. Men and women were selected so that they matched each other exactly in age, body mass index, blood cholesterol and triglyceride. They were placed on a low fat diet for eight weeks, and then for three weeks took a daily milkshake containing fat and cholesterol, followed by a fat-free milkshake for another three weeks. Blood cholesterol was measured on several occasions at the end of each period.

The research demonstrates the need to aim public health advice at people with clearly definable risks. One broad message given to the public at large will not be as effective as tailoring advice to suit people with different risk characteristics.

Very fast pulsars discovered

In July 1991 a team using the Parkes radio-telescope announced the discovery of ten new fast 'millisecond' pulsars. The discovery more than doubles the known number of such pulsars.

Pulsars are neutron stars — the collapsed cores of dead stars. They spin and at the same time send out a beam of radio waves, rather as a lighthouse sends out a beam of light. When the beam passes over the Earth, we see a 'pulse' of radio waves.

Most pulsars spin at less than ten times a second, but there are a few very fast 'millisecond' pulsars, which rotate at 200–600 times each second; they are the fastest spinning objects in the Universe.

The new pulsars were found in a globular cluster of stars on the fringe of our galaxy. The discovery implies that much of the mass of this cluster may be in the form of neutron stars.

The Parkes study also discovered the first known example of a pulsar and a young, bright star orbiting each other. The Australia Telescope Compact Array pinned down the position of the binary system, then the companion star was identified on optical pictures. This system may represent a link between 'normal' young pulsars, (which are thought to be formed when a star explodes) and the much older, millisecond pulsars, which are thought to have been spun up or 'recycled' in binary systems.

Developments

Nutritional pharmacology program

The Division of Human Nutrition has started a new program of research that is likely to become the major centre in Australia for research on nutritional pharmacology and diet-drug interactions. The merging of foods, nutrients and pharmaceuticals in selected areas of health care widens the potential range of health benefits and value-added business opportunities for the food and pharmaceutical industries.

This topic was the major theme of the Fifth National Food Conference, an event organised annually by the Division of Human Nutrition, and held in Adelaide in August 1991.

Better Cities program

In October 1991, CSIRO's Chief Executive and three Institute Directors gave a presentation to the Deputy Prime Minister, Mr Brian Howe, on CSIRO capabilities and research in relation to the objectives of the Government's 'Better Cities' program. CSIRO will be taking into account the objectives of this Program when planning and conducting related research activities.

Commercial test kits

The Division of Plant Industry has developed two commercial applications from its work with monoclonal antibodies. The first is a kit that enables doctors to detect coeliac disease in patients more accurately than current tests can. Coeliac disease is an intolerance to the glutein protein present in most cereals and in some cases can be fatal if left untreated. The kits will be made and marketed by Medical Innovations Pty Ltd.

The second kit enables farmers and others to test produce for pesticide residues. It has been developed in conjunction with the Grains Research and Development Corporation and will be manufactured by Immunosystems Inc. and Millipore Australia Pty Ltd.

Land Information Systems agreement

The Division of Information Technology and the South Australian Department of Lands have signed a Memorandum of Understanding to pursue research into the development and use of the next generation of land information systems.

The agreement gives LANDS SA access to CSIRO expertise in the development of spatial information systems, and gives CSIRO an opportunity to apply and further develop this technology as a core component of large commercial products and services for the domestic and international marketplace in urban infrastructure.

Co-operative Research Centres

CSIRO is a partner in 29 of the 35 Co-operative Research Centres (CRCs) announced by the Commonwealth Government in March and December 1991. Under the CRC Program, initiated by the Government in May 1990, up to 50 CRCs will be established with total funding rising to $100 million a year by 1995.

The CRC Program's objectives are:

- to support long-term, high quality research that will contribute to national objectives;
- to capture the benefits of research and to strengthen links between research and its users by involving research users in the work of the CRCs;
- to encourage concentration of research by promoting co-operative research;
- to stimulate education and training.

A university must feature in each application, with partners from CSIRO, State Departments and industry wherever possible. Industry support for CRCs is emphasised wherever possible.

CSIRO has been involved in approximately 170 of the applications, each of which was assessed to ensure that it was consistent with research priorities determined by CSIRO and that an appropriate commitment of resources could be made during the period of the program.

The areas covered by the CRCs in which CSIRO is involved are:

First round CRCs: Aerospace Structures; Antarctic and Southern Ocean Environment; Australia's Petroleum Industry; Cellular Growth Factors; Eye Technology; Extractive Metallurgy; Intelligent Decision Systems; Mining Technology and Equipment; Plant Science; Robust and Adaptive Systems; Soil and Land Management; Temperate Hardwood Forestry; Tissue Growth and Repair; Tropical Pest Management; and Waste Management and Pollution Control.

Second round CRCs: Materials Welding and Joining; Polymer Blends; Optical Fibre and Photonic Technology; Molecular Engineering and Technology; Cardiac Technology; Tropical Plant Pathology; Industrial Plant Biopolymers; Viticulture; Hardwood Fibre and Paper Science; Legumes in Mediterranean Environments; Australian Mineral Exploration Technologies; Hydrometallurgy; Catchment Hydrology; Biological Control of Vertebrate Populations.

The third round of successful applications will be announced in late 1992. CSIRO is involved in approximately 50 of these applications.

The process of consultation over the CRC applications has been positive, reinforcing existing collaboration and forming new collaborative activities between CSIRO and other partners.

International relations

CSIRO Chief Executive, Dr John Stocker, travelled to China in June 1992 to visit a number of centres where projects are being managed by CSIRO on behalf of Australia's aid agencies, the Australian Centre for International Agricultural Research (ACIAR) and the Australian International Development Assistance Bureau (AIDAB). He visited forestry research projects and projects that will provide technical facilities for improving water treatment, animal health and agricultural education. During the visit, Dr Stocker signed an arrangement formalising a longstanding relationship between the Guangdong Entomological Institute and the CSIRO Division of Entomology. He was also pleased to identify some new opportunities for strengthening commercial links between the two countries.

Australia's decision to rejoin the United Nations Industrial Development Organisation (UNIDO) on 1 January 1992 was welcomed by CSIRO in anticipation of increased support for international activities. In particular, the number of UNIDO-funded vocational trainees placed each year by CSIRO is expected to increase as a result.

Activities under the newly-signed Arrangement between CSIRO and the National Research Council of Italy began when three scientists from the Division of Biomolecular Engineering, including its Chief, attended a conference in Capri.

During the year, CSIRO received important visitors from Korea including Dr Bae Soonhoon, President of Daewoo Electronics, Dr Cho Wan-Kyoo, the former President of the University of Seoul—who has since become Minister of Science—and representatives of the Korean Science and Engineering Foundation (KOSEF). CSIRO staff also visited Korea. These exchanges reflect the growing interest in both countries in developing closer research and development linkages.

A notable visitor to CSIRO was Mr Isao Uchida, President of the Japan Marine Science and Technology Centre (JAMSTEC). Recent policy changes mean that JAMSTEC will develop its basic oceanographic research capacity, bringing its interests closer to those of the CSIRO Division of Oceanography. Mr Uchida discussed with the Chief Executive and the Chief of the Division of Oceanography opportunities for collaboration. As a result, the Chief has been invited to a symposium in Japan to develop possible multi-organisational collaboration in the tropical Pacific region.

CSIRO and the Department of Industry, Technology and Commerce will discuss at a workshop early next financial year a framework for considering priorities and strategies for the international aspects of research and development. On this basis, CSIRO plans to incorporate an international dimension into its research priorities exercise next year.

Awards

The Chairman's Medal and CSIRO Medals

The 1991 Chairman's Medal and CSIRO Medals were presented on 27 November 1991 by Mr Neville Wran AC QC, Chairman of the CSIRO Board.

The winner of the inaugural Chairman's Medal was Dr Peter Room of the CSIRO Division of Entomology for his work on the biological control of the water weed *Salvinia molesta*.

The CSIRO Medals were awarded to:

- The Viticulture Group, CSIRO Division of Horticulture, for developing new technologies for the mechanisation of Australian viticulture (Dr John Possingham, Mr Peter Clingeleffer, Mr George Kerridge and Mr Max Sauer);
- Dr Robin Hill, leader of the Ore Genesis Group, CSIRO Division of Exploration Geoscience, for nickel exploration research;
- Mr Bill Trahar, CSIRO Division of Mineral and Process Engineering, for developments in the flotation method of mineral separation;
- Professor Graham Farquhar, Research School of Biological Sciences, Australian National University, for research in plant physiology and its application to agriculture.

The winner of the Chairman's Medal, Dr Peter Room, with CSIRO Chairman Mr Neville Wran

CSIRO Medallists 1991 (l to r): Dr R La Nauze (for Mr Bill Trahar), Dr J Possingham, Mr P Clingeleffer, Mr G Kerridge, Professor G Farquhar, Mr Neville Wran (Chairman, CSIRO), Dr John Stocker (Chief Executive, CSIRO), and Dr R Hill, Dr S Barnes, Ms S Dowling and Dr M Gole (Ore Genesis Group)

Sir Ian McLennan Award 1991 (l to r): Sir Peter Derham (Chairman, Board of Management, Sir Ian McLennan Award Trust); Mr Don Beech, winner; Mr Neville Wran (Chairman, CSIRO); Dr John Stocker (Chief Executive, CSIRO)

Dr Hal Hatch

Sir Ian McLennan Achievement for Industry Award

This award was established by the former CSIRO Advisory Council in 1985 to recognise outstanding contributions by CSIRO scientists to Australian industry.

Winner of the Award in 1991 was Mr Don Beech of the Division of Tropical Crops and Pastures, for his contribution to the establishment of the chick pea industry in Australia

International Prize for Modern Biology

Dr Hal Hatch of the Division of Plant Industry was awarded the International Prize for Modern Biology for his work in the discovery of the mechanism and function of the C4 photosynthesis pathway. Dr Hatch travelled to Japan in November, where the Japanese Emperor, Akihito, presented him with the award and 10 million yen ($A95,273) in prize money.

The Australia Prize

The 1992 Australia Prize for scientific and technological excellence was awarded to CSIRO scientists Mr John Watt, Dr Brian Sowerby and Dr Nicholas Cutmore of the Division of Mineral and Process Engineering, and Dr Jim Howarth, Managing Director of the Adelaide-based firm Mineral Control Instrumentation Ltd.

The prize, worth $250,000, is presented annually by the Prime Minister to acknowledge outstanding achievement in science and technology promoting human welfare.

The achievement honoured by the 1992 Prize is development of a range of instruments for the on-line analysis of minerals and coals moving as solids on conveyor belts or as slurries. Sales of the systems have already topped $50 million. Benefits to Australia from enhanced coal marketing are estimated at another $50 million a year.

The winners of the prize were praised for their innovation, sensitivity to the needs of industry and entrepreneurial flair vital to the Australian economy during the next few decades.

The CSIRO members of the Australia Prize-winning team (L to R): Dr Nicholas Cutmore, Dr Brian Sowerby and Mr John Watt

Commercialisation highlights

- A $10 million agreement to develop technology to extract coalbed methane gas (see p. 33);
- A $50 million agreement to develop a magnesium metal industry (see p. 33);
- An agreement to develop and demonstrate active packaging technology (see p. 38);
- An agreement for the development of Mobilesat antennas (see p. 41);
- An agreement covering cholesterol reduction in egg products (see p. 38);
- A commercial arrangement for the production and sale of Linola edible oil products (see p. 28);
- A $10 million Memorandum of Understanding with the Sydney Water Board to conduct joint research (see p. 46).

CSIRO Institutes and Divisions use a number of mechanisms to promote the transfer of information and technology. They range from the use of print and electronic media, staff exchanges, the provision of the latest technical information to industry and the community through specialist staff, participation in industry committees and workshops with industry groups, to fully-fledged commercial partnerships.

Almost all Divisions employ a business manager whose task it is to work with business — to see that any matter involving or likely to involve commercial use of research results is handled effectively. The tasks of the business manager include arranging patent protection and negotiating collaborative and licence agreements, with the assistance of SIROTECH Ltd, CSIRO's commercial arm, depending on the complexity of the case.

An example of a major technology transfer activity this year has been the Division of Plant Industry's fellowship scheme enabling sponsors to support research. A fellowship can be devoted to a specific field, related to the business system of the sponsor, or to an individual researcher. A number of fellowships have been established:

- The Yasuko Hiraoka Myer Fellowship 1: drought-induced genes in plants;
- The Yasuko Myer Fellowship 2: reporter genes for genetic engineering;
- The Cotton Seed Distributors Fellowship: insect and herbicide proofing of cotton;
- The Goodman Fielder Wattie Fellowship: fatty acid metabolism in oilseeds;
- The CSBP Fellowship: improving yield of pastures in south western Australia;
- The Vincent Fairfax Foundation Fellowship: plants for management of acidity-prone land;
- The Coca Cola Amatil Fellowship: precision genetic engineering of potatoes;
- Pulp and Paper Manufacturers of Australia: genetic engineering for sterility and insect resistance in temperate eucalypts.

On the international stage, the Globe '92 Conference and Trade Fair in Vancouver provided CSIRO with the opportunity to speak about achievements in and prospects for transferring and commercialising several CSIRO technologies for improved management of the environment.

Equity participation

Equity is one of the ways CSIRO uses to get its research applied and to generate a return on its research. Other commercialisation arrangements include research

sponsorships, licences and unincorporated joint ventures.

During the year CSIRO reaffirmed its existing equity policy, which is to hold only minority equity positions and to divest itself of those at an early stage. Two new statements have been added to the policy relating to distribution of moneys earned from equity profits or sales and arrangements for the management of CSIRO's equity portfolio.

The companies in which CSIRO had an interest as at 30 June 1992 are shown on the next page.

SIROTECH Ltd corporate developments

SIROTECH launched a trainee business manager program in January 1992. The program will introduce CSIRO's participating Divisional business managers to the whole spectrum of commercial activities now being undertaken for CSIRO, during a period of full time secondment to the company.

SIROTECH presented its first report on CSIRO's equity holdings to the CSIRO Board in November 1991. The report summarised the performance of each company and made recommendations on investment valuation and whether CSIRO should maintain or divest itself of each equity holding. The report was compiled from a database, which is formally revised every six months, that contains detailed financial and background information on each company.

SIROTECH continued to oversee CSIRO's license portfolio and the receipt of more than $2.5 million in royalty payments for the financial year. A database covering more than 400 license agreements for CSIRO was improved in layout and design to ensure better monitoring of the obligations of the parties to each agreement.

SIROTECH continued to manage CSIRO's intellectual property portfolio, which is growing at around 10 per cent a year, with the total number of active cases in the portfolio now approaching 5000. The structure and content of portfolio reports to Divisions was upgraded during the year, and a series of seminars was presented to Divisions on the importance of patent searching prior to the commencement of a research project.

The companies in which CSIRO had an interest as at 30 June 1992 are as follows:

Name of Company	CSIRO's interest (%)	Principal activity
SIROTECH Ltd	Limited by Guarantee and controlled by CSIRO	Technology transfer
Bio-Coal Briquette Company Ltd	17.2%	Smokeless briquettes
Cassiro Pty Ltd	50%	Improved soil productivity
Dunlena Pty Ltd *	45.5%	From discovery to commercialisation of agricultural chemicals
Gene Shears Pty Ltd	34.7%	Modifying the effects of unwanted genes
Gropep Pty Ltd	35.1%	R&D of growth factors and related peptides
Preston Group Ltd *	20%	Simulation and scheduling systems for aviation and ground transportation

CSIRO also has less than 5 per cent equity holdings in the following companies:

- Queensland Metals Corp Ltd: magnesite processing;
- Mineral Control Instrumentation Ltd: scientific and industrial instruments.

* CSIRO's interests include SIROTECH Ltd's shareholdings in these companies.

Funding

With triennium funding creating a degree of certainty about the budget for the three years ahead, CSIRO was able to develop a balanced three-year budget and to plan resource shifts with greater confidence while retaining enough flexibility to respond to emerging priorities.

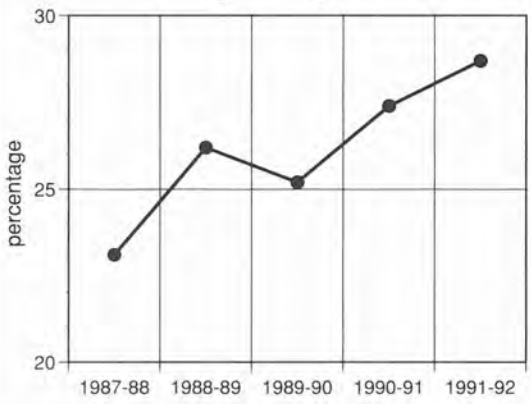
The Government made available an additional $20.72 million to CSIRO as the major part of a package to support capital infrastructure in the science agencies.

Of this money, $10 million came through the November 1991 Statement on the Economy and Employment ($4 million in 1991–92 and $6 million in 1992–93).

The allocation built on CSIRO's decisions that a constant proportion of the replacement value of its building assets should be committed to replacement, refurbishment, repairs and maintenance, and that a three-year investment program be implemented.

A number of recommendations have been implemented following the Australian National Audit Office's efficiency audit of CSIRO's generation of external funds. A formal policy for setting external funding targets has been adopted and performance indicators are to be trialled (see p. 77); policies on costing and pricing research have been disseminated to Divisions; and project management practices have been the subject of staff training courses.

External Earnings as a Proportion of Total Funds



Victorian grazier Mr Les Bett left CSIRO $2 million in his will to continue its research into sheep blowfly strike. Mr David Agnew of National Mutual is pictured presenting the cheque to CSIRO Chief Executive Dr John Stocker

Planning

Priorities drive planning

The *CSIRO Strategic Plan 1991–92 to 1995–96* was released during the year. It was based on the comprehensive assessment and implementation of national and CSIRO research priorities reported in last year's annual report. Major features of the plan included:

- a broad assessment of the benefits of major areas of CSIRO's research effort;
- the identification of several planned outcomes in each of ten groupings of national socio-economic objectives for which CSIRO conducts research. Annual progress towards achieving these outcomes has been described in the CSIRO Operational Plan 1992–93 approved by the Board in June 1992. The next step is to assess the benefits and costs of the outcomes.

The allocation of funds to research priorities for the first year of the 1991–94 triennium was reported in last year's annual report. Allocations for the second year are shown in the box on the next page.

Highest priority was given to research on the environmental aspects of economic development and strategic research for the minerals industry. These two areas will each receive around one third of the funds made available for redirection in 1992–93 through a reserve of funds from a levy of 1.5 per cent of appropriation funds applied pro rata across the Organisation. The remainder will be distributed between seven other research purposes. These funds will be matched by recipient Institutes through the redirection of resources from lower priority areas.

The priorities framework was also used to allocate $5.1 million non-recurrent funds made available by the CSIRO Board. The box on the next page shows that 29 per cent of those funds will go to strategic minerals research and 34 per cent to environmental aspects of economic development. The remaining 34 per cent will be shared among eight other research purposes.

Mr Ross Free, the Minister for Science and Technology (left), launched the CSIRO Strategic Plan in May. With him is the CSIRO Corporate Planner, Dr Don MacRae

Distribution of priority research funds and Board Initiative Funds 1992–93

Research Purpose	Priority funds ($ million)	Board Initiative Funds ($ million)
Minerals Industry	1.342	1.572
Economic Development — Environmental Aspects	1.320	1.844[1]
Rural-Based Manufacturing	0.140	0.244
Environment	0.269	0.120
Manufacturing Industries	0.511	0.296
Information and Communication Industries	0.350	0.260
Plant Production and Primary Products	0.342	0.510
Animal Production and Primary Products	0.222	0.228
Health	0.110	0.236
Energy Resources and Supply		0.075
Total	4.606	5.100

1 Includes $285,000 allocated to research into algal growth from contingencies reserves

A review has led to refinements of the priorities implementation process for 1993–94 and beyond. Six to eight proposals larger than those put up in the first two years of the triennium will ultimately be selected for funding.

Institutes, Divisions and Corporate Centre units are increasingly adapting the priority setting approach for their own purposes.

During the year, the Australian National Audit Office reviewed the research priority setting process as part of a broader review of CSIRO's evaluation processes.

Planning for the next review of CSIRO priorities

Planning began for the next triennial review of research priorities. Progress was made towards the compilation of time series data required to assess CSIRO's research priorities.

The Board made progress in preparing for a July 1993 workshop to assess the potential impacts of global and national challenges and CSIRO's ability to help Australia meet these challenges. The Board also prepared itself to assess CSIRO progress against expectations set by the government five years ago. The results of these assessments together with an appraisal of its own role will ensure that the Board provides the drive for the next strategic planning period and triennial review of research priorities.

Integration

As well as giving effect to the Strategic Plan, the Operational Plan is increasingly providing the basis for CSIRO's annual Program Performance Statement to the Parliament and providing key inputs to the Annual Report and the CSIRO component of the Portfolio Evaluation Plan required by Cabinet.

This integration of the research planning effort is matched by efforts to integrate planning across the five other areas where CSIRO systematically assesses its performance: transfer of research results, funding, communicating the research effort, and providing corporate development and human resource development services for that effort.

The continuing implementation of the Performance Planning and Evaluation program for all CSIRO staff is strengthening overall planning with respect to the six key performance areas.

Efforts during the year to develop effective management arrangements for Multi-Divisional Programs (MDPs) are also strengthening the planning of the research effort, including CSIRO's contributions to

the collaborative management of Co-operative Research Centres in which CSIRO is a major player. Increasing the effectiveness of MDPs will enhance CSIRO's ability to bring together multidisciplinary teams of scientists to focus on important national research issues.

Communication

Many requests for information on CSIRO's priority setting approach were received from government agencies in Australia and overseas. In a number of cases this led to direct support being given to transfer the approach, such as for the Indonesian Agency for the Assessment and Application of Technology.

Support was provided to the Australian Science and Technology Council (ASTEC) Working Party on National Research Facilities and to the Australian Research Council (ARC) Working Party conducting the Research Grants Priority Review. CSIRO helped organise and provided a speaker for two international conferences hosted by the Commonwealth Consultative Group on Technology Management:

- national science and technology strategies for Malaysia's Vision 2020, Kuala Lumpur, July 1991;
- technology venture management, London linked with Hong Kong, March 1992.

Distribution of research effort

CSIRO's distribution of research effort for the year is shown in the chart on the next page.

The data are presented as proportions of cash expenditure from all fund sources against the socioeconomic objectives (SEOs) sub-divisions of the Australian Standard Research Classification. The SEOs describe the purpose for carrying out research in terms of economic and community interest objectives. For presentational purposes, some sub-divisions have been aggregated and others sub-divided.

CSIRO's total cash expenditure increased marginally in real terms compared with 1990–91. Total cash expenditure for 1990–91 was $571.1 million and the figure for 1991–92 was $620.5 million, an increase of 3.6 per cent in real terms. This was due to an increase in Government appropriations for capital infrastructure needs and to increased external earnings in response to the efforts of research managers in attracting sponsored R&D funding.

The impact of the priorities exercise conducted during 1989–90 has become apparent in the results of the analysis. The major changes are

- an increase in strategic minerals research in support of the minerals industry;
- an increase in research to achieve sustainable development in production systems and to develop technologies to minimise environmental damage from economic development;
- a decrease in research into agricultural production due to a downturn in rural industry funding and an increased emphasis on work sustainable agriculture in response to the priorities decisions;
- a decrease in research into environment as research objectives were refocused to emphasise ecologically sustainable development. However, while the proportion of total effort may vary, the intention is to maintain the current level of expenditure on environment in real terms.

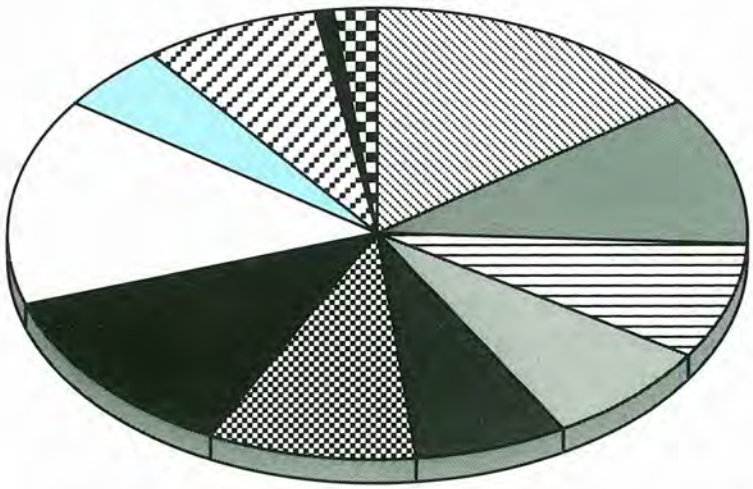
Small increases are also evident in research into energy resources and supply and into health while other areas of research have remained relatively constant as a proportion of total expenditure.

Efforts to improve the quality of the data on which the distribution analysis is based continue. In collaboration with the Australian Bureau of Statistics and other users of R&D statistics, the interim Australian Standard Research Classification (ASRC) was reviewed and several changes made to improve the quality and usefulness of the classifications for relating research activity to social, economic and environmental objectives.

The ASRC has now been confirmed as a Standard Classification and will be promulgated more widely by the ABS. A set of guidelines on how to classify research to the categories of the ASRC has been prepared for use within CSIRO by research managers.

More detailed information on the distribution of research effort may be obtained from the *CSIRO Data Book*, a pocket-sized compendium of key information on the Organisation's research effort and its financial and human resources.

Distribution of research effort 1991-92



- Animal Production and Primary Products (15.1%)
- Plant Production and Primary Products (10.7%)
- Rural-based Manufacturing (8.3%)
- Minerals (7.5%)
- Energy Resources and Supply (6.7%)
- Environment (9.1%)
- Economic Development – Environmental Aspects (12.5%)
- Manufacturing (15.0%)
- Information and Communications (4.9%)
- Infrastructure and Services (7.5%)
- International Aid (0.8%)
- Advancement of Knowledge (1.9%)

TOTAL CASH EXPENDITURE: $620.5 MILLION

Finance

1991–92 was the first year of the Organisation's second triennium appropriation budget. During the year a balanced appropriation budget for the triennium to 1993–94 was developed with Institute and Corporate budgets specifically identified, and the Capital Investment Plan's dependence on property revenue was completely removed.

Significant progress was made towards achieving CSIRO's objective of introducing accrual accounting prior to the beginning of the 1993–94 year. An accrual accounting policy framework was developed as the basis for the implementation, planned for 1992–93. Coopers and Lybrand were engaged to manage and provide the package of training courses that will be integral to the success of the implementation.

A commercial accounting package (Unibis) was selected and will be piloted in the Division of Plant Industry during August and September 1992.

An internal lease cost was implemented to reflect the asset usage cost of buildings in Divisional budgets.

With a fees-based banking agreement in place with Westpac, the banking structure was improved to reduce the number of major bank accounts from seven to one, and to implement a single bank account for settlement of the corporate credit card monthly accounts. EDI facilities were implemented between Westpac and CSIRO to automate bank reconciliations.

The benefits of a corporate travel contract were evaluated and, following a competitive bidding process, travel services were arranged with Australian Airlines/Westpac Travel and Qantas.

Internal audit

The internal audit program is supervised by an Audit sub-committee of the CSIRO Board. The committee consists of two non-executive Board members and an audit partner of a major accounting firm.

The internal audit program consists of three types of formal review: cyclic review of management units, risk-based review of information systems and risk-based review of corporate functions. These reviews are complemented by a program of continuous monitoring of the financial transactions of the Organisation.

During 1991–92 nine Divisions and one Institute headquarters were reviewed. Reviews of the following corporate systems or functions were completed:

- Resource Access Control Facility (RACF) security
- Payroll system
- Public relations
- Recruitment practices
- Fringe Benefits Tax
- Supercomputer facility
- Use of consultants by CSIRO

These audit reports contain not only findings and recommendations but also commitments to action by responsible managers. A quarterly follow-up process will track these commitments until agreed action has been completed and any deficiency resolved.

In 1991–92 information papers issued were issued on computer system security and the reconciliation of overseas travel expenses with Australian Government

Credit Card statements. Such papers include best practice statements for corporate activities; they are issued to all administrative units and are used as a benchmark in future audits of the functions.

Legal services

Changes to the Science and Industry Research Act 1949

The following amendments to CSIRO's constituting legislation have been made recently or are currently before Parliament:

- Section 32 (2) was amended to remove the requirement for CSIRO to obtain the approval of the Public Service Board for the Terms and Conditions of employment of its staff. CSIRO is now covered by the Federal Government's general industrial relations co-ordination arrangements under which the Department of Industrial Relations provides information, advice and assistance on industrial issues (Prime Minister and Cabinet Legislation Amendment Act 1991).
- Sections 10C and 10E were amended to tie the Chief Executive's recreation leave entitlements to those determined by the Remuneration Tribunal with other leave of absence to be determined by the Minister (*Industrial Relations Legislation Amendment Act* 1991).
- Section 9A was amended to introduce a Ministerial approval threshold of $1 million for the acceptance of moneys or other property by CSIRO (*Industry, Technology and Commerce Legislation Amendment Act* 1991).
- The financial threshold under Section 50 for Ministerial approval to enter into contracts was raised from $250,000 to $1 million (Statutory Rule No 330 of 1990 Science and Industry Research (Contracts) Regulations).
- An amendment to Section 10B (4) is before the Senate. The amendment would have the effect of transferring from the Governor-General to the Minister the role of determining certain of the Chief Executive's terms of office. (Industry, Technology and Commerce Legislation Amendment Bill 1992).

Syndicated R & D

Work continued on the possibility of entering into agreements with investors under syndicated R&D arrangements. These arrangements have been encouraged by the Government's 150 per cent tax concession.

Co-operative Research Centres

At the conclusion of the second round of grants made by the Commonwealth under the Co-operative Research Centre Program, CSIRO is involved in 29 out of the 35 CRCs established (for details see p. 51). The matter of incorporation of CRCs became an issue during the negotiation and development of CRC agreements. CSIRO and most universities took the view that incorporation was undesirable because it would militate against the prime objective of the CRC program which is to encourage co-operation between participants.

Technology litigation

Two of CSIRO's technologies, Pixelgram and Soil Slotting, became the subject of litigation. Neither of these matters is resolved as at 30 June 1992.

Legal Education

An extensive program of legal seminars was put in place for CSIRO staff. The topics included commercial issues such as product liability, computer contracts, the tax position of investors in science, collaborative research arrangements, intellectual property, professional negligence and general contracts, and administrative issues such as occupational health and safety, freedom of information and privacy. Other seminars covered environmental law, expert witnesses and international arrangements. The main purpose of these seminars is to help CSIRO managers to understand basic legal principles relevant to their work.

Employment and Administration Law

Matters included:

- a dispute before the Industrial Relations Commission on the issue of allowances payable to staff performing duty at sea; the dispute involved extensive case preparation, written submissions and advocacy;
- a discrimination complaint before the Human Rights and Equal Opportunity Commission. The complaint was dismissed for lack of substance following the presentation of detailed submissions and affidavits to the Commission.

Management information systems

During the year CSIRO selected the Australian accounting system Unibis, from Windhover, as the preferred supplier for the introduction of accrual accounting. This will provide CSIRO Divisions with a migration path from the existing proprietary architecture to a more cost-effective open environment.

Central computing services have continued successfully under a facilities management agreement with Fujitsu Australia Limited; similar arrangements for contracting out of services will continue.

As a national organisation, CSIRO relies totally on its internal telecommunications networks to deliver data and voice information successfully. The value of the networks has been increasingly understood, and considerable savings have been made with the sharing of digital band-width least-cost call routing and gateways to external networks.

Most CSIRO sites have been added to the Australian Academic Research Network (AARNet), in which CSIRO is a major shareholder. The network's facilities have been expanded and its band-width increased for imaging.

Expenditure on systems development has led to savings and efficiencies in many parts of the Organisation. This year a comprehensive suite to provide for workforce planning and more efficient administrative procedures was developed, in support of human resources development initiatives.

CSIRO has introduced new information retrieval products in recognition of the strategic role of information in business today. The products link different kinds of hardware and software, and provide the scope for business analysis and the receipt of better quality data for improved decision-making.

CSIRO uses computer-based training packages in implementing these new applications to increase understanding and acceptance of what management information systems offer.

An internal review of the corporate management information systems function made 20 recommendations about how information technology can better support the research activity of CSIRO. Of particular importance was the endorsement by senior management of the role and importance of information technology in the provision of integrated services to all CSIRO staff. The establishment of a formal structure of systems owners and of a user-pays principle will improve the level of accountability and acceptance of systems by their users. The review committee saw a wider role for information technology services in establishing policies, best practices and corporate licensing arrangements.

Property

The largest property development project undertaken by CSIRO, the $100 million self-funding redevelopment of CSIRO's major metropolitan site in Sydney at North Ryde, has advanced from the planning stage to Stage 1 of the ten-year project with the initial approvals being granted by the Parliamentary Works Committee and the Ryde City Council. Project design and development continues with infrastructure works beginning in September 1992.

CSIRO has funded a capital replacement program of $105 million over the current triennium as part of a long-term strategy to restore and replace much of the Organisation's research accommodation by the turn of the century.

Major works in progress include those at:

- the Division of Biomolecular Engineering at Parkville, Victoria;
- the Division of Mineral and Process Engineering at Clayton, Victoria;
- the Division of Atmospheric Research at Aspendale, Victoria;
- the Division of Building, Construction and Engineering at Highett, Victoria;
- the Division of Mathematics and Statistics at the Macquarie Information Technology Centre in New South Wales;
- the Division of Coal and Energy Technology at Lucas Heights, New South Wales;
- the Division of Tropical Crops and Pastures at St Lucia, Queensland.

Major capital projects completed or partially handed over were those at:

- the Division of Forestry's Forest Research Group in Hobart;
- child care centres at North Ryde in New South Wales, Black Mountain in Canberra, and Clayton in Victoria;
- the Division of Wool Technology in Geelong;
- the Division of Geomechanics in Pinjarra Hills, Queensland (state-funded);
- the Division of Human Nutrition in Adelaide;
- the Division of Animal Production in Armidale, New South Wales (funded by the Australian Wool Corporation).

The number of CSIRO sites has been reduced to 77 as part of a continuing process of rationalisation and consolidation.

CSIRO has developed and introduced an internal leasing scheme for its buildings that will readily identify the real capital costs of research and the amount needed to adequately repair and replace the capital assets.

Security evaluation of major sites continues with self-monitoring processes being developed to help Divisions and Units.

Workforce planning

Workforce planning issues dominated the Human Resources agenda in CSIRO for much of 1991–92. Considerable effort went into ensuring that best use is made of the skills and competencies of CSIRO's people.

A task force set up by the CSIRO Consultative Council prepared a report for consideration by the CSIRO Board outlining the need for improved, integrated workforce planning and redeployment processes. Two initiatives set in train during the past 12 months had already laid the foundations for dealing with this issue: the implementation of a new CSIRO Human Resources Information System and the Performance Planning and Evaluation Program.

A pilot workforce planning project has been trialed in a number of Divisions to develop a means of assessing the Organisation's medium and long term human resources needs and to better match research priorities with available skills.

Performance planning and evaluation

The Performance Planning and Evaluation (PPE) Program, which was developed as part of CSIRO's Award Restructuring agenda, was implemented in 1991–92. All permanent staff participate in discussions, goal-setting and appraisal of their training and development needs and their individual objectives and achievements. The Program is then used as the basis for reviewing rewards.

The Program helps managers link an individual's objectives with project and operational objectives, helps improve communication between managers and staff at a number of different levels, and ties in closely with staff development planning and workforce planning.

Extensive training and advice has been provided to help CSIRO managers and staff implement the PPE program. It has generally been well-supported and will be refined in response to comments from staff. A review of PPE is being undertaken, with the first phase already complete.

CSIRO Human Resources Information System

The new CSIRO Human Resources Information System (CHRIS) was implemented in 1991–92. The system improves access to information on a wide range of human resources issues, including training, skills, competencies, Occupational Health and Safety, Equal Employment Opportunity and PPE. The system will facilitate workforce planning and help management decision-making. In some areas it has brought about greater administrative efficiencies.

Consultative Council

The Consultative Council continued to operate as the peak forum for consultation between management and staff in the Organisation. Made up of an equal number of representatives from management and staff associations, the Council normally meets in April and October each year with continuing work being carried out by three sub-committees. The Council is chaired by CSIRO's Chief Executive and the current deputy chairperson is a member of the CSIRO Staff Association.

The work of the sub-committees included developing a key issues paper for the corporate development program, and surveys of the effectiveness of the research priorities process and the current status of industrial participation in the Organisation. The Council endorsed its continuing

commitment to support and strengthen industrial participation in CSIRO.

At the April meeting the Council established a Workforce Planning Task Force to examine all aspects of redeployment and redundancy in the Organisation. The Task Force reported to an extraordinary meeting of Council in June and recommended to the CSIRO Board key findings which underpin the corporate principles for human resource management.

Employee development

CSIRO's efforts to develop promising staff into future leaders continued through the Leadership Development and the Research Management Programs. The pilot Leadership Development Program involved 19 people and was completed in May 1992. The intake of 20 people for the second Program began in December 1991. Thirty people took part in each of two Research Management Programs.

A number of activities were also undertaken to help with strategic planning and team development for CSIRO Divisions and Multi-Divisional Programs. Regional trainers provided assistance with procedural training matters in the various regions.

A study of the potential for applying in CSIRO an Organisation Development process (for integrating the management of change as a continuous process) began in the latter half of the year. Progress is being made in investigations of the implications of a move to competency-based training.

Occupational Health and Safety

The CSIRO Occupational Health and Safety Policy, drawn up in 1985, is being revised to ensure compliance with the *Occupational Health and Safety (Commonwealth Employees) Act* 1991.

A revised OHS Agreement, signed by management and unions in April 1992 and covering the bulk of CSIRO staff, is now being implemented.

The Agreement contains structural arrangements for setting up OHS committees, establishing designated work groups and selecting health and safety representatives. The CSIRO health and safety committee (policy) and all Divisional/site safety committees have been established. Most designated work groups have been set up and health and safety representatives have been selected or are being selected.

A CSIRO health and safety representative training course, accredited by Comcare and available to all health and safety representatives, is being conducted at all major CSIRO sites.

A policy for the control of hazardous substances has been distributed throughout CSIRO for comment.

A policy for the medical assessment of CSIRO staff is being implemented. It covers pre-employment medicals and regular medical assessment of potentially at-risk staff.

A report on statistics of serious incidents and dangerous occurrences is being prepared using a new computer-based reporting system.

The first two stages of a four stage project to evaluate the management of rehabilitation and compensation have been completed.

CSIRO intends to produce a comprehensive annual OHS report by the end of the 1992–93 year that will comply with all of the requirements of the *Occupational Health and Safety (Commonwealth Employees) Act* 1991.

Equal Employment Opportunity

The EEO Education Campaign continued with briefings to senior line managers on anti-discrimination legislation. This was followed up during the year with the release of the EEO and Anti-Discrimination Legislation Handbook and the EEO Resource Kit.

A two-year EEO Management Plan was developed, outlining the program and objectives for EEO in CSIRO for the next two years and guidelines on implementation. A Target Group Advisory Committee was established in December. Target Groups Advisers act as a contact point for CSIRO staff members from identified EEO target groups to raise issues relating to their work, and to advise the Manager, EEO, on employment issues relating to their target group members.

Three CSIROCare childcare centres were opened during 1991–92 (at Black Mountain, ACT; North Ryde, NSW; and Clayton, Victoria). Each centre is now running close its capacity of 40 children. The centres are an initiative CSIRO has pursued to meet the needs of staff with family responsibilities.

Organisational counselling service

The Organisation's counselling service continued to provide a high quality service to an increasing number of staff during 1991–92. The service also provided strategy and skills advice to management involved with complex change management issues.

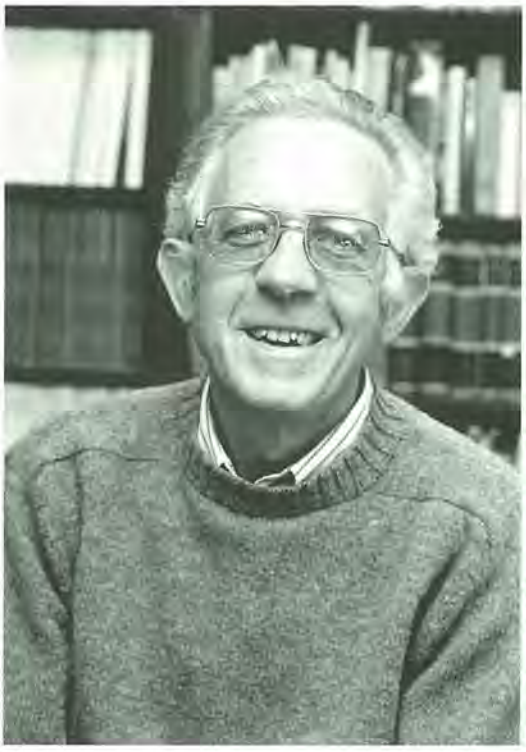
A booklet was produced for all staff outlining the full range of assistance available from the service. A major review of the service has been initiated.

Public relations

Project Ambassador, a campaign involving all members of CSIRO staff in explaining to Government, industry and the community how CSIRO delivers an excellent return on investment, continued as the major umbrella communication activity for the year.

CSIRO declared March 'Manufacturing Month' in an effort to raise the profile of CSIRO research for manufacturing industry. Highlights included eight industry breakfasts (some held in conjunction with *Business Review Weekly*), seven industry seminars, a media campaign and a special publication. Another Manufacturing Month will be run next year.

As part of its contribution to debate on the links between R&D spending and national economic performance, CSIRO brought to Australia Professor Nathan Rosenberg, an internationally respected economist from Stanford University in the United States. Professor Rosenberg delivered the 13th Rivett Lecture, the latest in a series of public lectures given to commemorate a former CEO of CSIRO.



Professor Nathan Rosenberg of Stanford University delivered the 13th Rivett Lecture on the links between R&D spending and national economic performance

The major corporate publication for the year, the five-year CSIRO Strategic Plan, attracted much media, industry and government interest. The Minister for Science and Technology, Mr Free, launched the Plan at a conference on research and technology in Sydney in May.

In March, CSIRO Chief Executive Dr Stocker delivered a speech to the National Press Club highlighting the importance to the economy of science, technological advance and innovation.

Media coverage of CSIRO research increased during the year, partly because of new computerised information delivery methods. Radio stations made good use of stories sent to them, and the Organisation maintained a high profile on television, especially on such programs as Quantum and Beyond 2000. A media training program for scientists and managers continued.

CSIRO brought issues and developments in science and technology before the general community through a variety of public events. The travelling exhibition 'Science for Survival' wound up after touring Australia for almost two years. 'Will Pigs Fly?', an interactive exhibition about genetic engineering designed by CSIRO's Film and Video Centre, began a national tour around large shopping centres and science centres. An education kit produced to support the exhibition sold over 1000 copies in the first six months.

CSIRO maintained its strong presence at agricultural shows in Sydney, Adelaide,

CSIRO took a high profile at the North Queensland Field Days held in Townsville in May

Brisbane and at the North Queensland Field Days; it also took part in the Great Australian Science Show in Melbourne.

An internal audit review of CSIRO's public relations and communication activities was carried out during the year. Recommendations aimed at improving the formal planning of communication and its integration across Divisions, Institutes and the Corporate Centre are being examined by line managers.

CSIRO management endorsed the major recommendation of a national conference of CSIRO communication specialists held in August: that in all Divisional budgets associated with major research projects, communication must be an adequately resourced and integral activity.

Science and Careers Education

CSIRO's Double Helix Science Club continued to grow, with membership exceeding 16,000. The Club magazine, *The Helix*, has included materials and activities for members such as a five piece electronics kit, a dodecahedron calendar and a large poster which explains the structure and function of DNA.

The Club began its largest national experiment so far when it launched Earthworms Downunder, a project supporting research into sustainable agriculture by CSIRO Divisions of Entomology and Soils. The project, involving 2,000 Double Helix members across Australia, was sponsored by the National Soil Conservation Program and the Co-operative Research Centre (CRC) on Land and Soil Management.

BHP continues to sponsor the state operation of the Club.

CSIRO Science Education Centres (CSIROSECs) continued their operation in seven capital cities, taking in 54,000 students for hands-on laboratory sessions. The Adelaide CSIROSEC moved to new premises at The Investigator Science and Technology Centre at Wayville and co-operates with Investigator programs as well as offering all CSIROSEC services.

Agreement was reached with the Plant Science Centre CRC and the Australian Capital Territory's Department of Education

'Earthworms Downunder' is a Double Helix Science Club national experiment. Members of the club are actively involved in research into the importance of earthworms to soil structure and fertility

and Training to establish a new CSIROSEC in Canberra. Development will start in the second half of 1992. More teacher in-service courses are being offered at CSIROSECs.

IBM sponsorship of travelling components of the CSIROSECs continued in four states.

The CSIRO Student Research Scheme operated nationally for the second year. More than 260 final year secondary students were placed with research scientists to undertake a research project related to the scientist's work. Many research institutions other than CSIRO offered places to students.

Over 1,000 students were represented in the 755 entries received for the 1991 BHP Science Awards. The two categories of the Awards cover student research and excellence in science teaching. They are jointly organised by CSIRO and BHP. The teacher category also attracted a large number of high quality entries.

The CSIRO Women In Science Project operated in seven cities, sometimes linking with related programs outside CSIRO.

Information and library services

CSIRO's information and library services provide the general public, students, industry and CSIRO staff with access to scientific and technological information.

The information produced and maintained is disseminated through on-line computer links, video, print, film, CD-ROM and a widely used public enquiry service. Multimedia is being developed as another option.

During 1991–92, more than 30,000 enquirers sought advice on science and technology topics through the six regional offices of the National Information Network.

A major upgrade of the Sybiz accounting system has improved the handling of book and journal sales, which reached $2.1 million, 10 per cent more than last year. The increase in sales, particularly in the secondary schools market, has largely been the result of intensive direct mail marketing.

Chief among the monographs published this year were *Rainforest fungi of Tasmania and South-east Australia*, Volumes V and VI

of *Australian weevils*, and *Our rainforests and the issues*. The esteemed *Insects of Australia*, jointly published with Melbourne University Press, won a book design award from the Australian Book Publishers Association.

CSIRO's libraries continued to generate cost savings by co-ordinating the acquisition of 12,000 serial subscriptions worth $4.5 million. A three-year exercise to overhaul the CSIRO Exchange and Publications Program is nearing completion, and the forecast savings of $200,000 a year are being realised.

The CSIRO Board agreed to a number of recommendations on library services in the area of new information technology, leading to better links with the National Library of Australia and the Australian Archives. Access to information on overseas research has greatly improved — through CSIRO's AUSTRALIS database to activities in the United States, through STN International to Japan, the EEC and Scandinavia, and through Kiwinet to New Zealand energy research.

CSIRO continually reviews its research and research support programs and resources at Divisional, Institute and corporate levels.

Reviews and evaluations

Some major reviews and evaluations completed during 1991–92 include:

- A review of CSIRO's research for the rural industry.

  The review team, made up of members of business, government and the research community, took a strategic perspective in identifying the key issues in research for the rural industries in the 90s and beyond.

  The report of the Review was presented to the June meeting of the CSIRO Board. The Chief Executive will submit his formal response to the recommendations to the Board in August 1992. It is expected that the report and response will be released as a public document at that time.
- A review of the corporate management information systems function.

  An internal review team made 20 recommendations on how information technology can better support CSIRO's research activities in terms of the Organisation's planning, management, information and administrative requirements and processes.
- An economic evaluation of the returns from ten successful projects in CSIRO rural research.

  The Australian Bureau of Agricultural and Research Economics (ABARE) found that rural research projects have produced a substantial economic return for Australia. A sample of ten projects showed returns to the economy estimated at $2,206 million for a research cost of $160 million.
- An economic evaluation of CSIRO industrial research, focusing on four research projects covering a variety of research.

  The Bureau of Industry Economics found that in all four projects total benefits were at least double the community resource costs.
- An economic evaluation of the returns from six environmental research projects.

  The study, conducted by consulting economists, showed an overall return on investment of 5.8:1.
- An economic evaluation of CSIRO research relevant to the aluminium industry.

  The ABARE study of 50 projects pointed to returns of $500 million over two decades from joint CSIRO–industry projects with an investment of $102 million.

Details of evaluations and reviews completed during 1991–92 are set out in the CSIRO Evaluation Plan, together with details of evaluations planned for 1992–93. Key elements of the CSIRO Evaluation Plan are incorporated in the Portfolio Evaluation Plan of the Department of Industry, Technology and Commerce.

In keeping with the long-term and risky nature of research, CSIRO has moved towards a system of review and evaluation in which line managers evaluate past performance against planned outcomes in operational plans. Reviews, particularly large ones and those involving independent panels of experts, are restricted more to forward-looking strategic reviews, thus complementing management-led strategic planning procedures.

Independent reviews are frequently commissioned of the scientific merit and

performance of particular research programs. Occasionally major performance reviews, such as that of the Division of Soils in 1991–92, are also conducted by independent groups.

The cost-benefit analyses described above were largely evaluations of completed research. CSIRO is increasingly conducting prospective cost-benefit evaluations to help its research priority setting before starting projects, its management of projects during their life, its commercialisation and extension of resulting technologies, and its marketing of research capabilities.

Each CSIRO Institute conducts annual or more frequent reviews of research priorities and budgets. The performance of each Division is also assessed in six key areas: research, technology transfer/commercialisation, funding, human resource development, communication and corporate development. External input to these reviews is obtained from Institute/Sector and Division Advisory Committees.

CSIRO's internal audit service this year completed reviews of nine Divisions, one Institute and seven corporate systems or functions (see p. 65 for details).

CSIRO's effectiveness in linking its research to the needs of users

Thirty per cent external funding target

CSIRO has shown it can achieve the 30 per cent target for external funding set by the Government as a budgetary measure and to stimulate links with users of research (see p. 59). Policy and procedures have been established to manage the Government's policy internally.

Each Division's external target is now recorded in its operational plan after negotiations between Institute Director and Division Chief. Levels of external funds vary substantially between Divisions. The targets reflect the unique environment in which each Division operates, including the degree to which its research outputs are of a public good type.

Measures of effectiveness

The percentage of funding from external sources, despite its value as an indicator, reflects only inputs to research. Better indicators of the commercial effectiveness and community impact of CSIRO's research are provided by outcome measures, such as:

- Value added to the Australian economy in general resulting from CSIRO research and development. For example, a recent series of benefit/cost analyses demonstrates a return on investment in CSIRO research of up to 14:1. (See, for example, evaluations described above.)
- The extent of adoption of research results. CSIRO's externally funded research programs now work to outcomes agreed to by industry and government partners.

CSIRO is working to identify a range of other indicators that extend beyond the percentage of external funding as measures of effectiveness of its links with research users.

This has been done in response to a recommendation by the Australian National Audit Office that 'CSIRO should develop economy, efficiency and productivity indicators to be used in decision-making'. A possible set of indicators will be trialled at Divisional level during 1992–93.

Institute/Sector Advisory Committees

Institute/Sector Advisory Committees provide an important link between CSIRO and its research users. Members are drawn

from business, government and other bodies, and are chosen for the contribution they can make to the setting of priorities for an Institute's research, the evaluation of that research and the effectiveness of the Institute in transferring the results of its research into commercial or other practice.

The CSIRO Agricultural Sector Advisory Committee (CASAC) provides an example of areas of Advisory Committee influence. In September, CASAC assessed priorities for rural research using methods employed by CSIRO. The Committee concluded that the Organisation should increase emphasis on research into environmental aspects of rural production. It should maintain its effort in field crops, horticultural crops (with increased selectivity), pastures (pending an improvement in research quality), sheep, beef cattle, intensive livestock, and fibre and leather processing. There should be greater selectivity in natural ecosystems, veterinary products and processed food.

Appendix 4 contains details of Committee memberships.

Staff performance

Measurement and evaluation of the performance of individual staff members in CSIRO is conducted through a formal Performance Planning and Evaluation (PPE) program. Individuals link their personal objectives and milestones to their work objectives and planned outcomes. Advancement and reward are then based on demonstrated achievements.

The scheme was introduced this year. Results will be reported in next year's Annual Report.

The Science and Industry Research Act 1949 (referred to below as 'the Act') and the *Audit Act* 1901 require the CSIRO Annual Report to include a general account of the operations of the Organisation and:

- a statement of the policies of the Organisation in relation to the carrying out of the scientific research of the Organisation that were current at the beginning of the year, together with a description of any developments in those policies that occurred during the year (see pages 308, 20-21 and 56-78);
- any determinations made by the Minister under sub-paragraph 9(1)(a)(iv) of the *Act* during the year;
- any directions or guidelines given by the Minister under section 13 on the *Act* during the year;
- any policies notified by the Minister under section 14 of the *Act* during the year;
- financial statements for the reporting year in a form approved by the Minister for Finance (see pages 91-108);
- the Auditor-General's report on these statements (see page 92).

The Minister made no determinations, gave no directions or guidelines, and notified no policies under the *Act* during the year.

Science and Industry Endowment Fund

In 1991–92, ten grants totalling $18,280 were provided from this Fund, which was established under the *Science and Industry Endowment Act* of 1926. Recipients of the grants ranged from retired professional scientists to a film production house to a school science association. This was in keeping with the intention of the *Act* to promote interest in scientific and industrial research and to provide support to worthy individuals who have no institutional support.

The Science Grants come from the annual return on the £A100 000 originally allocated to the Fund by the *Act*.

The Chief Executive of CSIRO is Trustee of the Science and Industry Endowment Fund.

F. D. McMaster Bequest Trust Fund

From this fund, four Fellowships were awarded in 1991–92, totalling $50,625. They were given to support eminent overseas scientists selected to work for a period in CSIRO Divisions in furthering research in animal health, horticulture and water resources.

The late Sir Frederick McMaster, a prominent NSW grazier, bequeathed in his will a substantial proportion of shares in his pastoral company to CSIRO on the condition that the proceeds from their sale be used to undertake research in agriculture or veterinary science.

Sir Ian McLennan Achievement for Industry Award

Established in 1985, the Sir Ian McLennan Achievement Award for Industry recognises outstanding contributions by CSIRO scientists to national development.

The winning scientist receives a medal and a grant of up to $10,000 to undertake an overseas study visit appropriate to the achievement. The company or organisation involved in the development and/or marketing of the innovation is presented with a plaque.

The award recognises the contributions of Sir Ian McLennan to the application of science and technology to Australia's industrial development.

Details of this year's winners can be found on p. 54.

Freedom of Information

The following information is presented in accordance with the requirements of section 8 of the *Freedom of Information Act*.

The Freedom of Information Act gives a right of access to the general public to documents held in CSIRO.

In the year to 30 June 1992, CSIRO received three requests under the *Act*.

At the end of October 1991 changes were made by the Freedom of Information Act Amendment Bill to the *Freedom of Information Act*. The Bill inserts a new section 15A to provide that an employee may not request access to his or her personnel records under the FOI *Act* unless the employee has first sought access to the records under the agency's internal procedures for staff access to records.

In the year to 30 June, CSIRO received two requests from officers of CSIRO for access to their own personnel records.

Categories of documents

CSIRO holds documents under the following headings:

Financial Management and Administration
Buildings and Property
Personnel and Industrial Relations
Scientific and Industrial Research

The following CSIRO documents are customarily made available to the public free of charge: policy circulars; information circulars; staff circulars; *CoResearch* (staff newspaper); film catalogue; list of saleable publications; information service leaflets issued by Divisions on a wide range of technical subjects attracting frequent inquiries from the general public; conditions of CSIRO post-doctoral awards; press releases; information on careers in CSIRO; and school project material.

Archives and disposal arrangements for documents

CSIRO maintains an archives collection in Canberra which has records dating from the establishment in 1916 of the Advisory Council for Science and Industry, the original predecessor of CSIRO. Certain Australian Archives Regional Officers also hold quantities of CSIRO records. The disposal arrangements for CSIRO records are made in accordance with the provisions of the *Archives Act* 1983. Access to records over 30 years old is provided in accordance with that *Act*.

Facilities for access

Arrangements can be made for documents that are the subject of FOI requests to be made available for inspection at the CSIRO office nearest to the address of the applicant. Help will be given to people with disabilities in entering and leaving CSIRO premises if prior arrangements are made.

FOI procedures and initial contact points

A central Freedom of Information co-ordinator is responsible for the receipt of requests, referring these to senior officers for decision and granting access to the documents. Initial enquiries should be made to:

FOI Co-ordinator
CSIRO
Limestone Avenue
CAMPBELL ACT 2601
or
PO Box 225
DICKSON ACT 2602
Tel: (06) 276 6123

In accordance with the *Freedom of Information Act*, formal requests to CSIRO should be addressed to the Chief Executive of CSIRO at the above address.

Appendix 1: Index of compliance with reporting guidelines

Enabling legislation: **p. 9 and 79**

Responsible Mininster: **p. 9 and 79**

Powers, functions and objects: **p. 9, 20–21 and 83–84**

Membership and staff: **p. 11–19**

Financial statements: **p. 91–108**

Activities and reports: **p. 20–78**

Operational problems: None. General operations are described on **p. 58–78**

Interests in companies: **p. 58 and 102**

Appendix 2: Functions and powers of CSIRO

Functions of the Organisation

1. The functions of the Organisation are

(a) to carry out scientific research for any of the following purposes:
  (i) assisting Australian industry;
  (ii) furthering the interests of the Australian community;
  (iii) contributing to the achievement of Australian national objectives or the performance of the national and international responsibilities of the Commonwealth;
  (iv) any other purpose determined by the Minister;

(b) to encourage or facilitate the application or utilisation of the results of such research;

(ba) to encourage or facilitate the application or utilisation of the results of any other scientific research;

(bb) to carry out services, and make available facilities, in relation to science;

(c) to act as a means of liaison between Australia and other countries in matters connected with scientific research;

(d) to train, and to assist in the training of, research workers in the field of science and to co-operate with tertiary-education institutions in relation to education in that field;

(e) to establish and award fellowships and studentships for research, and to make grants in aid of research, for a purpose referred to in paragraph (a);

(f) to recognise associations of persons engaged in industry for the purpose of carrying out industrial scientific research and to co-operate with, and make grants to, such associations;

(g) to establish, develop and maintain standards of measurement of physical quantities, and in relation to those standards
  (i) to promote their use;
  (ii) to promote, and participate in, the development of calibration with respect to them; and
  (iii) to take any other action with respect to them that the Chief Executive determines;

(h) to collect, interpret and disseminate information relating to scientific and technical matters; and

(j) to publish scientific and technical reports, periodicals and papers

2. The Organisation shall

(a) treat the functions referred to in paragraphs (1) (a) and (b) as its primary functions; and

(b) treat the other functions referred to in sub-section (1) as its secondary functions.

Powers of the Organisation

1. The Organisation has power to do all things necessary or convenient to be done for or in connection with the performance of its functions and, in particular, may

(a) arrange for scientific research or other work to be undertaken, on behalf of the Organisation, by any person or body;

(b) join in the formation of a partnership or company;

(c) make available to a person, on such conditions and on payment of such fees or royalties, or otherwise, as the Chief Executive determines, a

discovery, invention or improvement the property of the Organisation;

(d) pay to officers, or to persons undertaking work on behalf of the Organisation, such bonuses as the Chief Executive, with the approval of the Minister, determines in respect of discoveries or inventions made by them; and

(e) charge such fees, and agree to such conditions, as the Chief Executive determines for research and other services carried out or facilities made available by the Organisation at the request of any person.

2. The Organisation shall not, without the written approval of the Minister, hold a controlling interest in a company.

3. An approval under sub-section (2)

(a) may be of general application or may relate to a particular company or proposed company; and

(b) may be given subject to conditions or restrictions set out in the instrument of approval;

4. Where the Organisation commences to hold a controlling interest in a company, the Minister shall

(a) cause to be prepared a statement setting out particulars of, and the reasons for, the holding of that controlling interest; and

(b) cause a copy of the statement to be laid before each House of the Parliament within 15 sitting days of that House after

(i) the Organisation commenced to hold that controlling interest; or

(ii) if the Minister is of the opinion that the disclosure of the holding of the controlling interest would affect adversely the commercial interests of the Organisation, the Minister ceases to be of that opinion.

5. Nothing is invalid on the ground that the Organisation has failed to comply with sub-section (2).

6. Where the Organisation holds a controlling interest in a company, the Organisation shall ensure that the company does not do any act or thing that, if done by the Organisation, would not be within the functions of the Organisation.

Appendix 3: CSIRO research programs 1991-92

MULTI-DIVISIONAL PROGRAMS

Multi-Divisional Programs (MDPs) assemble multi-disciplinary teams from across the boundaries of CSIRO's management structure to respond to research problems and opportunities. They involve more than one Division and have their own formal management structures or steering committees.

Seventeen MDPs operated in 1991–92.

MDPs set up during this year are:

- Reducing Dependence on Pesticides (four Divisions)
- Coastal Zone (seven)
- Energy Storage (three)
- Alumina Production (four)
- Aluminium Production (three)
- Heavy Mineral Processing (two)
- Magnesite Processing (two)
- Iron Ore Processing (four)
- Fibre Utilisation (three)
- Vaccine Technologies (four)
- SAW/ELISA Biosensors (four)

MDPs set up before this year are:

- Climate Change (seven Divisions)
- Gene Shears Technology (eight)
- Land and Water Care (eight)
- Active Packaging (three)
- Boeing Memorandum of Understanding (four)
- BHP Memorandum of Understanding (Divisions from four Institutes)

INSTITUTE OF ANIMAL PRODUCTION AND PROCESSING

Animal Health

Control of Bacterial Diseases
Control of Parasitic Infections
Plant Associated Toxins
Avian Diseases
International Aid Consultancies

Animal Production

Efficiency of the Rumen Ecosystem
Sustainable Grazing and Product Quality
Reproductive Technologies
Sheep Breeding
Wool Biology
Growth and Stress

Australian Animal Health Laboratory

Disease Diagnosis
New Approaches to Disease Diagnosis
Molecular Virology

Biometrics Unit

Statistics for Animal Science
Statistics for Food Science

Food Processing

Process Technology
Abattoir Operations
Meat Quality
Technical Services
Value-Added Products
Energy Management
Microbial Technology
Protein Products
New Dairy Products
Industry and Consumer Liaison
Microbiology and Food Components
Food Processing and Preservation
Sensory Studies

Human Nutrition

Diet and Blood Pressure
Protein and Energy Metabolism
Tissue Growth and Repair
Dietary Fats and Heart Function
Social Nutrition and Epidemiology
Nutrition Control of Cardiovascular Disease
Nutrition and Cancer

Tropical Animal Production

Indigenous Viruses
Ticks and Tick-Borne Diseases
Cattle Genetics and Reproduction
Improving Growth in Cattle
Animal Nutrition
Fly Vaccines
Molecular Parasitology

Wool Technology

Wool Product Technology
Wool Processing Technology
Raw Wool Marketing
Sheepskin Processing
Systems Development

INSTITUTE OF INDUSTRIAL TECHNOLOGIES

Applied Physics

Electrotechnology
Electricity and Magnetism
Plasmas, Thin Films and Thermometry
Acoustics and Mechanics
Optical Technology

Biomolecular Engineering
Protein Structure
Protein Engineering
Therapies Targeting Gene Expression
Virus Replication and Assembly
Receptors and Cytokines
Biomaterials
Recombinant Vaccines and Diseases
Vascular Cell Technology

Chemicals and Polymers
Fine Chemicals
Industrial Chemicals
Polymers
Water and Wastewater Treatment
Pharmaceutical Chemicals

Manufacturing Technology
Process Technology
Integrated Manufacture

Materials Science and Technology
Alloys Research
Ceramics
Solid State Science
Advanced Materials Synthesis

INSTITUTE OF INFORMATION SCIENCE AND ENGINEERING

Australia Telescope National Facility
National Facility Support
Astrophysics
Parkes Operation

CSIRO Office of Space Science and Applications
COSSA became part of the Institute of Natural Resources and Environment from July 1992
Space-related science and engineering

Information Technology
High Performance Computing
Knowledge-Based Systems
Spatial Information Systems

Mathematics and Statistics
Applied and Industrial Mathematics
Applied and Industrial Statistics
Signal and Image Analysis
Computing, Software and Networks

Radiophysics
Real Time and Video Processing
Array and Adaptive Beamforming
Signal Processing General
Image Processing
Ultrasonics
Solid-State Devices
Electromagnetics and Optics
Antenna Contract Support

INSTITUTE OF MINERALS, ENERGY AND CONSTRUCTION

Building Construction and Engineering
Construction Materials
Engineered Products and Services
Structural Engineering
Planning and Management Systems
Fire Technology

Coal and Energy Technology
Coal Preparation
Coal Quality
Coal Combustion and Gasification
Liquid Fuels
Coal-derived Products
Environment — Air
Environment — Water

Exploration Geoscience
Oil and Gas Exploration
Exploration for Ore Deposits in Regolith Dominated Terrains
Integrated Geological and Geophysical Mapping Techniques
Exploration for World Class Hydrothermal Ore Deposits
Exploration for Ore Deposits associated with Magmatic Processes

Geomechanics
Metalliferous Mining
Oil and Gas Engineering
Coal Mining
Minesite Rehabilition (Inter-Institute Program)

Mineral and Process Engineering
Non-ferrous Beneficiation
Ferrous Metal Production
Non-ferrous Metal Production
Iron Ore Processing
Aluminium Production

Mineral Products
Energy Storage
Alumina Production
Heavy Mineral Processing
Magnesite Processing
Precious Metal Production

INSTITUTE OF NATURAL RESOURCES AND ENVIRONMENT

Atmospheric Research
Water Resources and Climate Change
Global Atmospheric Change
Atmospheric Pollution and Applied Meteorology
Radiation and Climate

Centre for Environmental Mechanics
Physical Ecology
Micrometeorology
Soil Physics
Physical Limnology
Applied Mechanics

Fisheries
Tropical Fisheries Resources
Pelagic Fisheries Resources
Mariculture
Temperate and Deepwater Fisheries Resources
Marine Environment Research

Oceanography
Climate
Environment
Resources
Technology

Wildlife and Ecology
Ecology and Management of Arid and Semi-Arid Rangelands
Ecology and Conservation Management of Tropical Forests and Savannas
Conservation Biology and Ecology
Physiological Adaptation of Australia's Vertebrate Fauna and Biological Control of Vertebrate Populations
Assessment and Management of Natural Resource Systems

Water Resources
Water Balance and Land Use
Hydrologic Processes
Contaminant Hydrology
Water and Salinity in Irrigation Areas
Pollution and Conservation of Surface Waters
Water Resources Policy and Management Systems

INSTITUTE OF PLANT PRODUCTION AND PROCESSING

Entomology
Improving Handling and Storage Economics
Livestock and Humans
Molecular Biology and Physiology Program
Insect Pathology
Insect Behaviour
Mass Spectrometry Unit
Electron Microscope Unit
Pests of Plants and Timber
Invertebrates-Pasture and Forage Crops
Pests of Trees and Timber
Weeds

Forestry
Softwood Plantations
Australian Tree Resources
Regrowth Forest Management
Hardwood Plantations

Forest Products
Fibres and Chemicals
Wood Science and Technology

Horticulture
Breeding and Management
Crop Environment Interaction
Postharvest Horticulture
Molecular Crop Improvement

Plant Industry
Sustainable Pasture Systems
Photosynthesis and Plant Productivity
Plant Hormones, Growth and Development
Plant Disease Control
Crop Adaptation
Dryland Crops and Soils
Siratac — Cotton Management
Flora Resources and Management
Wheat Research Unit
Gene Isolation, Regulation and Transfer
Gene Manipulation for Plant Improvement
Crop and Soil Management

Soils
Environmental Protection
Soil Fertility and Toxicity
Soil Management
Soil Organisms and Plant Growth
Soil Survey and Land Evaluation

Tropical Crops and Pasture
Crop Improvement and Management
Pasture Management and Livestock Production
Pasture Plant Improvement
Agricultural Systems and Land Resource Management
Applications of Biotechnology

Appendix 4: Institute/Sector Advisory Committees

Institute/Sector Advisory Committees provide an important link between CSIRO and its research users. Members are drawn from business, government and other bodies, and are chosen for the contribution they can make to the setting of priorities for an Institute's research, the evaluation of that research and the effectiveness of the Institute in transferring the results of its research into commercial or other practice.

CSIRO AGRICULTURAL SECTOR ADVISORY COMMITTEE

This Committee covers the Institute of Animal Production and Processing and the Institute of Plant Production and Processing

Chair
Mr David Asimus
Chancellor, Charles Sturt University

Members
Mr John Baker
Managing Director, Australian Horticultural Corporation

Mrs Marion Becker
Grazier, Central Queensland

Mr Julian Cribb
Agricultural journalist

Dr Brian Fisher
Director, Australian Bureau of Agricultural and Resource Economics

Mr Trevor Flugge
Wool and grain producer

Mr Geoffrey Jureidini
Managing Director, Premium Brands Pty Ltd

Professor Alec Lazenby
Honorary Research Associate, University of Tasmania

Mr John Mackenzie
Treasurer, National Farmers Federation; Chairman, Aboriginal Affairs Committee

Mr John McCracken
Grazier; Director, Wool Research and Development Corporation

Mr Doug McGuffog
Business Manager, Crop Protection, Incitec Ltd; Director, AVCA

Mr Ian Macrow
Chairman, Grains Research Foundation, Queensland Committee, Grain Research and Development Corporation

Dr John Radcliffe
Director-General, Department of Agriculture, South Australia

Professor Alan Robson
Professor of Agriculture (Soil Science), University of Western Australia

Dr Ross Squire
Manager, Victorian School of Forestry and Land Management

INSTITUTE OF NATURAL RESOURCES AND ENVIRONMENT ADVISORY COMMITTEE

Chair
Professor Stuart Harris
Australian National University

Members
Mr Alec Campbell
Senior Vice President, The Western Australian Farmers' Federation

Professor David Green
Chief Science Advisor, Department of Arts, Sport, Environment, Tourism and Territories

Mr Bill Hare
Deputy Director, Australian Conservation Foundation

Mr John Heussler
Grazier

Mr Neil Inall
Media Consultant

Mr Barry Schultz
Director, Australian Fishing Enterprises

Mr Bob Wilson
Managing Director, Water Board

Dr John Zillman
Director, Bureau of Meteorology

INSTITUTE OF INFORMATION SCIENCE AND ENGINEERING ADVISORY COMMITTEE

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Special Adviser for Information Industries, Office of the Minister for Industry, Technology and Commerce

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School of Information Science and Technology, Flinders University

Mr P F Rehn
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Executive Director, Steedman Science and Engineering

Mr R A Wheeldon
Australian Space Board

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Dr S M Richards
Managing Director, Aberfoyle Ltd

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Mr D Chandler
Fletcher Construction Group

Mr P Favretto
Director, Projects Finance Group

Dr I Gould
Group Executive, CRA Ltd

Dr T Haraldson
Chief Executive, Coal & Allied Industries Ltd

Dr M S Keating
Secretary, Department of Prime Minister and Cabinet

Mr J J Linden
General Manager (Marketing), Gwalia Consolidated Ltd

Dr P E Power
Managing Director, Ampol Exploration Ltd

The Institute of Industrial Technologies has no advisory committee because of the diverse nature of its Divisions' work. Each Division has its own Advisory Committee.

Appendix 5: Publications

CSIRO publishes every year about 4,000 scientific papers, monographs and reports, annual or biennial reports from its Institutes and Divisions, brochures, information leaflets and books. It is not practicable to list all these in CSIRO's Annual Report, but full details can be found in the reports of each of CSIRO's Divisions, from the Information Services Branch (314 Albert Street, East Melbourne, Vic. 3002) or by consulting the CSIRO Index on the AUSTRALIS database.

Corporate publications during the year have included:

- CSIRO *Annual Report 1990-91;*
- CSIRO *Stategic Plan 1991-92 to 1995-96;*
- CSIRO *data book 1992;*
- *Ecos* environmental magazine (quarterly);
- *Rural Research* magazine (quarterly insert to *Australian Farm Journal*);
- CSIRO *Business* (monthly insert to *Business Review Weekly*);
- *The Helix* (quarterly magazine for Double Helix Club members);
- Occasional Paper No. 6: *R&D spending and national economic performance*
- Occasional Paper No. 7: *Rural research — the pay-off*

In brief

CSIRO's audited financial statements for the year, which have been prepared on an accrual basis, are presented on the following pages.

Total revenue received during the year from direct appropriations and external sources amounted to $640.6m. Of this amount, $443.3m (69.2%) came from direct Parliamentary appropriations, $173.4m (27.1%) from funds provided by industry and other contributors and the remaining $24.0m (3.7%) came from revenues earned by the Organisation which includes unspent funds from 1991 and receipts from the Department of Primary Industries and Energy for its half-share of the operation of the Australian Animal Health Laboratory.

The year's total expenditure from appropriation and revenue funds for salaries and general running expenses was $637.9m.

Australian National Audit Office
Medibank House
Bowes Street
Woden ACT 2606

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION INDEPENDENT AUDIT REPORT

To the Minister for Science and Technology

Scope

I have audited the financial statements of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) for the year ended 30 June 1992. The statements comprise:

- Operating Statement
- Statement of Financial Position
- Statement of Cash Flows
- Notes to and forming part of the financial statements, and
- Board Members' Statement.

The CSIRO's Board members are responsible for the preparation and presentation of the financial statements and the information they contain. I have conducted an independent audit of the financial statements in order to express an opinion on them to the Minister for Science and Technology.

The audit has been conducted in accordance with Australian National Audit Office Auditing Standards, which incorporate the Australian Auditing Standards, to provide reasonable assurance as to whether the financial statements are free of material misstatement. Audit procedures included examination, on a test basis, of evidence supporting the amounts and other disclosures in the financial statements, and the evaluation of accounting policies and significant accounting estimates. These procedures have been undertaken to form an opinion whether, in all material respects, the financial statements are presented fairly in accordance with Australian accounting concepts and standards and statutory requirements so as to present a view of the CSIRO which is consistent with my understanding of its financial position and the results of its operations.

As disclosed in Note 1.2 to the financial statements, the CSIRO has not applied the recoverable amount test for valuation of non-current assets. I agree with this departure from AAS 10, *Accounting for the Revaluation of Non-current Assets*. Application of the recoverable amount test would be misleading because a reduction in the valuation based on the ability of the non-current assets to generate net cash inflows from their continued use and subsequent disposal does not represent a decline in the service value of these assets.

The audit opinion expressed in this report has been formed on the above basis.

Audit Opinion

In accordance with sub-section 51(1) of the *Science and Industry Research Act 1949*, I now report that the financial statements are in agreement with the accounts and records of the CSIRO, and in my opinion:

- the statements are based on proper accounts and records
- the statements show fairly the financial transactions for the year ended 30 June 1992 and the state of affairs of the CSIRO at that date
- the receipt, expenditure and investment of moneys by the CSIRO during the year have been in accordance with the Science and Industry Research Act 1949, and
- the statements are in accordance with the Guidelines for Financial Statements of Public Authorities and Commercial Activities, which require compliance with Statements of Accounting Concepts and applicable Accounting Standards.

P. A. Farrelly

P.A. Farrelly
Group Director
Australian National Audit Office
CANBERRA
30 November 1992

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION
OPERATING STATEMENT
For the year ended 30 June 1992

	Notes	1992 $'000	1991 $'000
COST OF SERVICES			
Operating expenses	2		
Research Programs			
Animal Production and Processing		134 834	121 690
Industrial Technologies		90 675	78 826
Information Science and Engineering		34 294	33 372
Minerals, Energy and Construction		102 919	86 821
Natural Resources and Environment		88 093	79 095
Plant Production and Processing		126 050	114 309
National Facilities		16 098	15 565
Research Support		44 965	41 870
Total operating expenses		**637 928**	**571 548**
Operating revenues from independent sources			
Revenue from research activities and user charges	1.13	173 375	167 825
Other revenue	3	23 964	21 547
Total operating revenues from independent sources		**197 339**	**189 372**
Net cost of services		**(440 589)**	**(382 176)**
REVENUE FROM GOVERNMENT			
Parliamentary appropriations received	2	443 264	414 360
Assets received free of charge	1.5	–	2 350
Total revenue from government		**443 264**	**416 710**
Operating results before abnormal items		**2 675**	**34 534**
Abnormal items	4	(43 334)	430
Operating results (deficits)		**(40 659)**	**34 964**
Accumulated results of operations at beginning of financial year		694 071	659 107
Accumulated results of operations at end of financial year		**653 412**	**694 071**

The accompanying notes form part of these statements.

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION
STATEMENT OF FINANCIAL POSITION
As at 30 June 1992

	Notes	1992 $'000	1991 $'000
Current assets			
Cash	5	37 398	11 544
Receivables	6	26 756	20 972
Investments	7	87 047	77 549
Other	8	8 973	6 473
		160 174	116 538
Non-recurrent assets			
Investments	7	3 729	3 109
Property, plant and equipment	9	708 352	750 862
		712 081	753 971
Total assets		**872 255**	**870 509**
Current liabilities			
Creditors	10	30 275	6 193
Provisions	11	49 757	45 433
Other	12	68 228	62 261
		148 260	113 887
Non-current liabilities			
Provisions	11	67 583	62 551
Borrowings	13	3 000	–
		70 583	62 551
Total liabilities		**218 843**	**176 438**
Net assets		**653 412**	**694 071**
Equity			
Accumulated results of operations		653 412	694 071
Total equity		**653 412**	**694 071**

The accompanying notes form part of these statements.

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION
STATEMENT OF CASH FLOWS
For the year ended 30 June 1992

	Notes	1992 $'000	1991 $'000
Cash flows from operating activities			
Receipts from user charges		179 440	168 836
Interest received	2	12 115	11 684
		191 555	180 520
Payments to suppliers and employees		(547 020)	(535 742)
Net cash flows used by operating activities	**14(b)**	**(355 465)**	**(355 222)**
Cash flows from investing activities			
Proceeds from sale of property, plant and equipment		4 664	6 289
Payments for property, plant and equipment		(59 491)	(50 773)
Payments for investments		(620)	(599)
Net cash flows used by investing activities		**(55 447)**	**(45 083)**
Cash flows from government activities			
Parliamentary appropriations	2	443 264	414 360
Loan from the Commonwealth	13	3 000	—
Net cash flows provided by government activities		**446 264**	**414 360**
Net increase in cash held		**35 352**	**14 055**
Cash at beginning of financial year		89 093	75 038
Cash at end of financial year	**14(a)**	**124 445**	**89 093**

The accompanying notes form part of these statements.

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION
NOTES TO AND FORMING PART OF THE FINANCIAL STATEMENTS

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION
NOTES TO AND FORMING PART OF THE FINANCIAL STATEMENTS

Note 1 Summary of significant accounting policies

1.1 Basis of Accounting

The financial statements have been prepared in accordance with the Guidelines for Financial Statements of Public Authorities and Commercial Activities approved by the Minister for Finance, and comply with accounting standards issued by the Australian accounting bodies.

Except where stated, the financial statements have been prepared on an accrual basis using historical costs.

1.2 Property, plant and equipment

Except where stated, all property, plant and equipment is valued at historical cost. The capitalisation threshold limit is $3 000. Assets costing less than the threshold limit of $3 000 were expensed in the year of purchase.

The valuation of buildings and leasehold improvements was performed by the Department of Housing and Construction and CSIRO officers in June 1986. Building valuation includes plant, fixtures and fittings which form an integral part of the building.

Land was valued by CSIRO's registered valuer in June 1986.

In valuing its non-current assets, CSIRO has not applied the recoverable amount test as currently required by Australian Accounting Standards AAS 10 and AASB 1010 "Accounting for the Revaluation of Non-current Assets". It is not considered appropriate to apply the recoverable amount test to a not-for-profit entity like CSIRO as the service potential of its non-current assets is related to the provision of goods and services rather than the generation of cash flows. This departure from the current standards has recently been approved by the Minister for not-for-profit entities and proposed amendments have been initiated to exempt such entities from the recoverable amount test.

Computer software, scientific glassware, experimental prototype equipment, and library monographs and serials are not capitalised as non-current assets owing to either their uncertain useful lives or the uncertainty of benefits to be derived from their development.

Property, plant and equipment totalling $4 680 943 (1991 $7 130 551) which are purchased from contract research funds and where their sale proceeds are refunded to the contributors under the terms of the agreements, have been expensed during the year of purchase. Separate records for these assets have been maintained and are disclosed in Note 17.

1.3 Depreciation and amortisation

Depreciation on plant and equipment, except land, buildings and leasehold improvements, is calculated on a straight line basis, so as to write off their cost or valuation less estimated residual value progressively over their estimated useful life.

In July 1991, a major review of the estimated useful lives of all plant and equipment was performed and the depreciation rates changed. The effect of the change is reflected in Note 4 as an abnormal item.

The valuation or cost of buildings and leasehold improvements is depreciated/amortised over their estimated useful lives or the unexpired period of the leases, whichever is the shorter.

1.4 Operating statement
In accordance with the revised "Guidelines for Financial Statements of Public Authorities and Commercial Activities" issued by the Department of Finance in February 1992, the Operating Statement replaces both the Statement of Activity and the Statement of Capital Accumulation. The Statement of Financial Position now shows 'Accumulated Results of Operations' which was previously shown as 'Capital Accumulation' and 'Accumulated Deficits'. Prior year figures have been recast to reflect the changes.

1.5 Assets received free of charge
In 1990-1991 buildings valued at $2 350 000 were transferred from the Victorian Government to CSIRO free of charge.

1.6 Consumable stores
Stocks of consumable stores comprise mainly fuel and lubricants, chemical supplies, maintenance materials and stationery. They are not material in terms of total expenditure or total assets and are expensed during the year of purchase.

1.7 Employee entitlements
Provisions for recreation and long service leave are calculated by multiplying the leave entitlements of employees by their current pay rates. Long service leave is provided for those employees with more than five years service.

1.8 Superannuation
CSIRO is an approved authority for the purposes of the Superannuation Act 1976 and the Superannuation Act 1990 and is required to meet the employer's share of the cost of benefits payable pursuant to those Acts to eligible employees. CSIRO discharges this liability by periodic payments to the Commonwealth of amounts, expressed as a percentage of the salary for superannuation purposes of eligible employees, estimated by the Commonwealth to be sufficient to meet CSIRO's share of the full accruing cost both of pensions granted on the retirement or death of such employees and any subsequent pension increases.
The amount of employer contributions paid in respect of 1992 was $39 034 566 (1991 $33 733 292) representing 12.4% of Public Sector Superannuation Scheme (PSS) members' and 16.7% of Commonwealth Supperannuation Scheme (CSS) members' superannuable salaries (1991 composite rate of 14.6%). The CSS and PSS rates resulted from a 1990 actuarial review and were applied from 1 July 1991.
CSIRO continues to periodically meet its liability for the superannuation productivity benefit on a pay as you can earn basis to Commonwealth PSS, CSS and other approved superannuation schemes. The total amount of the supperannuation productivity benefit paid in 1992 was $7 058 781 (1991 $7 348 852).

1.9 Investments
Managed funds, except on call deposits (Note 5), are shown as Investments at cost (Note 7). Interest in companies (including associated companies) other than SIROTECH Ltd (Note 15) are shown as investments at cost or Board Members' valuation (Note 7) when the shares were allotted/acquired. Associated companies are companies in which CSIRO exercises significant influence by holding shares and participating in financial and operating policies.

1.10 Research and development
Research and development costs are expensed as incurred, except where benefits are expected, beyond any reasonable doubt, to equal or exceed those costs.

1.11 Finance and operating leases
CSIRO has elected not to account and disclose finance and operating leases because the

amount involved is not material. This is in accordance with the Australian Accounting AAS Standard 17 'Accounting for Leases' (Paragraph 23).

1.12 Contract research
CSIRO has entered into various agreements with external parties for the research and development of technologies, products and scientific know-how. Details of the ownership of intellectual properties vary from agreement to agreement. These agreements do not involve sharing in common of liabilities and interests in assets, other than assets represented by intellectual properties to which CSIRO does not attribute any value in the accounts.
All costs incurred on research and development under the terms of the agreements have been expensed in accordance with Note 1.10 above.
Where CSIRO received licensing fees and/or royalties from sale of products or technologies developed under agreements, these have been brought to account when earned.

1.13 Revenue from research activities and user charges
Revenue from research activities and user charges represent revenue received from sources outside Parliamentary Appropriations and includes interest earned of $4 917 464 (1991 $7 972 478) on revenue from external sources. Research revenue received in advance (Note 12) represents unearned revenue and research debtors (Note 6) represent revenue earned but not yet received by CSIRO.

1.14 Foreign currency
Revenue and expenditure relating to overseas transactions are converted to Australian currency at the exchange rates prevailing at the dates of transactions and all foreign currency balances are converted to Australian currency at the exchange rate prevailing at balance date. Non-current assets are converted at exchange rates at the dates of acquisition or covered by fully hedged contracts.

1.15 Workers' compensation
CSIRO discharges its worker's compensation liability by payment of an annual premium to COMCARE (the Commission for the Safety, Rehabilitation and Compensation of Commonwealth Employees), a statutory authority which was formally established to administer the provisions of the Commonwealth Employees' Rehabilitation and Compensation Act 1988 covering the safety, rehabilitation and compensation of personnel employed by the Commonwealth.

1.16 Reporting by segments
CSIRO principally operates in the field of scientific and industrial research and development in Australia. It is therefore considered that for segment reporting, it operates in one industry and one geographical location.

1.17 Insurance
CSIRO has adopted a risk management policy and taken out external insurance for selected liabilities.

1.18 Income tax
CSIRO is not subject to income tax.

1.19 Comparative figures
Where applicable, prior year comparative figures have been restated to reflect the current year's format of financial statements.

Note 2 Operating results

	1992 $'000	1991 $'000
Operating results have been determined:		
After crediting as revenue:		
Interest received or due and receivable	12 115	11 684
Parliamentary appropriations		
- annual (Bills 1&2)	417 669	398 903
- capital (Bills 3&4)	25 595	15 457
After charging as expense:		
Loss on sale of non-current assets	2 359	1 042
Wages and salaries related payments	270 705	247 245
Superannuation (including productivity benefits)	46 093	41 082
Provision for long service leave	10 490	11 570
Provision for recreation leave	30 205	28 278
Provision for superannuation benefits	–	(948)
Provision for doubtful debts	–	75
Provision for diminution in value of shares	–	500
Depreciation and amortisation	51 644	36 869

Note 3 Other revenue

	1992 $'000	1991 $'000
Department of Primary Industries and Energy contribution to the cost of the Australian Animal Health Laboratory	5 536	5 307
Interest	7 197	3 712
Royalties	2 774	1 967
Sale of publications	2 484	2 366
Sale of produce and livestock	930	833
Profit on disposal of non-current assets	–	2 648
Miscellaneous (testing fees, rental income, etc)	5 043	4 714
	23 964	**21 547**

Note 4 Abnormal items

	1992 $'000	1991 $'000
Prior period net gains/(losses) relating to non-current assets	3 001	815
Loss associated with the sale and write-off of investment	–	(385)
Prior period depreciation charge as a result of changes in the depreciation rates (Note 1.3)	(46 335)	–
	(43 334)	**430**

Note 5 Cash

	1992 $'000	1991 $'000
Cash at bank and on hand	33 984	9 800
Deposits – at call	1 242	881
Managed funds – at call	2 172	863
	37 398	**11 544**

Note 6 Receivables

	1992 $'000	1991 $'000
Research debtors	23 951	18 251
Advances - SIROTECH Ltd	1 252	1 031
- Other	348	390
Other debtors	1 555	1 650
	27 106	21 322
Provision for doubtful debts	350	350
	26 756	**20 972**

Note 7 Investments (Note 1.9)

Current	1992 $'000	1991 $'000
Managed funds - at cost		
Government and semi-government stocks and bonds	29 296	–
Bank endorsed bills and government guaranteed promissory notes	22 676	77 549
Negotiable certificate of deposits	35 075	–
	87 047	**77 549**

Note 7 Investments (Cont'd)

Non-current

	%CSIRO interest	1992 $'000	1991 $'000
Shares - at cost			
Other		8	8
Shares - at valuation			
Associated companies			
Bio-Coal Briquette Pty Ltd	17.2	88	88
Gene Shears Pty Ltd	34.7	501	501
Dunlena Pty Ltd	42.1	419	386
Preston Group Ltd	14.1	495	495
Gropep Pty Ltd	35.1	101	1
Listed companies			
Queensland Metals Corporation NL		2 354	1 867
Mineral Control Instrumentation Ltd		260	260
Debentures and unsecured notes - at cost		3	3
		4 229	3 609
Provision for diminution in value		500	500
		3 729	**3 109**

Mineral Control Instrumentation Ltd and Queensland Metals Corporation N.L. are public listed companies. As at 30 June 1992 the total market values of these quoted shares were $340 000 and $7 180 291 respectively. These exceeded the total book values of CSIRO's non-current investments. CSIRO is a minority shareholder (less than 5%) in these listed companies.

In addition to the above named associated companies, CSIRO holds a 50% interest in Cassiro Pty Ltd (50 shares @ $1) and a 10% interest in Dynamic Transport Management Pty Ltd (20 shares @ $1).

Note 8 Other – current assets

	1992 $'000	1991 $'000
Prepayments	8 523	6 473
Property held for resale	450	–
	8 973	**6 473**

Note 9 Property, plant and equipment (Notes 1.2 and 1.3)

	1992 $'000	1991 $'000
Land (a)		
At cost	11 752	5 820
At valuation	94 560	94 750
	106 312	100 570
Buildings		
At cost	55 450	46 360
At valuation	462 412	460 741
	517 862	507 101
Accumulated depreciation	(97 551)	(80 407)
	420 311	426 694
Work in progress - at cost	14 482	7 869
	434 793	434 563
Leasehold improvements		
At cost	910	894
At valuation	16 943	17 180
	17 853	18 074
Accumulated amortisation	(8 175)	(7 227)
	9 678	10 847
Plant and equipment		
Equipment - at cost	250 675	233 012
Research vessel 'Southern Surveyor' - at cost	16 753	16 753
	267 410	249 765
Accumulated depreciation	(162 600)	(99 378)
	104 810	150 387
National facilities		
Oceanographic research vessel 'Franklin' - at cost	14 963	14 775
Australia Telescope - at cost	49 945	49 320
	64 908	64 095
Accumulated depreciation	(12 149)	(9 600)
	52 759	54 495
Total property, plant and equipment	**708 352**	**750 862**

(a) Includes Crown land and land held in Commonwealth title totalling $12 075 000 (1991 $12 075 000). Negotiations are continuing between CSIRO, the Commonwealth Government and ACT Government to have leases issued in CSIRO's name.

Note 9 Property, plant and equipment (Cont'd)

	1992 $'000	1991 $'000
Total property, plant and equipment (Summary)		
At cost	414 912	374 803
At valuation	573 915	572 671
	988 827	947 474
Accumulated depreciation and amortisation	(280 475)	(196 612)
Total written down value	**708 352**	**750 862**

Note 10 Creditors

	1992 $'000	1991 $'000
Trade creditors	9 788	6 193
Other creditors (a)	20 487	–
	30 275	**6 193**

(a) On the 30 June 1992, CSIRO entered into a Syndicated R&D transaction with investors and their associated entities. The $20,486,604 (including prepaid interest) received for the transaction is subject to an official tax ruling from the Australian Taxation Office.

Note 11 Provisions for employee entitlements (Notes 1.7 and 1.8)

	1992 $'000	1991 $'000
Current		
Provision for recreation leave	40 541	36 903
Provision for long service leave	9 216	8 530
	49 757	45 433
Non-current		
Provision for long service leave	67 583	62 551
	117 340	**107 984**

Note 12 Other – current liabilities

	1992 $'000	1991 $'000
Accrued expenses	12 175	8 920
Research revenue received in advance	56 053	53 341
	68 228	**62 261**

Note 13 Borrowings

	1992 $'000	1991 $'000
Loan from the Commonwealth	3 000	–

The loan of $3 million from the Commonwealth is the first drawdown of an approved loan of $10 million for the North Ryde Redevelopment Project. Subsequent drawdowns of $2 million and $5 million will be made in 1992/93 and 1993/94 respectively. Interest is paid annually and the principal will be repaid in full on 1 October 1997. Interest totalling $72 352, payable as at 30 June 1992, has been capitalised on the North Ryde Redevelopment Project.

Note 14 Statement of Cash Flows

(a) Reconciliation of cash

For the purpose of the Statement of Cash Flows, cash includes cash at bank and on hand, deposits at call and managed funds in the Statement of Financial Position as follows:

	Notes	1992 $'000	1991 $'000
Cash at bank and on hand	5	33 984	9 800
Deposits at call	5	1 242	881
Managed funds	5 & 7	89 219	78 412
		124 445	**89 093**

(b) Reconciliation of operating results with net cash flows from operations

	Notes	1992 $'000	1991 $'000
Operating results (deficits)		**(40 659)**	**34 964**
Non cash flows in operating results			
Depreciation and amortisation		51 644	36 869
Profit on disposal of property, plant and equipment		–	(2 648)
Loss on disposal of property, plant and equipment		2 359	1 042
Increase in provision for doubtful debts	6	–	75
Increase in provision for diminution in value	7	–	500
Increase in provision for employee entitlements	11	9 356	9 618
Abnormal items	4	43 334	(430)
Changes in assets and liabilities			
Increase in receivables	6	(5 784)	(6 204)
Increase in other current assets	8	(2 500)	(1 268)
Increase/(decrease) in creditors	10	24 082	(7 702)
Increase/(decrease) in other current liabilities	12	5 967	(3 328)
		87 799	61 488
Parliamentary appropriations		(443 264)	(414 360)
Assets received free of charge		–	(2 350)
Net cash flows from operating activities		**(355 465)**	**(355 222)**

Note 15 SIROTECH Ltd

SIROTECH Ltd was established by CSIRO, limited by guarantee and governed by a Board of Directors who are also Board members of CSIRO. It was incorporated on 15 November 1984. SIROTECH's main source of revenue comes from service fees paid by CSIRO to cover day to day commercial and intellectual property advice. During the year fees received from CSIRO totalled $4 068 527 (1991 $3 982 020). SIROTECH's net assets as at 30 June 1992 amounted to $761 565 (1991 $738 056). Having considered SIROTECH's commercial activities and its immaterial effect on CSIRO's financial statement, CSIRO has, in accordance with the Australian Accounting Standard AAS24 (paragraph 16), elected not to consolidate its accounts.

Note 16 Commitments

Commitments for expenditure not brought to account in the Statement of Financial Position as at 30 June 1992 were:

	1992 $'000	1991 $'000
Capital		
Property, plant and equipment	47 509	18 770
Lease		
Plant and equipment	–	9 819
Other		
Service contract	–	1 510
	47 509	**30 099**
Due and Payable:		
Not later than one year	31 429	18 991
Later than one year but not later than two years	10 080	6 585
Later than two years but not later than five years	6 000	4 523
	47 509	**30 099**

Note 17 Resources provided free of charge (Note 1.2)

	Land(a) $'000	Buildings $'000	Plant and equipment $'000	Total 1992 $'000	Total 1991 $'000
At valuation or cost	16 029	24 722	40 673	81 424	85 610
Accumulated depreciation	–	3 505	26 562	30 067	19 884
	16 029	**21 217**	**14 111**	**51 357**	**65 726**

(a) Includes lands $8 866 293 (1991 $10 766 293) which have been purchased previously out of contract research monies and are in CSIRO titles. In accordance with the contract research agreements, any sales proceeds from disposal of these assets shall be refunded to the contributors.

Note 18 Monies held in trust

Monies held in trust are not disclosed in the Statement of Financial Position and are represented by the following investments at cost and cash at bank:

Investments	1992 $'000	1991 $'000
St George Bank	114	104
State Electricity Commission of Victoria	12	12
Advance Bank	203	186
Commonwealth Bank of Australia	2 567	2 350
Westpac Banking Corporation	–	15
	2 896	2 667
Cash at bank	83	90
	2 979	**2 757**
The components of trust funds are as follows:		
William McIlrath Trust Fund	209	191
David Rivett Memorial Lecture Fund	86	74
FD McMaster Bequest	2 542	2 356
Sir Ian McLennan Achievement for Industry Award	142	136
	2 979	**2 757**

Note 19 Contingent liabilities

Contingent liabilities for which no provision has been provided in the accounts as at 30 June 1992 were:

	1992 $'000	1991 $'000
Performance guarantee	193	143
Estimated personal injury and workers compensation claims pre 1988 and "Boran Tuli" claim against CSIRO all of which are being defended.	2 000	1 200
	2 193	**1 343**

In addition, two legal actions were initiated against the Organisation during the year. These claims are being contested vigorously. Legal advice indicates that it is unlikely that material liability will eventuate.

Note 20 Auditor's remuneration

The total amount paid and payable to the Commonwealth Auditor-General for the audit of CSIRO amounted to $235 500 (1991 $366 740). No other benefits were received by the Auditor-General.

Note 21 Board members' remuneration

Remuneration received or due and receivable by full-time and part-time Board members was as follows:

	1992 $'000	1991 $'000
Full-time member	215	208
Part-time members	134	124
	349	332

The number of Board members whose total rumuneration falls within the following bands was as follows:

$			1992 Number	1991 Number
1	–	10 000	3	1
10 001	–	20 000	5	7
20 001	–	30 000	1	1
200 001	–	210 000	–	1
210 001	–	220 000	1	–

Note 22 Executives' remuneration

Rumuneration recieved or due and receivable by the Executives whose remuneration was $100 000 or more was as follows:

1992 $'000	1991 $'000
1 196	1 162

The number of Executives whose total remuneration falls within the following bands was as follows:

$			1992 Number	1991 Number
120 001	–	130 000	1	1
130 001	–	140 000	–	6
140 001	–	150 000	6	–
200 001	–	210 000	–	1
210 001	–	220 000	1	–

Note 23 Subsequent events

On 21 August 1992, CSIRO entered into a contract for a 3 year lease of a supercomputer at a cumulative cost of $6 097 863, and an associated maintenance and software support contract of $400 432 for the fist year.

BOARD MEMBERS' STATEMENT

In our opinion, the accompanying statements of the Commonwealth Scientific and Industrial Research Organisation show fairly:

- the state of affairs as at 30 June 1992;
- the operating result for the year ended 30 June 1992; and
- the cash flows for the year ended 30 June 1992.

The statements have been made out in accordance with Statements of Accounting Concepts and applicable Accounting Standards.

Signed at Melbourne this 25th day of November 1992 in accordance with a resolution of the Board Members.

Adrienne E Clarke
Chairman

John W Stocker
Chief Executive and Board Member

Index

(* indicates illustration or table)

Index

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