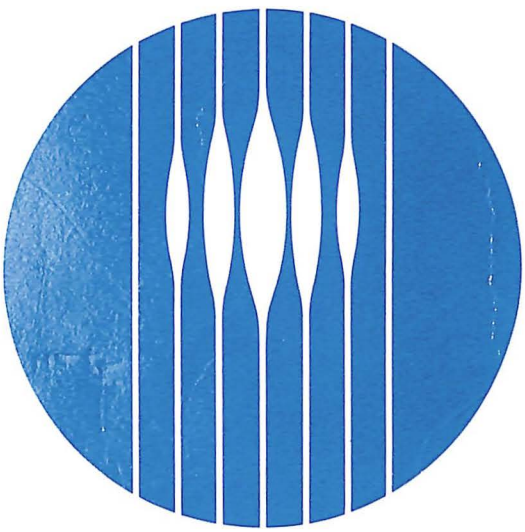
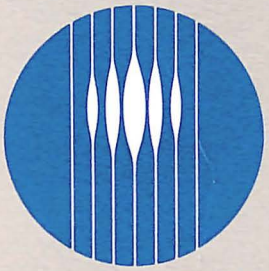
J. North

CSIRO ANNUAL REPORT 1986/87



CSIRO

AUSTRALIA



A new symbol, shown here and on the cover, has been adopted to help project CSIRO's corporate identity. It will be used in conjunction with the words *Research Advancing Australia*.

The Honourable Barry O. Jones, MP
Minister for Science and Small Business
Parliament House
CANBERRA, A.C.T. 2600

We have pleasure in submitting to you, for presentation to Parliament, the thirty-ninth annual report of the Commonwealth Scientific and Industrial Research Organisation. The report was prepared in two parts. The first covers the operations of the Organisation from 1 July 1986 to 30 June 1987, and with your approval was published separately in December 1987. The second part contains financial statements and the Auditor-General's report for the period 1 July 1986 to 30 June 1987.

Neville Wran
(Chairman of the Board)

N.Keith Boardman
(Chief Executive)

December 1987

Chairman
The Hon. Neville Wran, QC
Executive Director of Whitlam Turnbull & Co. Ltd, formerly Premier of New South Wales (1976–86)

A distinguished Board with broad experience in Australian industry, community affairs and scientific research assumed direction of CSIRO on 5 December 1986. Replacing the former Executive, the Board is committed to maintaining and enhancing CSIRO's vital role in research for Australian industry and the community, and its tradition of scientific excellence.

Dr Keith Boardman
Chief Executive of CSIRO

Dr Kevin Foley
Managing Director, Kevin Foley and Associates Pty Ltd, Chairman of the Primary Industry Research Councils Selection Committee

Mr Bill Mansfield
Assistant Secretary of the Australian Council of Trade Unions, Member of the Australian Manufacturing Counc

Sir Roderick Carnegie
Company director and President, Business Council of Australia

Dr Tony Gregson
Wheat farmer, formerly Associate Professor of Chemistry at the University of New England

Sir Gustav Nossal
Director of the Walte and Eliza Hall Institu of Medical Research

Professor Adrienne Clarke
Director, Plant Cell Biology Research Centre, University of Melbourne

Mr David Hoare
Chairman, Bankers Trust Australia Ltd and AUSSAT Pty Ltd

Mr Graham Spurlin
Managing Director, Pacific Dunlop International Battery Group

Contents

CSIRO — across Australia

Chairman's Foreword

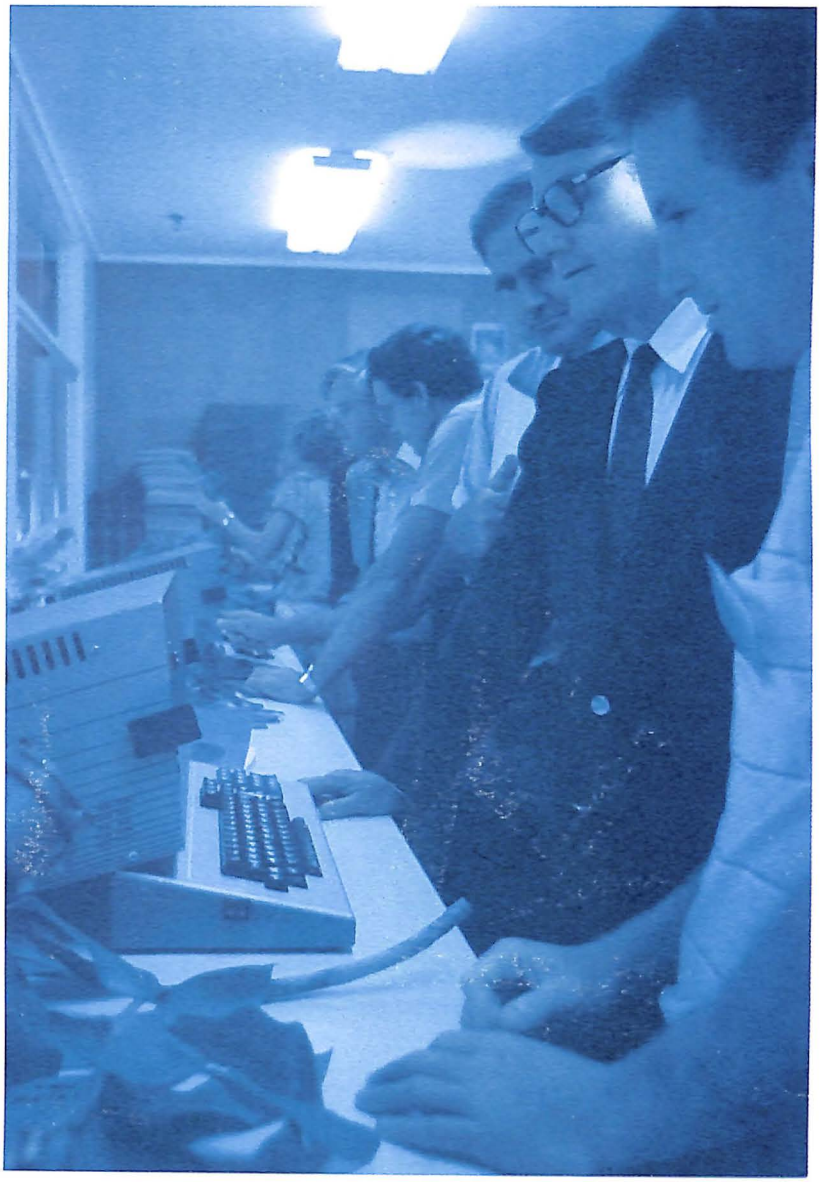
The past year has been one of critical change for CSIRO — new legislation, a new Board, a new organisational structure and, more recently, inclusion in the Industry, Technology and Commerce portfolio.

CSIRO has, of course, a long and proud history of contribution to Australia's development, but its role has never been more important than now with the need to restructure and revitalise Australia's manufacturing and service industries and to develop new export industries.

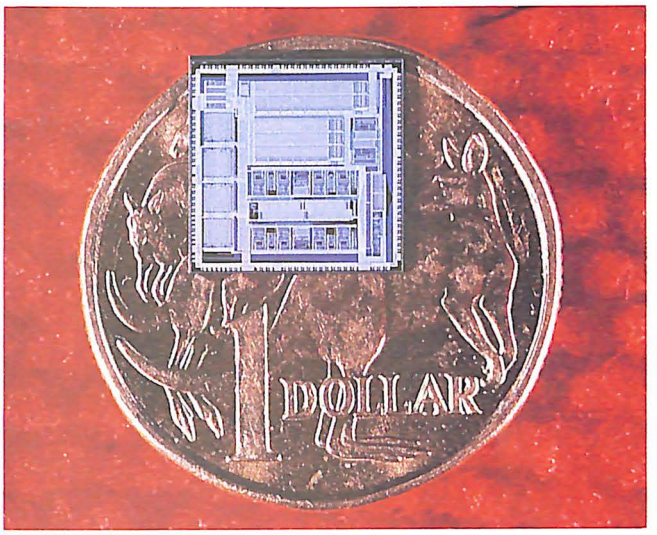
The current reorganisation is designed to meet that need by placing greater emphasis on the alignment of scientific research and economic and social benefit to Australia.

The decision to restructure CSIRO is an historic one. It reflects recognition of the intrinsic role of fundamental research whilst committing CSIRO to an important role in the current restructuring of Australian industry.

The pursuit of excellence will be assured.



The Chairman, Mr Wran, at CSIRO's Tropical Forest Research Centre at Atherton, Qld, which he officially opened in February 1987.



This tiny silicon chip represents a major advance in technology and an important opportunity for Australian industry (see page 15).

The Board is determined that nothing that is excellent will be sacrificed in the restructuring of CSIRO. It is equally determined that the development of new technologies and the means of transfer of those technologies to industry will be more collaborative and more pertinent.

As national objectives change, so must CSIRO's research priorities. It is vital not only that CSIRO operates at maximum effectiveness but that it gets its research priorities right.

The new structural arrangements reflect these aspirations and imperatives. Under the reorganisation:

- ☐ the existing CSIRO structure of 41 Divisions grouped into five Institutes will be changed to 32 Divisions grouped into six Institutes;
- ☐ the new Divisions and Institutes will be more closely allied to industry and community groups;
- ☐ there will be tighter monitoring of research to maximise its economic or social value to the Australian community, while maintaining the scientific excellence for which CSIRO has a world-wide reputation;
- ☐ the Divisions and Institutes will perform much more of their own administrative work, reducing the number of tasks performed at the CSIRO corporate centre in Canberra and cutting red tape;
- ☐ line management will be strengthened by giving Chiefs of Divisions and Directors of Institutes greater authority while at the same time being made more accountable for their decisions and use of resources;
- ☐ a vigorous program of management training will be introduced; and
- ☐ the corporate centre will be streamlined.

Neville Wran, QC

Chief Executive's Review

A new era for CSIRO commenced in December 1986 with the first meeting of the corporate-style policy-making Board, with Mr Wran as non-executive Chairman and eight other part-time members selected for their outstanding personal abilities rather than as representatives of particular sectoral interests. For the first time in the 60-year history of the Organisation, there is now a clear separation of policy making and management. In the new arrangement, the Chief Executive is the only full-time member of the governing body.

In his introductory remarks to the first meeting of the Board, the Minister for Science, the Hon. Barry Jones, outlined the enormous task facing Australia in bringing the country up to date and coming to grips with the full impact of the technological revolution sweeping the advanced countries of the world.

High-technology products, which now represent the fastest growing sector of world trade, result from considerable investment in research and development. If Australian industry is to become more diversified and its products and services more competitive on world markets, it must invest more of its financial resources in research and development.

"I see the focusing of the research effort as the greatest challenge for CSIRO in the next few years."

CSIRO for its part must maintain its position as a leading research organisation, nationally and internationally, and its research must remain at the forefront of developments in science and technology. There is scope, however, for CSIRO scientists to be more entrepreneurial in perceiving opportunities for the successful application of their research results.

Most industrial countries have selected the same broad areas of research for special effort — for example, biotechnology, new materials, information technology and space technologies. Australia must focus its research effort to take advantage of strengths in human and natural resources.

Efficient rural and mining industries will continue to be important to the prosperity of Australia. The rapid advances in biotechnology in the past few years have enormous implications for the future competitiveness of the rural industry, and space technologies are playing an important role in mineral exploration. There is considerable scope for adding value to our primary industry commodities by further processing and the application of creative new technologies.

I see the focusing of the research effort as the greatest challenge for CSIRO in the next few years. It is often argued that concentration of effort can be counter-productive since the outcome of research, particularly basic research, cannot be predicted. But Australia, as a small industrial nation with a total research expenditure less than those of the largest private sector performers in the USA, cannot afford to spread its effort too thinly.

It must also be recognised that selecting priorities for strategic research requires commercial as well as scientific judgments.

A major challenge is to improve the transfer of research results to industry and other users. Each Division of CSIRO now has an advisory committee, including industry membership, to assist the Chief of the Division in setting priorities and interacting with the users of the Division's research.

Sirotech, CSIRO's technology-transfer company, is playing a central role in negotiating collaborative agreements, including some joint partnerships, between CSIRO Divisions and commercial partners.

During the year, Sirotech conducted technology-marketing workshops to improve the appreciation by CSIRO researchers of market forces and the factors that limit the successful exploitation of a new product or process.

McKinsey and Co. were commissioned in May 1987 to review the top management structure of CSIRO. They recommended that in general Institutes/Divisions be structured to serve similar or complementary businesses or users of CSIRO research, but it was considered essential that the potential to create new industries be accommodated in

any new structure. The main advantages seen for changing to a new structure along these lines included better relationships with customers or potential customers of research and easier priority setting and allocation of resources.

The consultants worked closely with CSIRO's Institute Directors to develop the new Institute/Division structure, which has now been approved by the Board with some minor modifications. The new structure will come into being when the Directors of the Institutes have been appointed towards the end of 1987.

"It augurs very well for CSIRO that it has the staff to maintain the highest levels of professionalism in such challenging times."

McKinsey and Co. recommended a strengthening of line management throughout CSIRO, with a reduction in decision-making by committees. They also proposed a further devolution of administrative tasks to Institutes and Divisions and a streamlining of the corporate centre. These recommendations were adopted by the Board.

Stimulated by the 150% tax incentive, research and development in the private sector is now increasing after a stagnant period of almost a decade. The demand by the private sector for CSIRO expertise is also showing a steady growth. Paradoxically, however, this is occurring at a time when the Government's budgetary problems are leading to steadily diminishing appropriation funds for CSIRO.

Dr Geoff Taylor, a full-time member of the Executive for over four years, opted in October to return to the Australian National University as a research fellow. He played a vital role in the expansion of CSIRO's research in support of the manufacturing sector, in the formation of Sirotech Ltd and in administrative reform within CSIRO. His fine contribution to CSIRO as both a researcher for 30 years and a member of the Executive is greatly appreciated.

The introduction of the new Board arrangements saw the passing of the Executive, the Advisory Council and the State and Territory Committees. Part-time members of the Executive Professor Adrienne Clarke, Dr Kevin Foley and Mr Graham Spurling joined the new Board, and Justice Michael Kirby and Mr David Wright finished their terms. On behalf of the Organisation, I would like to express my appreciation of the outstanding contributions they made.

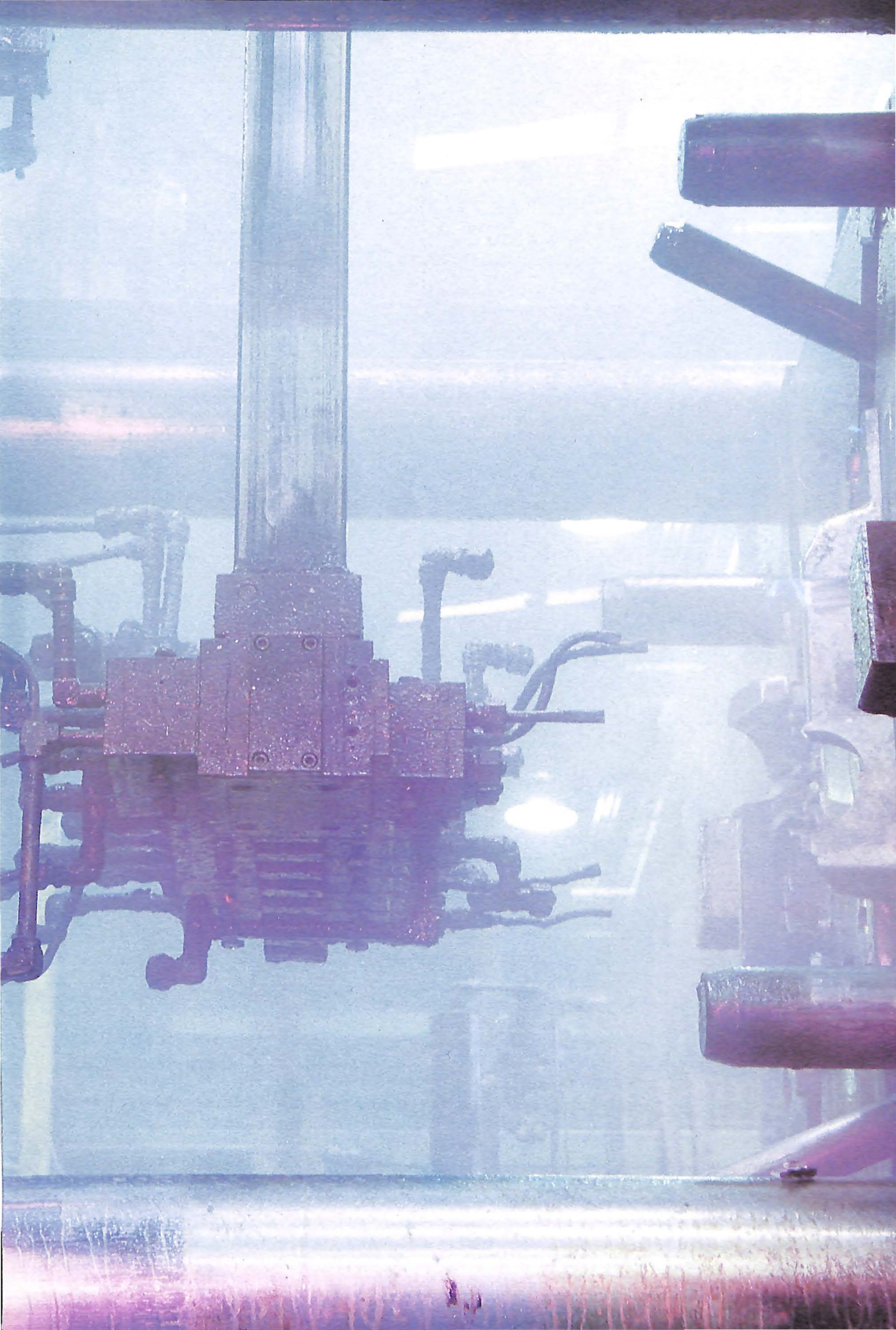
I would also like to thank members of the Advisory Council and the State and Territory Committees for the contributions they made to debate on important issues in CSIRO.

Finally, I would like to pay special tribute to the staff of CSIRO. They have maintained the creative output for which they have an outstanding reputation, and improved the transfer of research results to industry for the benefit of the Australian economy. This they have done with enthusiasm and goodwill. The year has been a particularly difficult one, and it augurs very well for CSIRO that it has the staff to maintain the highest levels of professionalism in such challenging times.

Highlights of the Year

CSIRO's research has produced many major advances in the past year. The examples described in this section illustrate the Organisation's commitment to advancing Australian industry and community well-being.

A steam-cleaning device prepares a diecasting unit for operation. CSIRO technology is helping to improve productivity in Australia's diecasting industry (see page 14).



CAR-MAKERS ADOPT DIECASTING TECHNOLOGY

An Australian company, Moldflow Pty Ltd, has successfully marketed CSIRO-based diecasting technology to manufacturers in Detroit, home of the United States' car industry.

CSIRO worked closely with Moldflow to develop computer software used in the design of diecast components of vehicles. The software, known as 'Metlflow', incorporates knowledge derived from CSIRO's diecasting research program carried out by the Division of Manufacturing Technology.

Metlflow's big strength is its ability to design diecasting tools that minimise flaws caused by surface defects and air pockets in the cast metal, problems that can lead to serious failures when the parts are in service.

It has already been used by suppliers to General Motors Holden in designing diecasting tools for Holden engines exported to Europe and by Nissan in their Australian vehicles.

Now, Moldflow has sold die-design work for vehicle components to Sealed Power Corporation of Michigan, manufacturer of parts for the 1988 range of Ford vehicles.

A major export success for Australian technology, the sale is helping to establish Moldflow on the world market.

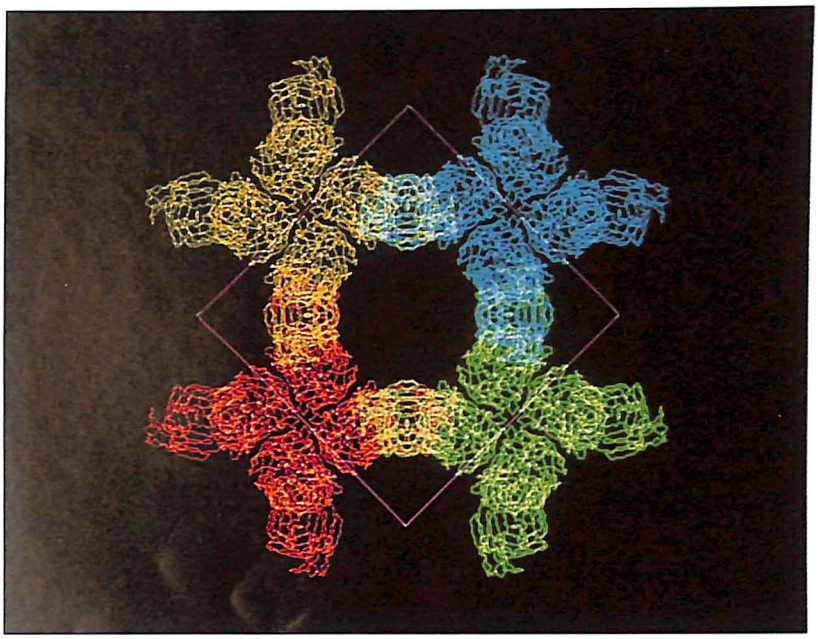
TOWARDS A FLU CURE

Despite the best efforts of medical science, influenza epidemics continue to sweep around the world with distressing regularity. No cure is available and vaccines against one year's strain are ineffective against the next. Unlike other viral diseases such as measles, influenza is not a once-only affair; one attack does not leave behind effective defences against subsequent infection.

The problem is the constantly changing structure of the surface proteins of the influenza virus. It is these proteins that antibodies — built up by an attack of the flu or by vaccination — act against. When confronted with a new set of surface proteins, the antibodies are unable to provide any protection against influenza virus attack.

However, the situation is not hopeless. Research by the CSIRO Division of Protein Chemistry, the Australian National University and the Victorian College of Pharmacy is showing promise of leading to a cure for the flu. An Australian company, Biota Holdings Ltd, is supporting the work.

A key finding by the CSIRO team is that one of the influenza virus's surface proteins — called neuraminidase — contains a portion that does not vary from



Research at the Division of Protein Chemistry has revealed how antibodies bind to the influenza virus. This computer image shows detail of the crystal packing on an influenza antibody/antigen complex.

strain to strain. A flu drug that targeted this part should be effective against all strains, and the collaborating researchers are investigating the possibility of producing such a chemical.

The CSIRO group determined the three-dimensional structure of neuraminidase — an important step forward in the search for an anti-flu agent. Recently the researchers achieved another major success with their determination of the structure of a neuraminidase/antibody complex. This has thrown new light on the whole question of how antibodies interact with invading viruses and microbes.

MAJOR MICROCHIP ADVANCE

Researchers from CSIRO's Division of Radiophysics have collaborated with Austek Microsystems Pty Ltd in designing a microchip that represents both a major advance in technology and an important opportunity for Australian industry.

The chip uses very-large-scale-integration technology and is designed to carry out a mathematical procedure known as fast Fourier transforms (FFT). It operates five times faster than its known competitors.

FFT analysis is useful in searching for patterns in large volumes of complex information. It is used in areas such as communications and computer-based voice recognition.

At first, the uses for the chip are likely to be in specialist fields. However, it is so fast that it should revolutionise electronic equipment in a wide range of fields, from laboratory and engineering machinery to mining, telecommunications and remote sensing. It should eventually appear in consumer items such as videos and hi-fi equipment.

BETTER ROBOTS FOR CAR-MAKERS

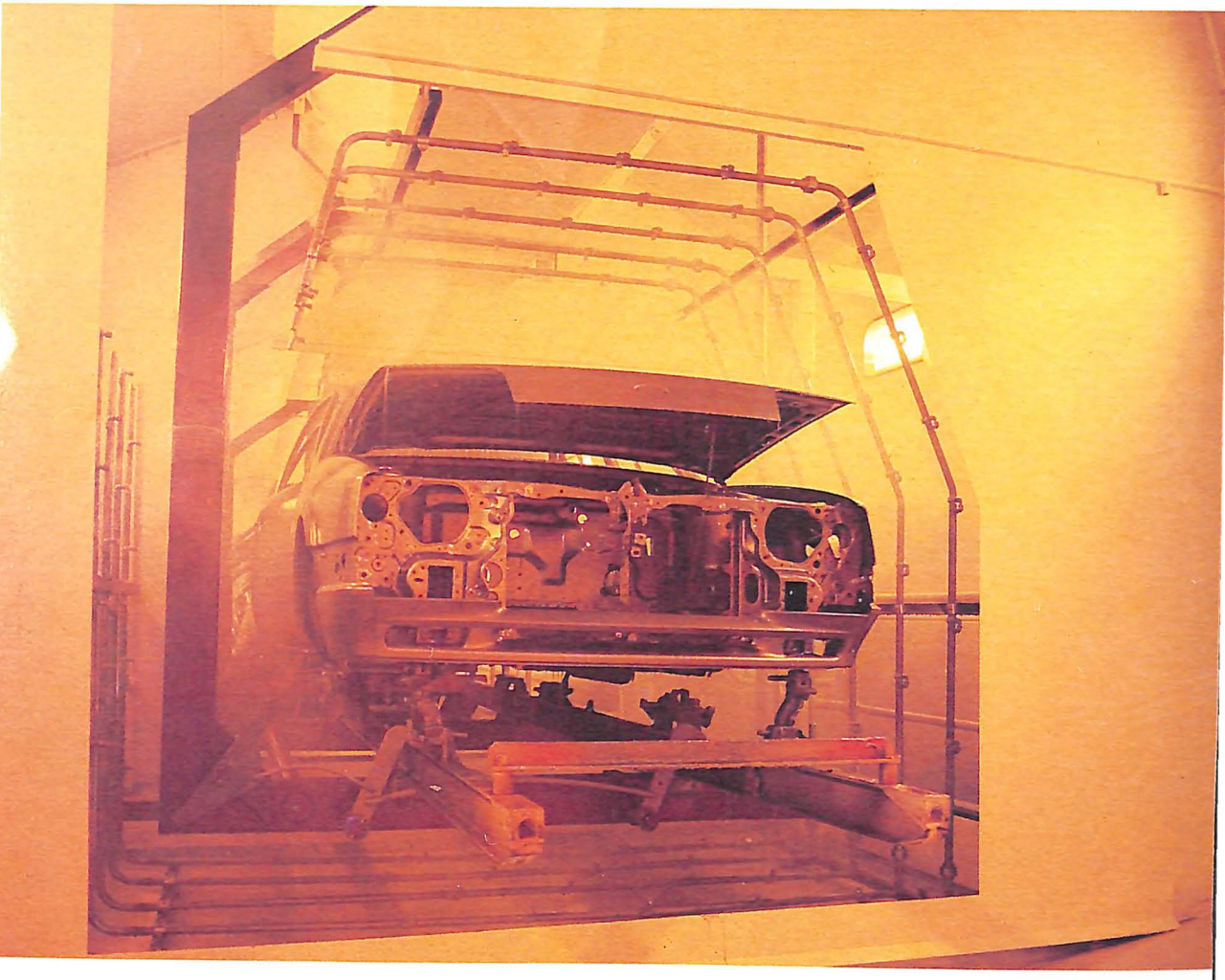
Inside the new $60 million paint shop at Ford Australia's plant at Broadmeadows, Melbourne. Collaborative computer simulation studies by CSIRO and Ford contributed to its design. The picture shows the final rinse stage of the corrosion protection process.

CSIRO involvement in industrial computer programming has helped Australia's largest robot manufacturer, Machine Dynamics Pty Ltd, win a $6 million order from car-maker Ford Australia.

Machine Dynamics will provide two 'flexible manufacturing systems', incorporating 27 industrial robots, for use in production of the new EA 26 Ford Falcon.

CSIRO's Division of Manufacturing Technology worked with Machine Dynamics in preparing a detailed computer simulation of the robot production line, which convinced Ford that the Australian product could do the job better than imported machines.

The order will provide Machine Dynamics with a solid base for expansion into the



export market for robots and manufacturing systems.

The Division of Manufacturing Technology has also collaborated with Ford Australia in the design of a new $60 million paint shop at the company's Broadmeadows plant in Melbourne. The work involved computer simulation of the operations of the paint shop and an associated car-body storage system, and led to design modifications to increase the reliability of operations.

DIRECTLY REDUCING STEEL-SMELTING COSTS

Research has a big role to play in cutting capital and operating costs in the iron- and steel-making industry. Building on their process-modelling experience in the minerals industry, researchers from the CSIRO Division of Mineral Engineering are now working on a high-intensity direct-smelting process for iron and steel.

Direct smelting is a single-stage process in which iron ore is mixed directly with fuel and oxygen in a molten iron bath inside a converter. As the fuel burns and provides the process heat, the iron ore is reduced and more liquid metal obtained.

The process has several advantages over conventional blast-furnace techniques. It allows the use of cheaper fuels than blast-furnace coke, avoids problems of agglomeration of the iron ore, and is much less polluting. One of its biggest advantages is that it can be operated profitably on a smaller scale than is required for most iron- or steel-making plants.

The CSIRO researchers are collaborating with CRA in a major research program that links industrial performance data with fundamental research findings. Earlier work on coal gasification in liquid iron, supported by the National Energy Research, Development and Demonstration Council, has contributed to the development of direct smelting.

CRA has purchased steel-making technology and is operating a pilot plant in West Germany to develop a range of direct-smelting processes. CSIRO's involvement has been in developing thermodynamic and fluid models of the process described above, experiments with small high-intensity furnaces, and development of software for process control.

Direct ferrous-smelting promises to be a major step forward for Australia's steel industry.

Steel-making. A collaborative research project is investigating a direct-smelting process that may cut capital and operating costs in the iron and steel industry.

The State Rail Authority of New South Wales is among major purchasers of advanced technology, developed by CSIRONET and an industrial collaborator, for linking computers and computer networks.

BETTER COMPUTER NETWORKS

Recent multi-million-dollar sales have demonstrated the worth of a new product known as an 'ultranode' in linking computer networks and different types of computers. The ultranode was developed by CSIRONET (the independent computing agency of CSIRO) and the company Network Research.

Under a $3.4 million contract, the State Rail Authority of New South Wales is buying ultranodes to provide high-speed data links between its computer systems. And in South Australia a $2 million contract will see them installed as a vital element in the State's new Justice Information System.

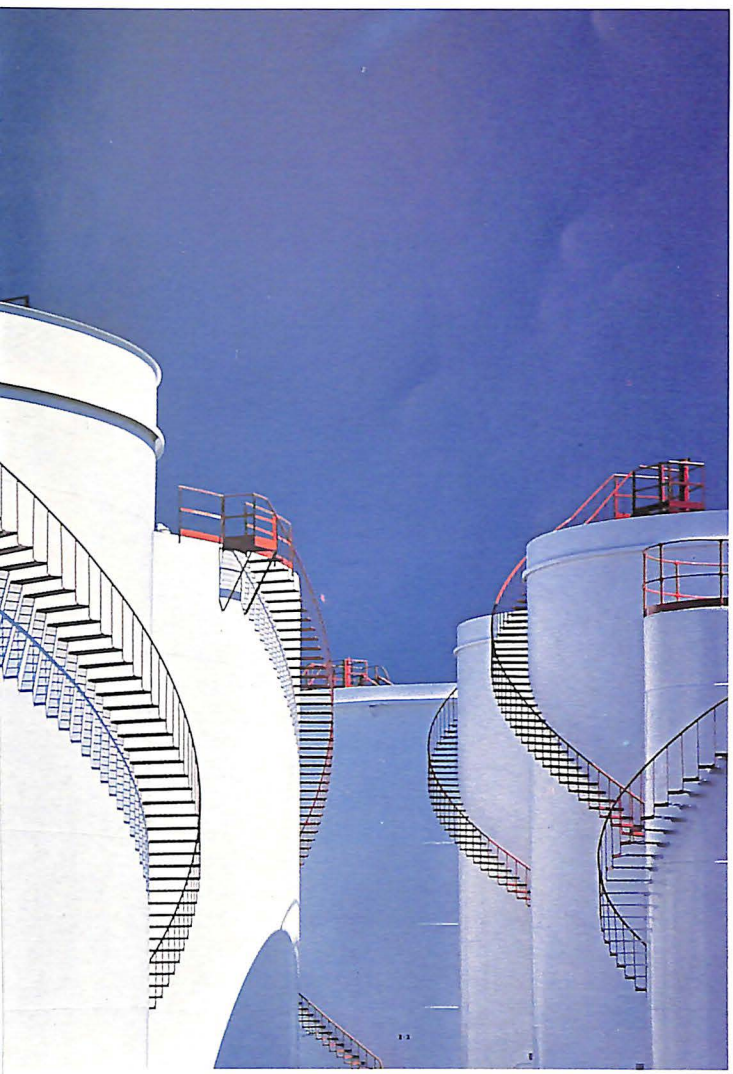
In February 1987, CSIRONET and the Techway group of companies (to which Network Research belongs) formed a joint venture company to market computer communications systems. The ultranode is the cornerstone of its major marketing drive both overseas and in Australia. The new company, Network Automation, is 40 per cent owned by CSIRONET and 60 per cent by Techway.

Barely the size of a suitcase, the ultranode can link mainframes and mini-computers as well as personal computers across whole continents or, indeed, around the world. Having no moving parts, it is very reliable and can operate in a wide range of

environmental conditions. Its sophisticated circuitry enables faults in a network to be detected before they cause a breakdown and inconvenience users.

In the Justice Information System network, ultranodes will link terminals and printers at 186 locations. The network will allow quicker police checks on outstanding warrants and improve management of crime statistics, making it easier to monitor trends in crime. The State Rail Authority computer network, when fully operational, will be able to support 1200 terminals at locations throughout New South Wales. It will improve the efficiency of activities as diverse as time-tabling, rolling-stock management, bookings acceptance, and locomotive maintenance scheduling.

A major new research project is investigating a promising process for producing liquid fuels — able to power Australia's cars and transport fleets — from natural gas.



TRANSPORT FUELS FROM NATURAL GAS

Converting natural gas to liquid transport fuels is a tantalising prospect in Australia, which has extensive reserves of gas but only limited reserves of oil.

At the moment, the New Zealand gas-to-gasoline process is the only example of such a conversion process operating on a commercial scale, and it initially required a considerable investment from the government.

CSIRO has now joined with BHP and researchers from four universities — New South Wales, Sydney, Tasmania and Macquarie — in a task force aimed at developing a catalytic process that converts methane (the main constituent of natural gas) to ethylene (a precursor to gasoline and diesel fuels).

The process is showing promise, and is based on simple, cheap catalysts. It has the potential to be considerably more efficient than conventional gas-conversion technologies, and could prove less costly. CSIRO researchers from the Divisions of Fossil Fuels, Energy

Three of the more than 6000 people who visited CSIRO's Division of Entomology in Canberra during its Open Day in August 1986.

Chemistry, and Materials Science and Technology are working on various aspects of the process, and the work is coordinated by the Chief of the Division of Fossil Fuels.

The collaborative effort is receiving substantial funding from the National Energy Research, Development and Demonstration Council and the Industry Research and Development Board.

INCINERATING INTRACTABLE WASTES

Many industries use or produce organic chemicals that are toxic or hazardous in some way. Most of these substances can be chemically or physically neutralised without leaving any dangerous residues.

But some, such as the 'PCBs' (polychlorinated biphenyls), are extremely stable, as well as extremely dangerous. At the moment, they are exported for destruction (at a cost of up to $6000 a tonne) or stockpiled, though an unknown amount is illegally dumped.

Without a proper disposal system, these chemicals are a mounting problem. Over 7000 tonnes of waste are sitting around the country at present, and about a thousand tonnes are produced each year.

CSIRO researchers have developed a small, high-temperature incinerator that can completely destroy these chemicals. The unit was built to deal with waste organic chemicals resulting from research at the Division of Applied Organic Chemistry.

It is the only unit in Australia capable of handling these chemicals, and is designed to meet Victorian Environmental Protection Authority emission and effluent standards.

Although the incinerator can only handle liquids, it may offer an alternative to a single, large incinerator for handling the country's dangerous organic wastes. Such an installation is planned, but there is strong resistance from people living near proposed sites.

In collaboration with an Australian company, the researchers aim to develop a commercial version that companies could install on-site, or that could be used as a mobile unit to visit waste-generating companies periodically.

LEAN MEAT LOWERS HEART-DISEASE RISK

Research at the Division of Human Nutrition shows that moderate lean-meat consumption in a fibre-rich diet is compatible with reduced risk of heart disease.

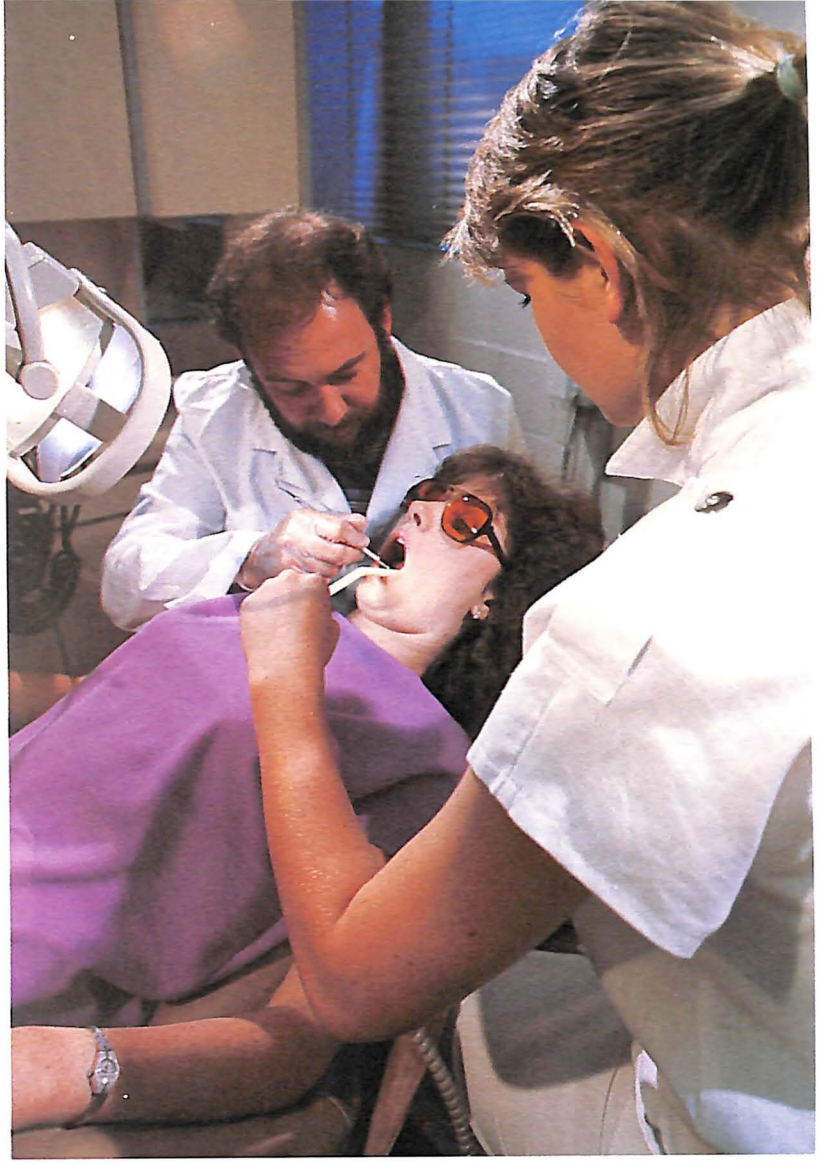
The typical Australian diet is high in fats, high in cholesterol and low in fibre — a regimen that increases the risk of heart disease. Researchers in CSIRO's Division of Human Nutrition have demonstrated that moderate lean-meat consumption in a general fibre-rich diet can lower that risk.

The researchers measured blood pressure and serum cholesterol (a substance linked to increased heart-disease risk) in the blood of three groups of men given different diets: a typical Australian diet, a 'prudent' lean-meat diet, and a vegetarian diet.

The energy intake in each diet was the same, but in the Australian diet, more energy came from fats, and particularly from cholesterol-rich foods. The lean-meat and vegetarian diets contained much less fat and differed only in the source of protein — meat in the former and plant protein in the latter.

After 12 weeks, the Australian diet had produced a rise in serum cholesterol. The vegetarian diet, on the other hand, had succeeded in reducing both blood pressure and serum cholesterol — an eight per cent fall in cholesterol levels being recorded. The lean-meat diet also gave good results, reducing serum cholesterol by about five per cent.

These results clearly demonstrate that a prudent diet can include lean meat, yet significantly lower a major risk factor for heart attack — good news for both meat producers and meat eaters.



A multi-million-dollar market is likely for a new polymer adhesive for tooth fillings developed by CSIRO in collaboration with industry.

BETTER DENTAL FILLINGS

Better-looking, safer and easier dental fillings will be the result of collaboration between CSIRO polymer researchers from the Division of Applied Organic Chemistry, Southern Dental Industries Limited and the National Biological Standards Laboratory.

The scientists have developed a polymer adhesive that will bond to both the plastic filling and the remaining part of the tooth. The research has involved synthesising a new polymer made up of two types of segments; one bonds securely to dentine (the tooth material), and the other to the restorative filling material.

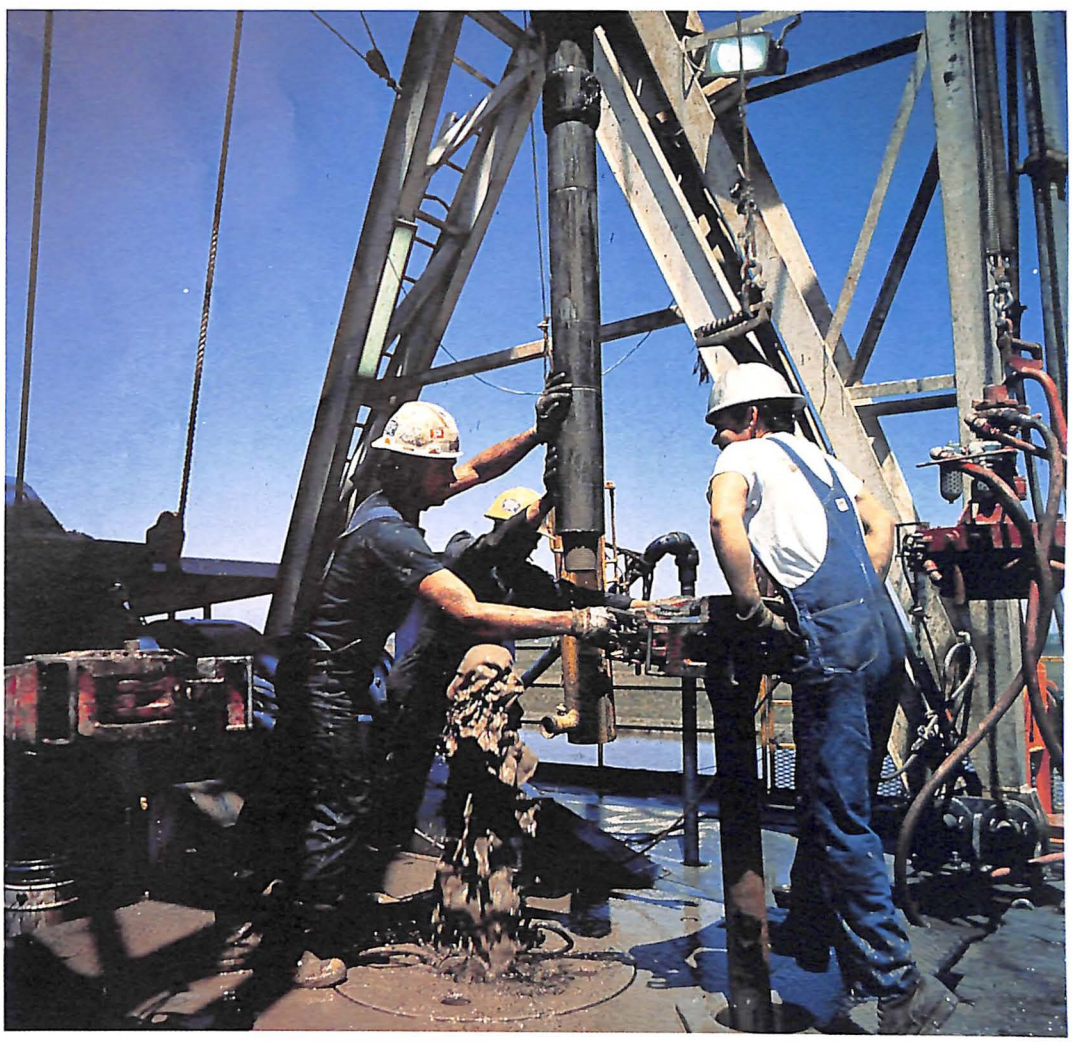
CSIRO's wide experience in novel polymer research has been drawn on to come up with the right composition. The new polymer will allow the development of new techniques for filling teeth, as well as making current methods faster, easier and more comfortable for the patient. The collaborators estimate that the new adhesive will have a multi-million-dollar world-wide market.

Energy Research, Development, and Demonstration Council, CSIRO's Division of Mineral Physics and Mineralogy is collaborating with the Bureau of Mineral Resources in studying the use of microbes to extract the extra oil.

The process exploits bacteria that produce natural surfactants, gases, and other substances that encourage oil flow. In early tests on a Queensland deposit, flushing with a bacterial culture raised oil recovery from 49 to 70 per cent.

Now, work is concentrating on selecting the best strains of microbes and testing their nutrient and environmental requirements. The researchers are also working with TMOC Ltd in field trials of the technique in Queensland's Surat Basin. As well, the technology has been licensed to BWN–Vortoil to be developed and marketed in Australia and overseas.

The use of microbes to increase the amount of oil extracted from oil wells is showing considerable promise.



SAFER RADIOACTIVE-WASTE DISPOSAL

CSIRO geomechanical researchers have proposed a major innovation for long-term, safe storage of high-level wastes from the nuclear industry.

Most storage proposals involve immobilising wastes from spent nuclear fuel in a solid such as glass or SYNROC. Canisters of the solid would then be buried deep in some geologically safe part of the Earth.

The radioactive wastes must be isolated for up to a million years. Not only that, they produce large amounts of heat, and can corrode their storage vessels.

Even the safest underground storages contain water moving through the rock. The decaying waste would heat the water, seriously increasing its corrosive effect on both the waste canisters and the surrounding rock.

The groundwater could carry away radioactive material leached from the canisters — possibly back to the surface and into our ecosystem.

The CSIRO development uses a 'thermosyphon loop' to reduce the leaching. The technique uses the groundwater to cool the waste, via the same principle utilised in a solar water-heater.

Groundwater would circulate through a channel of rubble around the storage, driven by heat from the waste. The heat would dissipate into the surrounding rock without ever producing damaging temperatures. Securely isolated, the waste would decay slowly and predictably towards safe levels.

CSIRO experiments have confirmed that such a method is feasible, and more research is planned to develop a workable system. The Commonwealth Department of Industry, Technology and Commerce is funding the work to the tune of $300 000.

MICROBIALLY ENHANCED OIL RECOVERY

Facing uncertain future supplies, Australia has a big incentive to find more oil. But new discoveries are becoming more costly — and less and less likely.

One alternative is to get more out of current and exhausted fields — present methods typically extract only 30 per cent of the oil in a deposit.

There are several ways to increase recovery: flushing with water, gaseous hydrocarbons or carbon dioxide; heating to increase the flow; and flushing with a chemical surfactant that makes the oil droplets less 'sticky'. But all these methods require energy; the extra oil garnered may not justify the effort or expense.

Funded by the Australian Mineral Industries Research Association and the National

The development of processes for producing 'super-clean' and 'ultra-clean' coal promises to open up new markets for Australian coal.

BIG SAVINGS FROM CLEANER COAL

When it is mined, coal typically contains about 20 per cent ash-forming mineral matter, and this figure can reach 30 per cent or more. While conventional coal-cleaning methods lower the ash content to between 6 and 20 per cent, this level of impurity rules out some potential uses of coal.

Overseas customers are looking increasingly for coal with lower ash contents, particularly for uses such as coking. Also, large prospective markets exist for even higher-quality coals that are clean-burning and more easily handled and transported.

Scientists in the CSIRO Divisions of Energy Chemistry and Fossil Fuels are working on coal-cleaning technology that can yield 'super-clean' (1 to 6 per cent ash) and 'ultra-clean' (0·1 to 1 per cent ash) coals. The premium coals can be produced as dry powders or as suspensions in water.

These coals could replace expensive fuel oil in furnaces and boilers. They could also eventually be used in internal-combustion engines and gas turbines, as well as being a feedstock for manufactured carbon products. The coal industry would be able to offer a wider range of products tailored to specific uses. This should lead to higher exports, lower imports and better use of our coal reserves.

CSIRO is collaborating with engineering consultants to demonstrate the integration of super-clean coal production with that of normal coal, and has also formed a consortium with industry and New South Wales Government authorities to develop a prototype plant for ultra-clean coal. The consortium plans to build the pilot plant at a New South Wales mine site to treat coals from several mines for use in combustion studies.

WATER-TREATMENT PROCESS EXPORTED

A purification process invented by researchers from the CSIRO Division of Chemical and Wood Technology will be used in a new water-treatment plant in the United Kingdom. The process, called Sirofloc, uses small magnetite particles to remove colour and impurities from water.

Austep Pty Ltd, the exclusive licensee of the CSIRO technology, won the order via its UK agent, Davy McKee Environmental Ltd. The purchaser is the Yorkshire Water Authority, which is building a new plant at Redmires, near Sheffield.

The $A3.8 million installation is based on a Sirofloc pilot plant constructed to the Austep design and endorsed by the UK Water Research Centre.

Austep is confident that the sale will lead to further orders in Europe, particularly because the Sirofloc process can be used in tandem with existing treatment plants. It is especially effective in areas where land is in short supply. The speed of the process greatly reduces the size of the overall plant, making it a good alternative to conventional treatment in, for example, South-east Asian cities.

CSIRO coordinates national judging for the BHP Science Prize in its role as co-organiser of the competition with BHP and the Australian Science Teachers Association, with support from Westinghouse. The photograph shows Stephen Murphy of Melbourne — the 1986 winner and at 12 the youngest-ever recipient of the $5000 award — with the Chairman of BHP, Sir James Balderstone.

CSIRO put its work in manufacturing, biotechnology, space science and advanced materials on show at the International Technology Exhibition, held in Canberra in March 1987. The event was aimed at senior industrial management and government officials. The Prime Minister, Mr Hawke, and the Minister for Industry, Technology and Commerce, Senator Button, were among visitors to CSIRO's exhibit.

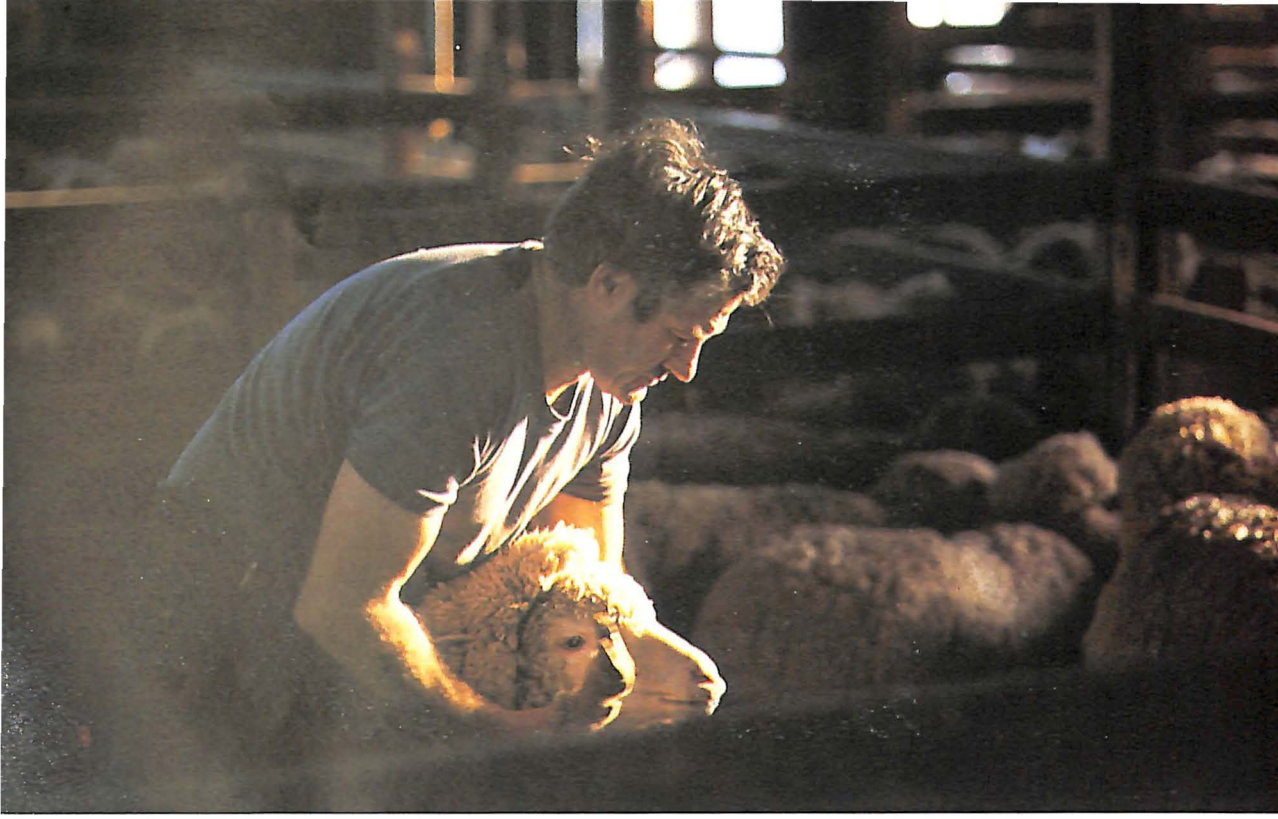
MILK AND CHEESE

Australia's dairy industry and dairy-product consumers stand to benefit from CSIRO developments that have also opened up new export opportunities.

One is an automated, continuous method of making cheddar cheese. A replacement for traditional batch processes, it produces up to eight per cent more high-quality cheese from a given amount of milk. CSIRO researchers from the Division of Food Research have developed the process — known as APV–Sirocurd — in collaboration with APV Bell Bryant Pty Ltd. The first plant is operating in Victoria, and substantial sales of the Sirocurd technology and APV equipment are likely in Australia and overseas.

Another world first is the recent establishment of a Victorian plant that produces milk powder suitable for people who cannot easily digest lactose, a sugar found in milk. Lactose intolerance is a widespread inherited characteristic, particularly among Asian and Aboriginal people. The new process, developed by researchers from the Sumitomo Chemical Company of Japan and CSIRO in collaboration with two Australian companies, APV Bell Bryant Pty Ltd and Miles Laboratories Australia Pty Ltd, splits lactose into the simple sugars, glucose and galactose.

Lower milk transport costs are likely to result from the application of a process that uses membranes to remove water from milk. In Australia, most dairy farms and country milk depots are a long way from urban markets, and milk is heavy, bulky and expensive to transport. Cut its volume by half, and transport costs are reduced by a similar amount. After an equivalent amount of water is added to the milk concentrate, taste testers cannot distinguish it from normal milk. The process is being evaluated in collaboration with a Victorian dairy company.



Australia's livestock industries benefit from the development of new and improved vaccines.

VACCINES FOR THE FARM

Major advances in developing vaccines for farm animals have been made by CSIRO researchers from three Divisions — Animal Health, Protein Chemistry, and Molecular Biology.

A vaccine to protect cattle, sheep, and goats against the mammary-gland infection mastitis — sought by veterinary researchers since early this century — is moving towards commercial reality. So are two of the first vaccines produced using recombinant-DNA (genetic engineering) technology — for foot-rot in sheep and a highly contagious condition in chickens called infectious bursal disease.

Mastitis costs Australian dairy farmers more than $50 million a year, and also causes losses for prime-lamb producers. In most cases the infamous golden staph (*Staphylococcus aureus*) is responsible, and the new vaccine counters this bacterium. Researchers faced many problems in developing it, including the fact that warm milk in the udder is an excellent growth medium for bacteria. Success was a long time in coming; now a vaccine has been patented and development is proceeding, in conjunction with two veterinary chemical companies.

Development of the foot-rot vaccine is also proceeding in collaboration with industry. Foot-rot costs farmers some $60 million a year, and researchers from the three CSIRO Divisions and the University of Sydney collaborated in the pioneering research that led to the new vaccine. The recombinant-DNA technology that produces it has many advantages over the procedure used to produce conventional foot-rot vaccine, and tests have shown the new product to be at least as effective as the old.

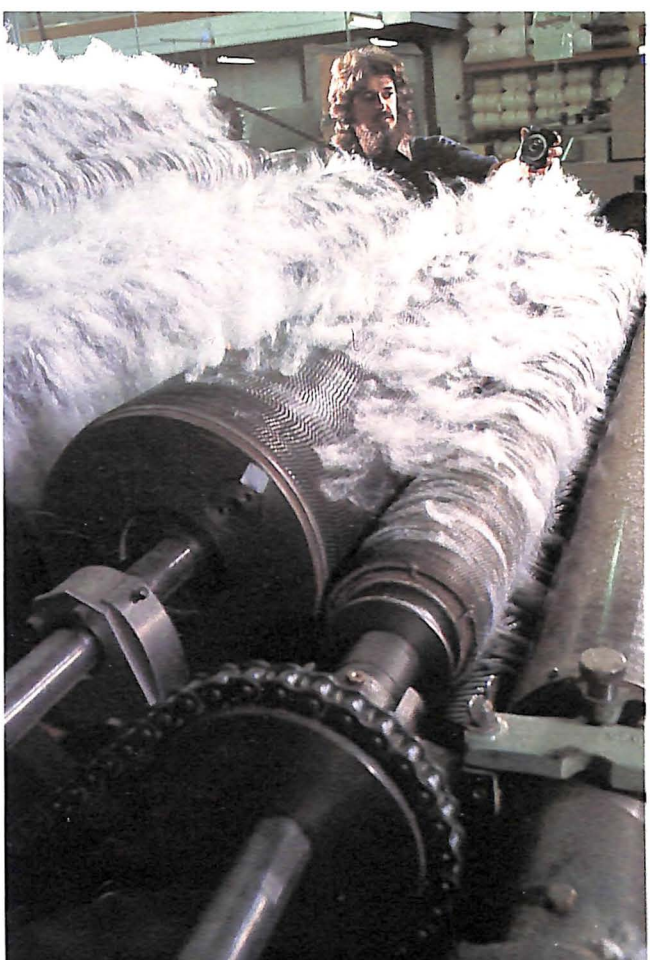
The other genetically engineered vaccine will protect chickens against a viral disease that damages their immune system and can lead to large economic losses as young birds succumb to viral and bacterial infections that would normally cause few problems. Like the mastitis and foot-rot vaccines, this infectious bursal disease vaccine will be commercialised under a collaborative CSIRO–industry arrangement.

LOWERING WOOL-PROCESSING COSTS

Research continues to improve the efficiency of wool processing, and hence the competitiveness of wool products. New findings have led to a major productivity improvement in carding, the process that turns scoured wool into a continuous web of fibres.

Australia's position as the world's leading fine-wool producer depends on wool processors being able to keep pace with competition from synthetic and other fibres.

Researchers from CSIRO have contributed to better wool-processing technology through developments such as Sirospun. Recent research at the Division of Textile Industry has made a significant contribution to improving the productivity of worsted carding. In this process, the scoured wool is disentangled into individual fibres by rollers covered with metal teeth and reassembled into a continuous web of fibres called a sliver. This must be done with a minimum of fibre breakage in order to reduce waste in subsequent combing and to maintain fibre length for efficient spinning.



The capital costs of carding are significant, upwards of $500 000 per card. While carding productivity for fibres such as cotton has improved in recent years, worsted carding of wool has not achieved the same increases, mainly because higher carding rates caused greater fibre breakage. The CSIRO studies have shown that, provided the density of fibres on the surface of the rollers in critical sections of the card is controlled, the speed can be increased. Card speeds in worsted wool processing now match those used in cotton or synthetic fibre carding, without any detriment to fibre length or wastage in combing.

The higher card speeds bring large increases in card

productivity. In trials with a leading Australian wool-processing company, a 60 per cent increase in production rate has been achieved. This means two cards can do the work of three, and substantial savings in capital replacement costs have been made.

MANAGING ELECTRICAL DEMAND IN INDUSTRY

Factories consume large amounts of electrical power, and the cost of this energy can be a significant part of the total economics of running a business. Also, the tariffs charged for electricity are becoming more complex — big users of power can find themselves carrying unnecessary costs owing to poor scheduling of operations.

Researchers from CSIRO's Division of Energy Technology have developed a computer program, known as ELMO, that can help plant managers minimise their electricity costs. The program models the operation of a plant, allowing for the changing demand for electricity from different processes and at different times of the day. All forms and consumption of energy are linked together in the model, and a range of industrial equipment, such as boilers, turbines and pumps, can be accommodated.

The program analyses how much and at what time electricity will be needed in the plant. The results can be used to operate the plant in a way that cuts the total demand for electricity. Also, the method can be used to take 'snapshots' of the plant's energy flows, to assess its efficiency and to analyse the effects of upgrading equipment.

The first commercial application of ELMO has been a study of the operation of the AMCOR Pty Ltd paper mill at Botany, in Sydney.

Right: Minimising energy use can produce big savings for industry. A CSIRO-developed computer program — ELMO — is helping companies cut their electricity requirements.

CUTTING BUILDING-QUOTE COSTS

The time and cost of preparing quotations for building new houses and alterations and additions are being cut significantly with an on-line computer service developed by researchers from CSIRO's Division of Building Research.

The system, called QUOTE, also operates on most personal computers and allows a builder to prepare cost estimates based on answers to a series of questions about the job specifications, such as floor, wall and roof type, and proposed dimensions.

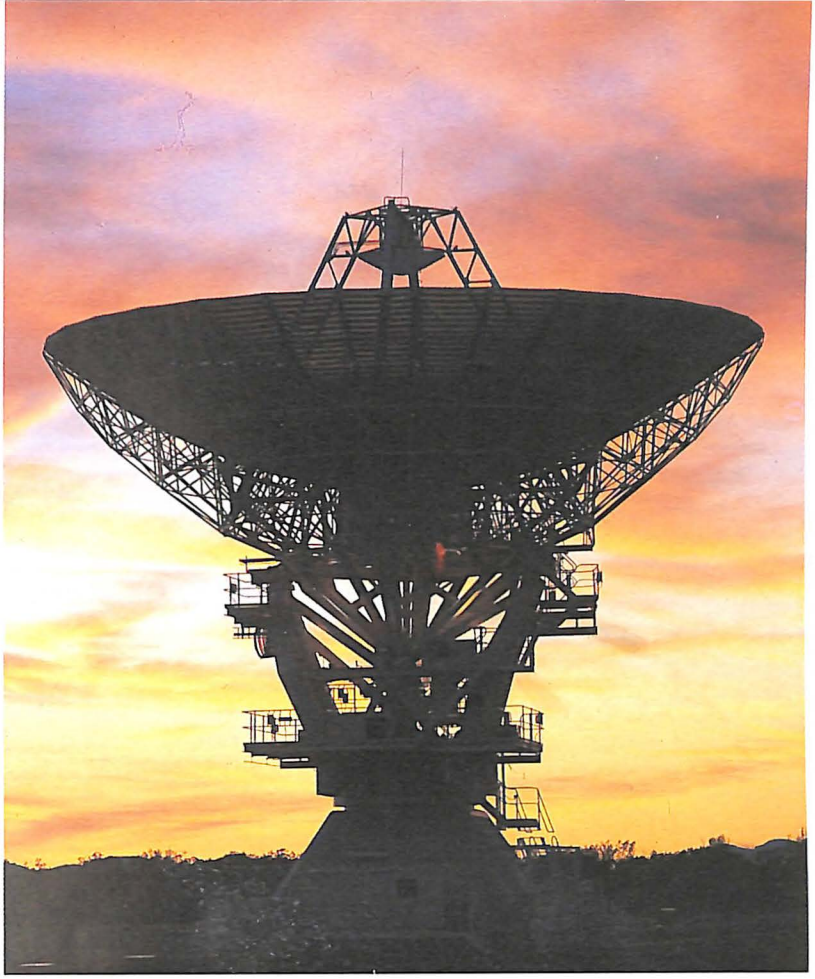
The program calculates the quantities of components and materials needed and provides the builder with an estimated cost for each part of the job and its total cost, based on a price file held in the computer. Since builders often have different ways of allocating overhead costs and profit, these are not included in the program.

The QUOTE system is interactive, allowing the user to

review and modify any of the costs before settling on a final figure. It should provide more consistent and accurate quotations by removing many of the time-consuming and error-prone parts of the process.

QUOTE is being marketed by the Housing Industry Association under a collaborative agreement with CSIRO and is accessible by builders using the Association's HIATEX videotex system. There are more than 150 regular users of QUOTE, and it is becoming more popular as builders recognise its value.

A computer-based system for preparing building cost estimates is proving a boon to house builders.



At Culgoora, N.S.W. — the first Australia Telescope antenna.

AUSTRALIA TELESCOPE — THE FIRST ANTENNA

The Australia Telescope, a Bicentennial project, reached a major milestone recently when the first antenna was handed over to CSIRO. The Telescope will eventually comprise an array of mobile radio-telescope antennas centred on Culgoora, near Narrabri, N.S.W., with a further antenna at Siding Spring, near Coonabarabran, and links to the Parkes 64-metre radio-telescope.

The antenna was constructed by Evans Deakin Industries Pty Ltd based on specifications provided by the CSIRO Division of Radiophysics, in conjunction with its consulting engineers, Macdonald Wagner Pty Ltd. The Division will operate the Telescope as a national facility.

The Australia Telescope will be one of the world's largest, and will be able to map the universe in unprecedented detail. It will be a very versatile instrument whose capabilities can be extended by linking it to radio-telescopes elsewhere in the world.

The design and construction of the Telescope is providing a big boost to Australian industry. For example, the technology used in the VLSI/FFT chip (page 15) was developed in the design of the correlator chips that will process the enormous amount of information to be collected by the Australia Telescope.

BIG, BLACK AND SEEDLESS

Researchers from the CSIRO Division of Horticultural Research recently released what is believed to be the world's largest black seedless table-grape variety.

They are hopeful that the variety will help Australia's penetration of the lucrative northern-hemisphere table-grape market and increase exports to traditional markets in South-east Asia and the Middle East. During the off-season in Europe, supplies mainly come from Chile and South Africa.

The new variety can average 21·5 millimetres in berry diameter without the application of chemicals that are often used to increase berry size in other black and white seedless varieties. The export standard for seedless table grapes is 16 millimetres.

The 1987 season was the first time that the new grape was grown in commercial quantities. Trial shipments were sent to the Middle East and South-east Asia, and the limited quantities released on the home market sold well in capital cities.

A crew from the ABC's *Quantum* program obtained some spectacular footage when they visited the CSIRO Division of Building Research to film investigations being carried out into factors that determine how houses and their fittings stand up to bushfires.

CHEMICAL CONSULTANCY

CSIRO has moved to make its expertise in chemistry more readily available to Australian industry. The Organisation's technology-transfer company, Sirotech Ltd, has joined with Australian Mineral Development Laboratories Pty Ltd (AMDEL) in setting up Sirochem, a company that provides consultancy services for industry and government bodies.

Using the expertise and equipment of the CSIRO Division of Applied Organic Chemistry and AMDEL, Sirochem provides advice on chemical problems occurring in product manufacture and chemical processes. Sirochem offers a national facility with access to all AMDEL laboratories throughout Australia and to the CSIRO Division.

The Chairman, Mr Wran, the Minister for Science, Mr Jones, and CSIRO's Chief Executive, Dr Boardman, were among the official party shown over the new headquarters building of the CSIRO Division of Manufacturing Technology at its opening in February 1987. Mr Wran officially opened the laboratories, which are at Preston, Melbourne.

Already, Sirochem has worked on a number of industrial developments, including a new approach to effluent treatment, a multiple re-use adhesive, and a non-fouling bird-repellent compound.

INFRA-RED IRRIGATION CONTROL

Crops grow best and yield most when water is freely available to the plants. But matching water supply to crop requirements is a difficult and expensive exercise.

Irrigation farmers would benefit greatly from a quick and accurate method of determining the water status of their crops. Until now, this has required very elaborate equipment, but recent advances in infra-red thermometry have made it cheaper and easier.

Researchers from CSIRO's Centre for Irrigation and Freshwater Research have developed the use of a 'temperature gun' that can provide a read-out used to calculate a crop's water status.

The principle behind the device is that the leaves of well-watered plants are generally at much the same temperature as the surrounding air. However, when water is short, and the leaf pores begin to close, water flow through the plant slows up and the leaf temperature rises.

The operator takes readings of the air and leaf temperatures, and compares the difference with those that might arise in a well-watered crop. The farmer will then know whether or not the crop needs watering.

The researchers have applied this method, and the device, to the development of automatic irrigation systems. The detectors are permanently positioned above the field, and send their measurements to the farm's computer. When water stress is detected, the computer turns on the irrigation system and applies the required amount of water.

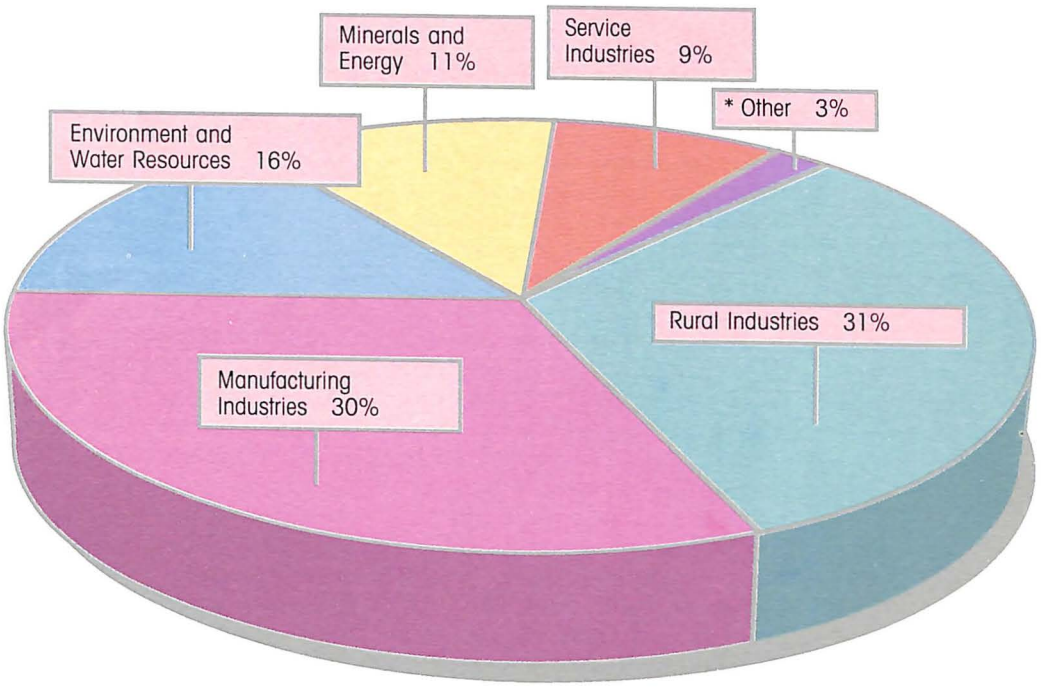
Distribution of Research Effort

The current distribution of CSIRO's research effort across major industry sectors and areas of community interest is set out in the chart below. This shows the proportions of CSIRO's professional staff engaged in research for each sector.

The table gives more detail and reveals that, in terms of appropriation-funded professionals, the manufacturing industries sector now receives the greatest support — some 30% of the total. However, when external support is included, rural industries by a small margin still account for the highest proportion of research activity (31% of total professional staffing).

At June 1987, the total number of professionals engaged in research activities was 2489, of whom just over 85% were funded from appropriation and nearly 15% from external sources. Despite a small increase in the number externally funded, an overall decrease of some 30 professionals has occurred since June 1986.

Since June 1984, the number of appropriation-funded professionals employed by CSIRO has decreased by about 70. This reflects the progressive tightening in government



*Other includes Astronomy and International Aid

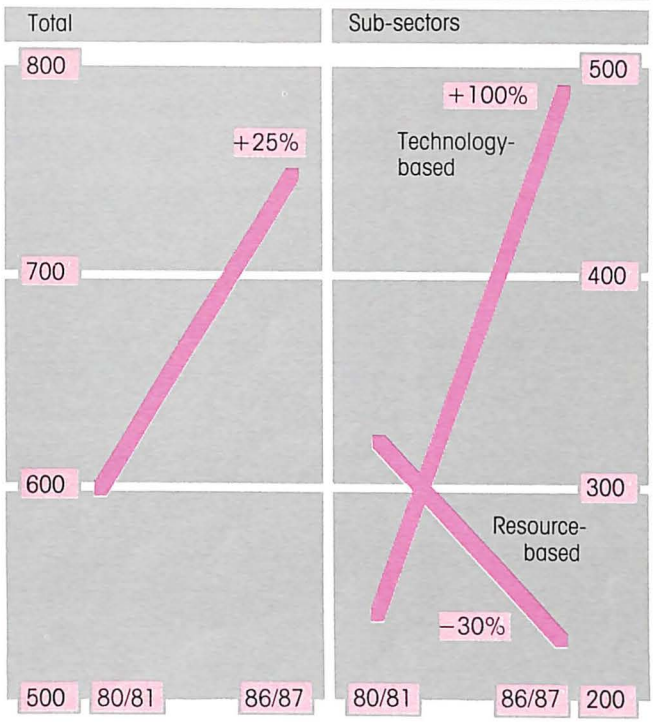
Distribution of CSIRO Research Effort — June 1987

Sector	% of appropriation-funded professional staff	% of total professional staff
Manufacturing Industries	30	30
Rural Industries	28	31
Environment and Water Resources	17	16
Minerals and Energy	11	11
Service Industries	10	9*
Astronomy	3	2
International Aid	1	1
	100	100

*Service Industries comprises:

Construction and Civil Engineering	3%
Human Health	3%
Information and Communication Industries	2%
Standards for Service Industries	1%

Professional Staffing — Manufacturing Industry Sector



funding of the Organisation over the last three years. The reduction has, however, been offset by an increase of about the same number in externally funded professionals — representing a 25% increase in professionals funded from external sources.

The main changes in the distribution of research effort in recent years have been the increases in support for manufacturing and information technology research.

Manufacturing Industries

In the six years since June 1981, the number of professionals engaged in manufacturing industries research has increased by about 25% — from some 600 to 750. And, as the graph shows, there has been an even more dramatic shift within this sector in the levels of support provided for different industries.

Support for technology-based manufacturing industries has increased by more than 100%, or nearly 250 professionals. This reflects the increasing importance CSIRO has placed since the start of the decade on research that can help broaden Australia's economic base and improve its export performance.

In recent years governments and industry also have increasingly recognised the need for a more internationally competitive and technology-based Australian manufacturing sector. The fruits of the early recognition by CSIRO of this

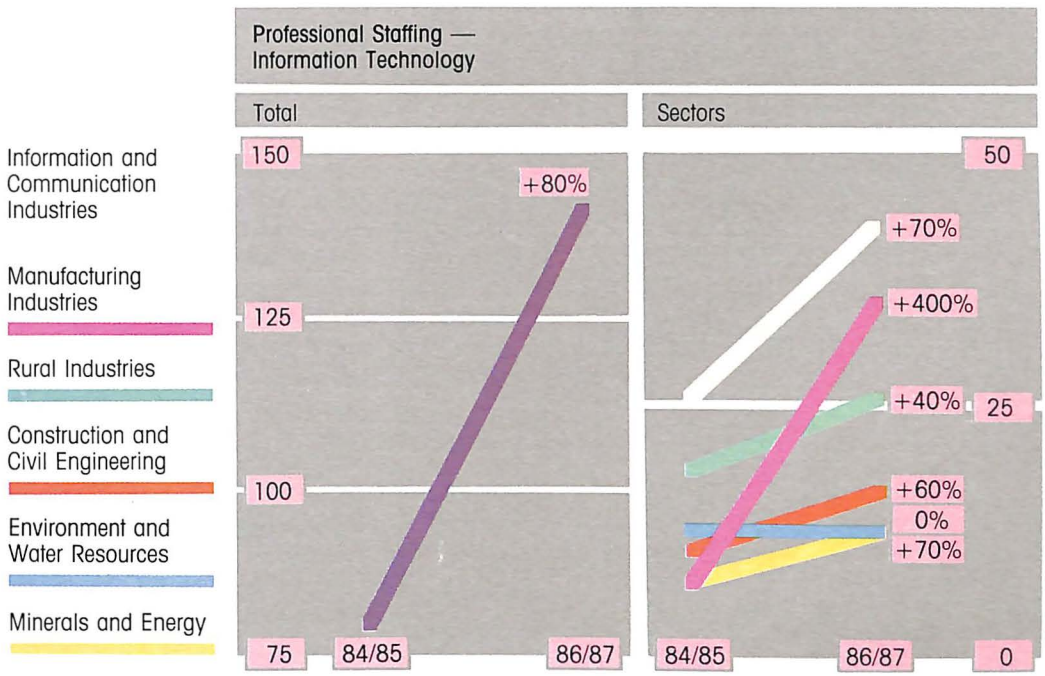
need are now being seen in increased commercialisation by Australian manufacturing enterprises of CSIRO-generated technologies.

The increase in support for technology-based manufacturing since 1981 has been achieved through redeployment of appropriation-funded staff positions and a build-up in external funding. Some 40% of the increase has come through transferring resources from the resource-based manufacturing area. A further 40% is attributable to redeployment from other sectors, predominantly from work on minerals and energy, and the remaining 20% has come from expanded external support. In respect of the whole manufacturing sector, external support has increased by 30%, or 25 professionals, since 1984.

Information Technology

Since June 1985, resources devoted to information technology have increased by more than 60 professionals, or about 80%, to the current level of some 140 professionals. The two years have seen a rapid build-up of effort in the new Division of Information Technology, which was established in 1985.

The widespread and diverse applications of information technology in industry and the community are reflected in the distribution of CSIRO's information technology resources across six use sectors (see the graph). These sectors range from the 'information and communication' industries (42 professionals, 30% of activities) to 'minerals and energy' and

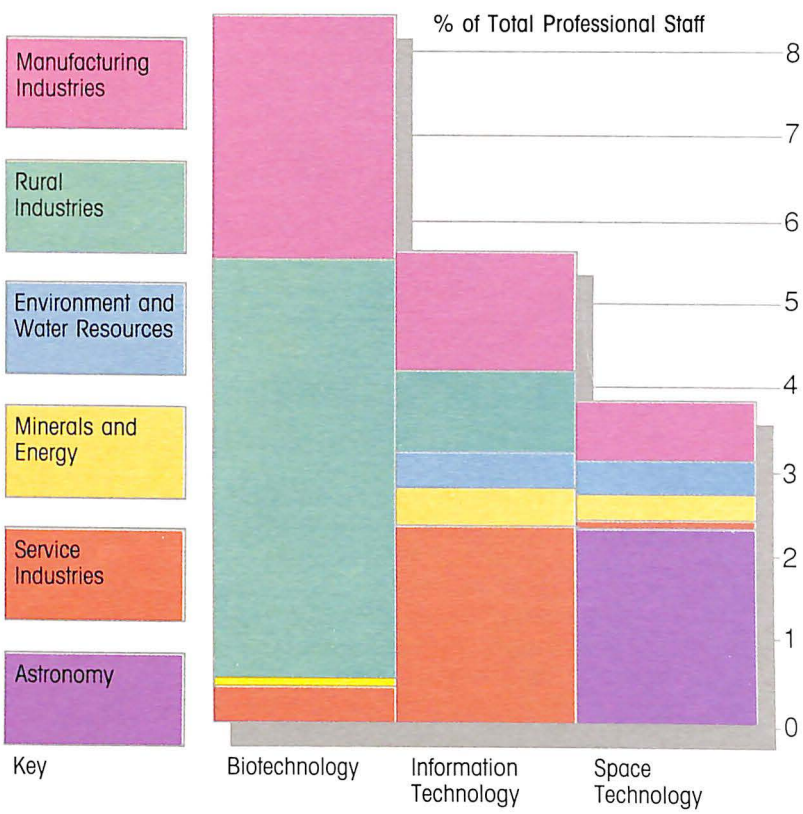


'environment and water resources', each with 12 professionals (approximately 10%). The greatest rate of growth has been in research on information technologies applicable to manufacturing industry; support has increased by 28 professionals, or 400%, over the two years to June 1987.

Biotechnology, Information Technology and Space Technology

CSIRO devotes about 18% of its research resources to three key technologies — biotechnology, information technology and space technology — that have applications across all of the sectors shown in the chart on page 36.

The chart below shows how research in these technologies is spread among the sectors. Overall, research on biotechnology occupies 8·4% of professional staff, information technology 5·6%, and space technology 3·8%.



Staff Matters

Performance Review and Development Program

A new performance review and development program has been formulated, for introduction in July 1987. To apply to all staff, it will see individual officers working to established objectives that are negotiated annually. The aim of the program is to enhance performance, productivity, job satisfaction and morale by:

- ensuring that all officers and their supervisors have a mutual understanding of job objectives and a way of assessing how well those objectives are achieved; and
- encouraging officers and supervisors to communicate regularly and openly about these and related matters.

Early Separation Incentive Scheme

The Early Separation Incentive Scheme, designed to free resources for redeployment to high-priority research areas, was introduced in November 1986. It offered incentives to selected staff to leave the Organisation. The scheme was introduced following Government consideration of the ASTEC report 'Future Directions for CSIRO'; the Government provided $5 million to help CSIRO meet its costs.

When the scheme is wound up following separations in December 1986 and July 1987, some 260 officers will have left CSIRO. About half will have been aged 55 or below.

Personnel Management Reforms

Following the Prime Minister's statement of September 1986 on proposed streamlining of procedures in Commonwealth departments and authorities, CSIRO has drawn up a schedule of proposed reforms to personnel management practices. The schedule includes measures relating to probation, appeals, disciplinary matters, redundancy, inefficiency and invalidity retirements. These are being negotiated with the staff associations.

CSIRO is also endeavouring to achieve greater flexibility in recruitment, staff rewards and job mobility. Currently under examination are the use of contract staffing, performance pay systems, superannuation, and staff exchanges and secondments.

Consultative Council

The Consultative Council, a forum for consultation between senior management and staff associations, met with the

CSIRO Board on 23 April 1987 and discussed, among other things, the working relationship to be established between the Board and the Council. Both accepted the need to concentrate on consultative processes in matters relating to organisational change in CSIRO. Council members from the staff associations confirmed to the Board that CSIRO had no major industrial problems.

At the regular Council meetings in October 1986 and April 1987 and at various sub-committee meetings, consultations took place on a range of matters including the implications of various recommendations in the ASTEC report, staff development and training, equal employment opportunity, personnel policies and employment conditions, and industrial democracy.

Sirotech

Sirotech Ltd plays a major role in promoting constructive links with industry and commercial development of the products of CSIRO research.

One highlight of 1986/87 was the negotiation of a $3 million research contract with the Australian Industry Development Corporation for work on low-toxicity agricultural chemicals. Others included the finalisation of commercial agreements for the large-scale development of new CSIRO smelting technology and for the manufacture of four new grade and quality measuring systems for the mining and mineral processing industries. Veterinary vaccines, electronics, information technology, wool and textiles, advanced materials, and timber products are among other areas covered by agreements concluded during the year.

Major ventures initiated on behalf of CSIRO in earlier years, including the Dunlena joint venture with Du Pont Australia Pty Ltd and the Z-Tech joint venture with ICI Australia Operations Pty Ltd, have been further developed. CSIRO/Sirotech equity at the end of the financial year in joint ventures that Sirotech has negotiated stood at more than $18 million.

Sirotech manages the CSIRO-Manufacturing Industry Collaborative Program, aimed at promoting mutually beneficial collaborative research funded jointly by CSIRO and industry. Fifteen projects were supported under this Program in 1986/87, with funding totalling just over $1 million. Research areas covered included minerals processing, veterinary vaccines, and polymer performance.

Provisional patent filings, to provide patent protection for CSIRO developments with commercial potential, totalled 123 in 1986/87, up from 71 in the previous financial year. Rationalisation of CSIRO's patent holdings has continued; about 800 patent applications and patents have been abandoned since the review began in 1985, leading to substantial cost savings.

Science and Industry Endowment Fund

In 1986/87 grants totalling $28 852 were provided from this Fund, which was established under the *Science and Industry Endowment Act* 1926 to assist with research and in the training of research workers. Recipients of the 1986 Science Grants ranged from retired professional scientists to amateur naturalists. They also included school science associations, which received small grants to encourage an interest in science in young people. The year's grants — 16 in all — ranged from $200 to $3991.

Availability of the 1986 grants was advertised nationally in June of that year. Thirty-five applications were received, of which eleven, totalling $26 006, were approved. The additional $2846 provided comprised $2129 in 'ad hoc' grants and $717 as the balance of a grant approved in 1985/86.

The Science Grants come from the annual return, currently about $30 000, from the 100 000 Pounds allocated to the Fund by the *Science and Industry Endowment Act*. As at 30 June 1987, the amount available for 1987 grants was $44 300. The Chief Executive of CSIRO is Trustee of the Science and Industry Endowment Fund.

Advisory Council and State and Territory Committees

Advisory Council

In accordance with recommendations contained in the 1985 ASTEC report 'Future Directions for CSIRO', the CSIRO Executive, the CSIRO Advisory Council and the six State and Territory Advisory Committees were dissolved on 5 December 1986 and replaced by the corporate-style CSIRO Board.

The Advisory Council, chaired by Sir Victor Burley (1979–1981) and Sir Peter Derham (1981–1986), had provided advice to the Executive on a broad range of policy issues. At the time of the changes, the Minister for Science, Mr Barry Jones, and the then Chairman (now Chief Executive) of CSIRO, Dr Keith Boardman, expressed appreciation for its valuable contribution to CSIRO. The Minister noted that the new legislation provided for the establishment of advisory committees by the CSIRO Board.

During this financial year, Council provided CSIRO with reports on future research on soil conservation and erosion, future research in the Northern Territory, CSIRO's environmental research, and integration of pasture research in southern Australia.

Further reports to CSIRO came from a workshop on

science communication and a meeting with the food and biotechnology sub-group of the Australian Industrial Research Group.

Council members served on the Chairman's Committee on the organisation of CSIRO's water resources research, and on review committees for the Divisions of Radiophysics, Oceanography, and Energy Chemistry.

No advice requiring a formal response in accordance with the legislation was provided by Council to the CSIRO Executive during the year.

Sir Ian McLennan Achievement for Industry Award

Nominations received for this Award, established by the Advisory Council, were again of a very high standard. Last November the medal and prizes were presented by the Victorian Minister for Industry, Technology and Resources, Mr Fordham, to Mr John Coleman of the CSIRO Divison of Chemical and Wood Technology for developing an automatic, high-speed process for producing waxed corrugated cardboard boxes.

State and Territory Committees

Activities of these Committees were considerably reduced in the five months to 5 December 1986 due to the impending introduction of the new CSIRO legislation. They included a public meeting arranged by the New South Wales Committee in Wollongong to discuss 'CSIRO research—What's in it for you', a study into the problem of waste disposal in small cities and towns initiated by the Queensland Committee, and activities related to the establishment of local Science Education Centres undertaken by the Northern Territory and Western Australian Committees. The Committees provided inputs to a variety of Advisory Council activities.

Finance

Expenditure by CSIRO of funds under its control totalled about $446 million in 1986/87. Of this amount, $362m (81%) came from funds appropriated directly to CSIRO by Parliament. Another $54m (12%) came from funds provided by industry and other contributors. The remaining $30m (7%) came from revenue earned by the Organisation, unspent funds from 1985/86 and receipts from the Department of Primary Industry for its half-share of the operation of the Australian Animal Health Laboratory.

The year's expenditure from appropriation and revenue funds for salaries and general running expenses was $353m, a gross increase of 4·8% over that in 1985/86. This percentage increase reduces to 3·4% when the $5m specifically appropriated in 1986/87 for the Early Separation Incentive Scheme (see page 40) is taken into account.

CSIRO's audited financial statements for the year are presented on pages 46 to 63.

Construction of Australia's newest symbol, the flagpole on Parliament House, Canberra, required high-quality welding. Synchro-Pulse, the welding machine chosen for the job, was developed by the CSIRO Division of Manufacturing Technology in collaboration with Welding Industries of Australia Pty Ltd.

OFFICE OF THE
AUDITOR-GENERAL

G.P.O. Box 707
Canberra, A.C.T. 2601
Telephone 48 4711

9 December 1987

The Honourable the Minister for
Science and Small Business
Parliament House
CANBERRA ACT 2600

Dear Minister

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION
AUDIT REPORT ON FINANCIAL STATEMENTS

Section 51 of the Science and Industry Research Act 1949 declares the Commonwealth Scientific and Industrial Research Organisation to be a public authority to which Division 3 of Part XI of the Audit Act 1901 applies. Pursuant to sub-section 63M(2) of the Audit Act 1901, the Commonwealth Scientific and Industrial Research Organisation has submitted for audit report its financial statements for the year ended 30 June 1987. These comprise:

- Statement of Activity
- Statement of Capital Accumulation
- Statement of Assets and Liabilities
- Notes to and forming part of the statements, and
- Certificate of Chief Executive and Manager, Financial Services and Systems.

As stated in Note 1 to the statements this is the first year that the Organisation has prepared its financial statements on an accrual basis. Opening balances as at 1 July 1986 were not able to be calculated on an accrual basis, and consequently it was not possible to prepare a meaningful Statement of Sources and Applications of Funds. For similar reasons the Statement of Activity includes some income and expenditure relating to 1985/86. It has not been possible to quantify the financial effect on the Statement of Activity or Statement of Capital Accumulation.

The statements have been prepared in accordance with the policies outlined in Note 1 to the statements and except as referred to above are in accordance with the Guidelines for the Form and Standard of Financial Statements of Commonwealth Undertakings approved by the Minister for Finance and are in the form approved by the Minister for Finance pursuant to sub-section 63M(1) of the Audit Act 1901. A copy of the financial statements is enclosed for your information.

These statements have been audited in conformance with the Australian Audit Office Auditing Standards.

In accordance with sub-section 63M(2) of the Audit Act 1901, I now report that the statements are in agreement with the accounts and records of the Organisation and, except in relation to the matters referred to above and Note 21 to the statements, in my opinion:

- the statements are based on proper accounts and records, and
- the receipt, expenditure and investment of moneys and the acquisition and disposal of assets by the Organisation during the year have been in accordance with the Science and Industry Research Act 1949.

Yours sincerely

(Sgd.) D.J. Hill

D.J. Hill
Acting Auditor-General

Commonwealth Scientific and Industrial Research Organisation
Statement of Activity for the year ended 30 June 1987

	Notes*		1986/87 $'000
Income			
Parliamentary Appropriations		367 757	
Transfers to Capital Accumulation		48 011	319 746
Other Income	2		26 593
Grants and Contributions	3	46 619	
Transfers to Capital Accumulation		2 574	44 045
Total income			**390 384**
Expenditure	4		
Headquarters Administration			23 415
Research Programs			
Animal and Food Sciences			80 789
Biological Resources			95 174
Energy and Earth Resources			52 948
Industrial Technology			54 326
Physical Sciences			57 426
Information and Public Communication			11 264
Other			37 572
Total expenditure			**412 914**
Deficiency of income over expenditure before provisions and unfunded charges			**22 530**
Provisions and unfunded charges	5		**31 367**
Unfunded liability — transferred to Statement of Capital Accumulation			**53 897**

* The accompanying notes form part of these statements.

Commonwealth Scientific and Industrial Research Organisation
Statement of Capital Accumulation for the year ended 30 June 1987

	Notes*	1986/87 $'000
Balance as at 1 July 1986	1.3	**613 098**
Transfer from Statement of Activity for capital appropriation		48 011
Capital receipts from Grants and Contributions	3	2 574
		663 683
Unfunded liability transferred from Statement of Activity		**53 897**
Balance as at 30 June 1987 transferred to Statement of Assets and Liabilities		**609 786**

* The accompanying notes form part of these statements.

Commonwealth Scientific and Industrial Research Organisation
Statement of Assets and Liabilities as at 30 June 1987

	Notes*	1986/87 $'000
Capital accumulation from Statement of Capital Accumulation		**609 786**
represented by		
Current assets		
Cash at bank and on hand		9 075
Short-term deposits		21 350
Debtors	6	6 453
Prepayments		3 430
Consumable stores	1.6	4 669
		44 977
Non-current assets		
Land, buildings and leasehold improvements	7	549 989
Other fixed assets	8	147 848
Investments	9	931
Leased assets	13	120
		698 888
Total assets		**743 865**
Current liabilities		
Accrued expenses		4 440
Creditors		14 816
Grants and revenue received in advance	11	21 253
Provision for recreation leave	1.7	28 545
Provision for long-service leave	1.7	54 622
Provision for workers' compensation	1.8	1 000
Lease liability	13	48
		124 724
Non-current liabilities		
Provision for long-service leave	1.7	9 298
Lease liability	13	57
		9 355
Total liabilities		**134 079**
Net assets		**609 786**

* The accompanying notes form part of these 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 General

Except where stated, the financial statements have been prepared in accordance with the historical cost convention, the Guidelines for the Form and Standard of Financial Statements of Commonwealth Undertakings issued by the Minister for Finance and the Australian Accounting Standards. The form of the financial statements has been approved by the Minister.

This is the first year CSIRO has prepared its financial statements on a full accrual basis. As a result of the change in accounting policy and method of presentation of the financial statements, no comparative figures are available this year and consequently the Statement of Sources and Applications of Funds could not be provided. It will be provided in the 1987/88 financial statements.

1.2 Statement of Activity

As this is the first year the financial statements have been prepared on a full accrual basis, it has not been possible to determine and reverse income and expenditure relating to 1985/86; hence they are included in this year's operating result. The financial effect of this non-reversal has not been quantified.

1.3 Capital Accumulation

The Capital Accumulation balance of $609 786 179 represents the Commonwealth's equity in CSIRO. This amount has been derived under full accrual accounting by recognition of the total value of CSIRO assets and liabilities as at 30 June 1987. The opening balance in the statement is notional.

1.4 Fixed Assets

Except where stated, all fixed assets are valued at historical cost. Assets costing less than the threshold limit of $1000 are expensed during the year of purchase.

The valuation of buildings and leasehold improvements were performed by the Department of Housing and Construction and CSIRO officers as at 30 June 1986. Building valuation includes plant, fixtures and fittings that form an integral part of the building.

Land has been valued by CSIRO's registered valuer as at 30 June 1986.

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

Assets which are purchased from Specific Research Funds (amounting to $3 274 150 in 1986/87) and where the sale proceeds are refunded to the grantor under the terms of the grant agreement, have been expensed during the year of purchase. Separate records for these assets have been maintained and are disclosed in Note 16.

1.5 Depreciation and Amortisation

Depreciation on fixed assets except land 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 lives.

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

1.6 Consumable Stores

Consumable stores are valued at the lower of cost or net realisable value.

1.7 Provisions for Recreation and Long-service Leave

Provisions for recreation and long-service leave are calculated by multiplying the leave entitlements of employees by their current pay rates. Probability factors are applied to employees with less than ten years' service to calculate provision for long-service leave.

The provisions for recreation leave and long-service leave have been calculated for the first time as at 30 June 1987. It has not been possible to accurately determine the expense that relates to the 1986/87 financial year so that it could be correctly reflected in the Statement of Activity. As a result the total provisions as at 30 June 1987 have been brought to account by debiting the opening balance of the capital accumulation account.

1.8 Workers' Compensation

CSIRO carries its own risk in relation to workers' compensation, and in line with common accounting practice, is moving to record a full assessment of the outstanding workers' compensation liability in its financial statements. The provision for workers' compensation liability of $1 000 000 has been determined by estimating the liability for the next 12 months in respect of recipients who have terminated employment with CSIRO. An independent actuarial assessment will be undertaken to determine a current and future valuation of the liability.

1.9 Superannuation Contributions

CSIRO is an approved authority for the purposes of the Superannuation Act 1976 S159(2) and is required to meet the employer's share of the cost of benefits payable pursuant to that Act to eligible officers and employees. CSIRO discharges this liability by periodic payments to the Commonwealth of amounts, expressed as a percentage of the salaries of eligible officers and employees, estimated by the Commonwealth to be sufficient to meet CSIRO's share of full accruing cost of both pensions granted on the retirement or death of such officers and employees and any subsequent pension increases.

An actuarial review was performed as at 30 June 1983 and the rate of 20·5% was recommended by the actuary as sufficient to meet the cost of benefits accruing in respect of future service, allowing for new entrants. CSIRO has not departed from the recommended rate.

The amount of employer contributions paid in respect of the 1986/87 financial year was $38 285 900 ($35 870 661 in 1985/86). This represents 20·5% of salaries for superannuation purposes paid to eligible employees.

1.10 Investments

Interests in companies (including associated companies) other than SIROTECH Ltd (see Note 10) are shown as investments at cost or Board Members' valuation (see Note 9). Associated companies are companies in which CSIRO exercises significant influence by holding shares and participating in financial and operating policies.

1.11 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.

1.12 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.

1.13 Leases

Leases of fixed assets where substantially all the risks and benefits incidental to the ownership of the asset are transferred to CSIRO are classified as finance leases. Finance leases are capitalised recording an asset and a liability equal to the present value of the minimum lease payments, including any guaranteed residual values. Lease payments are allocated between the reduction of the lease liability and the lease interest expense for the period (see Note 13).

Lease payments for operating leases are charged as expenses in the periods in which they are incurred (see Note 15).

The transitional disclosure provisions of AAS17 have been applied in respect of all finance leases for computing equipment held by CSIRONET because CSIRO will not be the lessee as at 1 October 1987. These leases have been assigned to an associated company, Vantage Solutions Australia Ltd, on that date. As a result they have been separately disclosed in Note 14.

1.14 Specific Research Funds

Specific Research Funds consist of moneys made available to CSIRO for specific research programs nominated by grantors. Funds may only be spent on nominated projects and in the manner specified in the agreements between the grantors and CSIRO.

1.15 Insurance

CSIRO carries its own risks, with the exception of the insurance on the Oceanographic Research Vessel *Franklin*.

Note 2 Other Income

	1986/87 $'000
CSIRONET computing services[a]	12 204
Department of Primary Industry's contribution to the cost of the Australian Animal Health Laboratory	4 400
Interest	3 406
Royalties	742
Sale of publications	920
Sale of produce and livestock	699
International consultancies	724
Profit on disposal of fixed assets	438
Miscellaneous	3 060
	26 593

[a] Excludes revenue from CSIRO users of $4 748 166.

Proceeds from the sale of fixed assets amounting to $5 139 574 are included in other income.

Note 3 Grants and Contributions

	1986/87 $'000		
Source of funds	**Grants and Contributions**	**Transfers to Capital Accumulation**	**Total**
National Energy Research, Development & Demonstration Program	1 751	93	1 658
Rural Credits Development Fund	248	20	228
Wool Research Fund	14 144	43	14 101
Meat Research Fund	3 293	–	3 293
Wheat Research Account	980	–	980
Fishing Industry Research Account	1 346	–	1 346
Other Rural Industry Research Funds	3 109	–	3 109
Contributions by private companies, public agencies, and others	21 748	2 418	19 330
	46 619	**2 574**	**44 045**

Note 4 Expenditure

	1986/87 $'000		
	General Research Funds	Specific Research Funds	Total
Headquarters administration	**23 181**	**234**	**23 415**
Research programs			
Animal and Food Sciences	63 147	17 642	80 789
Biological Resources	80 249	14 925	95 174
Energy and Earth Resources	46 038	6 910	52 948
Industrial Technology	42 604	11 722	54 326
Physical Sciences	55 855	1 571	57 426
Information and Public Communication	10 484	780	11 264
	298 377	**53 550**	**351 927**
Other			
CSIRONET[a]	10 229	141	10 370
SIROTECH Ltd	2 910	–	2 910
CSIRO Office of Space Science and Applications	1 854	84	1 938
Centre for International Research Cooperation	467	328	795
Grants to external bodies	975	–	975
Miscellaneous[b]	17 736	2 848	20 584
	34 171	**3 401**	**37 572**
	355 729	**57 185**	**412 914**

[a] Expenditure for CSIRONET excludes the value of CSIRONET services provided to CSIRO users of $4 748 166.

[b] Miscellaneous includes loss on sale of fixed assets of $974 961.

Note 5 Provisions and Unfunded Charges

	1986/87 $'000
Provision for doubtful debts	332
Depreciation	29 996
Amortisation	39
Provision for workers' compensation	1 000
	31 367

Provisions for recreation leave and long-service leave were debited against the opening balance in the capital accumulation account (see Note 1.7).

Note 6 Debtors

	1986/87 $'000
Specific research debtors	3 575
Interest receivable	387
Advances — SIROTECH Ltd	153
— Other	48
CSIRONET trade debtors	1 636
General research debtors	592
Associated company	60
Other accrued income	334
	6 785
Provision for doubtful debts	332
	6 453

Note 7 Land, Buildings and Leasehold Improvements
(see Notes 1.4 and 1.5)

	1986/87 $'000			
	Leasehold improvements	**Buildings**	**Land [a]**	**Total**
At valuation	19 573	451 028	82 494	553 095
Accumulated depreciation	2 102	15 721	–	17 823
	17 471	**435 307**	**82 494**	**535 272**
At cost	366	181	–	547
Work in progress	–	14 170	–	14 170
	17 837	**449 658**	**82 494**	**549 989**

[a] Crown land and land held in Commonwealth title totalling $12 950 000 have been included in the above land values. Negotiations have taken place between CSIRO and the Commonwealth Government to have leases or title deeds issued in CSIRO's name.

Note 8 Other Fixed Assets (see Notes 1.4 and 1.5)

	1986/87 $'000		
	At cost	**Accumulated depreciation**	**Written-down value**
Equipment			
Transport equipment	9 915	1 028	8 887
Agricultural equipment	2 542	962	1 580
Computing equipment	55 072	26 632	28 440
Workshop equipment	7 219	3 042	4 177
Office furniture and equipment	7 958	3 014	4 944
General scientific equipment	100 153	46 178	53 975
Total equipment	**182 859**	**80 856**	**102 003**
National Facilities			
Oceanographic Research Vessel *Franklin*	14 409	2 432	11 977
Australia Telescope Construction in progress	33 868	–	33 868
Total National Facilities	**48 277**	**2 432**	**45 845**
Total equipment and National Facilities	**231 136**	**83 288**	**147 848**

Note 9 Investments (see Note 1.10)

	1986/87 $'000
Shares — at cost	
SIROMATH Pty Ltd[a]	150
Network Automation Ltd[b]	350
Other	6
	506
Shares — at Board Members' valuation	
Dunlena Pty Ltd[c]	315
Austek Microsystems Pty Ltd [d]	100
Incor Ltd [e]	10
	425
	931

Associated Companies

[a] CSIRO holds a 37·5% equity shareholding in SIROMATH Pty Ltd, a private company established to provide high-level mathematical consultancy services, primarily to Australian industry.

[b] During the year CSIRO subscribed a total of 80 000 shares (20% equity) in Network Automation Ltd. On 1 July 1987, CSIRO took up an additional 80 000 shares for $350 000. On 1 October 1987 the total shareholdings were transferred to a new associated company, Vantage Solutions Australia Ltd, as part of the sale of CSIRONET operations (see Note 18).

[c] CSIRO was originally allotted 350 001 shares (42% equity) in exchange for the assignment of intellectual property, which was valued in the shareholders' agreement at $10 000 000, and an expenditure commitment of $5 000 000 towards research and development (see Note 12). During the year 35 000 shares were transferred to SIROTECH Ltd in recognition of their contribution, on CSIRO's behalf, to the joint venture company. CSIRO currently holds 315 001 shares and they have been valued at Board Members' valuation.

Other Companies

[d] CSIRO holds 130 000 shares in Austek Microsystems Pty Ltd, at a cost of $156 585. In addition, CSIRO was allotted 250 000 shares for the assignment of licence rights. The total 380 000 shares have been valued at Board Members' valuation.

[e] As part of the licence rights agreement between CSIRO and Incor Ltd, 50 000 shares with a par value of $0.20 were accepted. These shares have been valued at Board Members' valuation.

Note 10 SIROTECH Ltd

SIROTECH Ltd is a non-profit company established by CSIRO, limited by CSIRO guarantee and governed by a Board of Directors. The company was incorporated on 15 November 1984. SIROTECH's main source of revenue comes from an annual service fee paid by CSIRO to cover day-to-day commercial and intellectual property advice. During 1986/87, payments made by CSIRO to or on behalf of SIROTECH totalled $3 153 650. SIROTECH's net assets as at 30 June 1987 amounted to $495 787. SIROTECH's accounts have not been consolidated in the CSIRO financial statements as at 30 June 1987.

Note 11 Grants and Revenue Received in Advance

	1986/87 $'000
Revenue received in advance	221
Grants received in advance	21 032
	21 253

Note 12 Contractual Capital Commitments

Anticipated payments for the next 12 months against capital contracts entered into but not completed as at 30 June 1987 are estimated at:

	1986/87 $'000		
	General Research Funds	**Specific Research Funds**	**Total**
Buildings	12 835	–	12 835
Major laboratory equipment	1 410	569	1 979
National Facilities	4 402	–	4 402
Other fixed assets	2 608	1 273	3 881
	21 255	**1 842**	**23 097**

In addition to the above contractual capital commitments, as at 30 June 1987, CSIRO had a contractual commitment to spend an estimated $1 000 000 on research and development as part of its agreement with Du Pont (Australia) Ltd relating to Dunlena Pty Ltd (see Note 9(c)).

Note 13 Finance Leases (see Notes 1.5 and 1.13)

13.1 Leased Assets

	1986/87 $'000
Office equipment at cost	210
Accumulated amortisation	90
Written-down value	**120**

13.2 Lease Liability

	1986/87 $'000
Lease commitments	
Not later than one year	62
Later than one year but not later than two years	42
Later than two years but not later than five years	25
Later than five years	–
Minimum lease payments	**129**
Future finance charges	24
Lease liability	**105**
Current liability	**48**
Non-current liability	**57**
	105

13.3 Finance charges for finance leases on office equipment amounted to $20 759 and have been included in determining the operating result for the year.

Note 14 Non-capitalised Finance Leases (see Note 1.13)

14.1 Rental expense for computing equipment was $2 729 954 and has been included in determining the operating result for the year.

14.2 Lease Commitments

	1986/87 $'000
Not later than one year	2 694
Later than one year but not later than two years	2 517
Later than two years but not later than five years	2 101
Later than five years	–
	7 312

14.3 Present Value of Minimum Lease Payments — Computing Equipment **5 400**

Note 15 Operating Leases (see Note 1.13)

15.1 Non-cancellable operating lease commitments not provided for in the accounts

	1986/87 $'000
Not later than one year	2 196
Later than one year but not later than two years	1 250
Later than two years but not later than five years	950
Later than five years	1 535
	5 931

15.2 Rental expense for operating leases was $2 456 006 and has been included in determining the operating result for the year.

Note 16 Resources Provided Free-of-Charge (see Note 1.4)

	1986/87 $'000			
	Buildings	**Land[a]**	**Other assets**	**Total**
At valuation or cost	15 414	22 432	24 482	62 328
Accumulated depreciation	879	–	11 798	12 677
	14 535	**22 432**	**12 684**	**49 651**
Work in progress	402	–	–	402
	14 937	**22 432**	**12 684**	**50 053**

(a) Includes land ($11 816 000) which has been purchased out of specific research funds and is in CSIRO titles. In accordance with the grant agreements, any sales proceeds from disposal of these assets shall be refunded to the grantors.

Note 17 Contingent Liabilities

Contingent liabilities for which no provision has been provided in the accounts as at 30 June 1987 are:

	1986/87 $'000
a) Guarantee of bank accommodation of an associated company, SIROMATH Pty Ltd (unsecured)	244
b) Estimated workers' compensation common law claims that are pending but not admitted and will be defended	5 000
	5 244

Note 18 Subsequent events

On 1 October 1987, CSIRO sold its CSIRONET operations to an associated company, Vantage Solutions Australia Ltd. The sale involved the following transactions on that date:

- estimated net assets of CSIRONET operations totalling approximately $5 377 000 were transferred to Vantage Solutions Australia Ltd;
- CSIRO was issued with 5 550 000 ordinary fully paid shares of $1.00 each in Vantage Solutions Australia Ltd;
- CSIRO sold 3 330 000 (60%) of the shares to Idaps Investments Pty Ltd for $6 000 000;
- CSIRO contributed approximately $3 000 000 to Vantage Solutions Australia Ltd as its initial operating capital; and
- finance leases relating to computing equipment (see Note 14) were assigned to Vantage Solutions Australia Ltd.

Note 19 Moneys Held in Trust

19.1 Trust funds are represented by the following investments at cost and cash at bank:

	1986/87 $'000
Investments	
Reserve Bank of Australia	50
State Electricity Commission of Victoria	12
Primary Industry Bank of Australia	96
Canberra Building Society	1 685
National Bank of Australia	12
	1 855
Cash at bank	**44**
Total funds held as at 30 June 1987	**1 899**

19.2 The components of trust funds are as follows:

William McIlrath Trust Fund	110
David Rivett Memorial Lecture Fund	55
F.D. McMaster Bequest	1 629
Sir Ian McLennan Achievement for Industry Award	105
Total funds held as at 30 June 1987	**1 899**

Note 20 Auditor's Remuneration

The total amount paid and payable to the Auditor-General for the audit of CSIRO amounted to $258 275. No other benefits were received by the Auditor-General.

Note 21 Overdrawn Bank Accounts

On three occasions during the year the following bank accounts which did not have bank overdraft approval under the Science and Industry Research Act 1949 were overdrawn:

Regional Administrative Office Brisbane account	$860 492
Regional Administrative Office Melbourne account	$548 437
Regional Administrative Office Sydney advance account	$ 8 024

Note 22 Executive and Board Members' Emoluments

Emoluments or other benefits received or due and receivable directly or indirectly by full-time and part-time members of the Executive and Board Members were as follows:

	1986/87 $'000
Executive (1-7-86 to 4-12-86)	
Full-time members	116
Part-time members	17
Board (from 5-12-86 to 30-6-87)	
Full-time member	51
Part-time members	54
	238

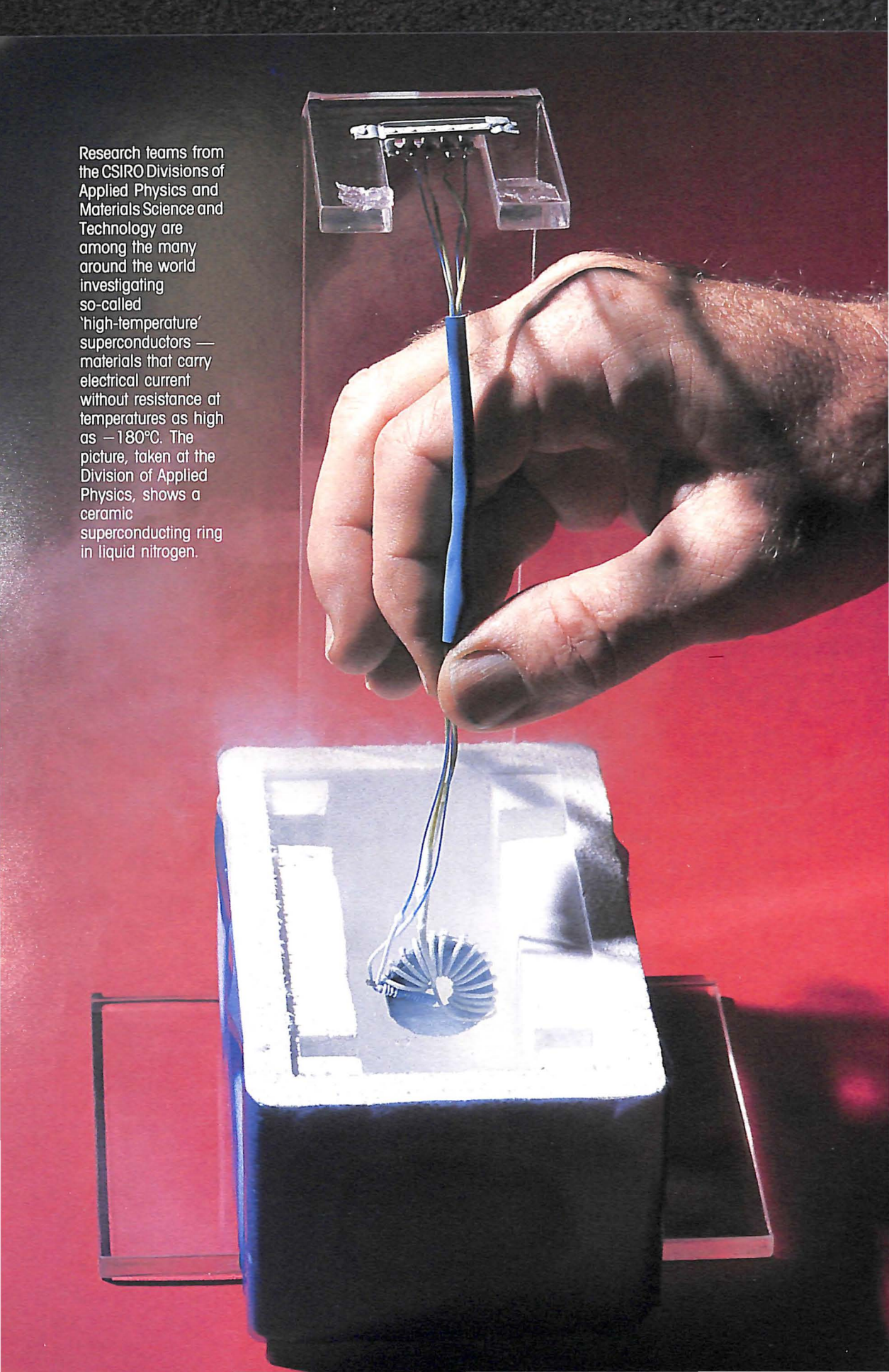
These rates are in accordance with determinations of the Remuneration Tribunal.

Certification of Statements

In our opinion the Statement of Activity, Statement of Capital Accumulation, Statement of Assets and Liabilities and the accompanying notes to and forming part of the statements have been prepared in accordance with the Guidelines for the Form and Standard of Financial Statements of Commonwealth Undertakings, and, except where stated in Notes 1.1, 1.2 and 21, show fairly the operations of the Commonwealth Scientific and Industrial Research Organisation for the year ended 30 June 1987 and the state of affairs as at that date.

N.K. Boardman
(Chief Executive)
27.11.87

G.I. Batchelor
(Manager, Financial Services and Systems)
27.11.87



Research teams from the CSIRO Divisions of Applied Physics and Materials Science and Technology are among the many around the world investigating so-called 'high-temperature' superconductors — materials that carry electrical current without resistance at temperatures as high as −180°C. The picture, taken at the Division of Applied Physics, shows a ceramic superconducting ring in liquid nitrogen.

CSIRO's Statutory Reporting Requirements

The *Science and Industry Research Act* 1949 requires the CSIRO Annual Report to include a general account of the operations of the Organisation and:

- ☐ financial statements for the reporting year in a form approved by the Minister for Finance (see pp. 44–63);
- ☐ the Auditor-General's report on these statements (see p. 45);
- ☐ 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 pp. 4–11 and 36–41);
- ☐ any determinations made by the Minister under sub-paragraph 9(1)(a)(iv) during the year;
- ☐ any directions or guidelines given by the Minister under section 13 during the year;
- ☐ any policies notified by the Minister under section 14 during the year;
- ☐ any advice furnished by the Advisory Council under section 34 of the *Act* prior to amendment;
- ☐ any comments by the Executive on advice furnished to it by the Advisory Council.

The Minister made no determinations, gave no directions or guidelines, and notified no policies under the *Act* during the year. The Advisory Council furnished no advice under section 34.

Terms of Office of CSIRO Board and Executive Members

Board:

The Hon. N.K. Wran, QC (Chairman) 5.12.86–4.12.91
Dr N.K. Boardman, ScD FTS FAA FRS (Chief Executive) 5.12.86–4.3.87 (*Acting*), 5.3.87–4.3.90
Sir Roderick Carnegie, BSc MA (Oxon) MBA FTS, 5.12.86–4.12.91
Prof. A.E. Clarke, BSc PhD 5.12.86–4.12.89
Dr K.J. Foley, MCom PhD 5.12.86–4.12.89
Dr A.K. Gregson, PhD DSc FRACI 5.12.86–4.12.90
Mr D.M. Hoare, BEc AASA ASIA 5.12.86–4.12.90
Mr W.C. Mansfield, LLB 5.12.86–4.12.90
Prof. Sir Gustav Nossal, CBE MB BS BSc PhD FTS FAA FRS 5.12.86–4.12.91
Mr G.G. Spurling, ED BTech MAE FIEAust, 5.12.86–4.12.89

Executive:

Chairman and Chief Executive
Dr N.K. Boardman, ScD FTS FAA FRS 25.9.85–24.6.86, 25.6.86–4.12.86
Full-time Member
Dr G.H. Taylor, DSc DrRerNat FTS 1.5.82–10.10.86
Part-time Members
Prof. A.E. Clarke, BSc PhD 23.6.85–22.3.86, 23.3.86–24.6.86, 25.6.86–4.12.86
Dr K.J. Foley, MCom PhD 23.6.85–22.3.86, 23.3.86–24.6.86, 25.6.86–4.12.86
The Hon. M.D. Kirby, CMG BA LLM BEc, 11.8.83–10.8.86, 11.8.86–4.12.86
Mr G.G. Spurling, ED BTech MAE FIEAust, 9.9.82–8.9.85, 9.9.85–8.6.86, 9.6.86–4.12.86
Mr P.D.A. Wright 1.12.79–30.11.82, 4.2.83–3.2.86, 4.2.86–24.6.86, 25.6.86–4.12.86

About CSIRO

The primary functions of CSIRO are to:

- perform scientific research aimed at assisting Australian industry, benefiting the Australian community, and contributing to the achievement of national goals
- encourage and facilitate use of the results of its research.

An independent statutory authority, CSIRO operates under the provisions of the *Science and Industry Research Act* 1949. Throughout the reporting year Mr Barry Jones, Minister for Science, was the responsible Minister.

A 10-member Board is 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 management.

Staff are employed under Section 32 of the *Science and Industry Research Act* 1949. At 30 June 1987 CSIRO had a total staff of 7347. Names of senior staff are shown opposite.

CSIRO's research is performed in 41 Divisions and research units grouped into five Institutes; new arrangements to be implemented in 1987/88 will see these replaced by 32 Divisions grouped into six Institutes.

CSIRO produces a wide range of publications related to its research; information on these can be obtained from the CSIRO Bookshop, PO Box 89, East Melbourne, Vic. 3002 (Tel. (03) 418 7333).

Scientific and technical inquiries may be directed to CSIRO's National Information Network (see p. 68).

Media inquiries may be directed to the Media Office at CSIRO's Canberra headquarters: Tel. (062) 48 4484.

Freedom of Information inquiries: Tel. (062) 48 4123.

CSIRO's structure
— as at July 1 1987

BOARD

The Hon. Neville Wran (*Chairman*)
Dr N.K. Boardman (*Chief Executive of CSIRO*)
Sir Roderick Carnegie
Prof. A.E. Clarke
Dr K.J. Foley
Dr A.K. Gregson
Mr D.M. Hoare
Mr W.C. Mansfield
Prof. Sir Gustav Nossal
Mr G.G. Spurling

MANAGEMENT COMMITTEE
Chief Executive
Directors
Corporate Secretary
General Managers

CSIRO
AUSTRALIA

INSTITUTE OF ANIMAL AND FOOD SCIENCES

Director
Dr A.D. Donald
(Acting)

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

INSTITUTE OF BIOLOGICAL RESOURCES

Director
Dr J.J. Landsberg
(Acting)

Divisions and Chiefs
Entomology
Dr M.J. Whitten
Forest Research
Mr A.G.J. Brown
(Acting)
Horticultural Research
Dr J.V. Possingham
Centre for Irrigation and Freshwater Research
Dr D.S. Mitchell
Plant Industry
Dr W.J. Peacock
Soils
Dr D.E. Smiles
Tropical Crops and Pastures
Dr E.F. Henzell
Wildlife and Rangelands Research
Dr B.H. Walker

INSTITUTE OF INDUSTRIAL TECHNOLOGY

Director
Dr D.H. Solomon
(Acting)

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

INSTITUTE OF ENERGY AND EARTH RESOURCES

Director
Dr A.F. Reid

Divisions and Chiefs
Energy Chemistry
Dr P.G. Alfredson
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