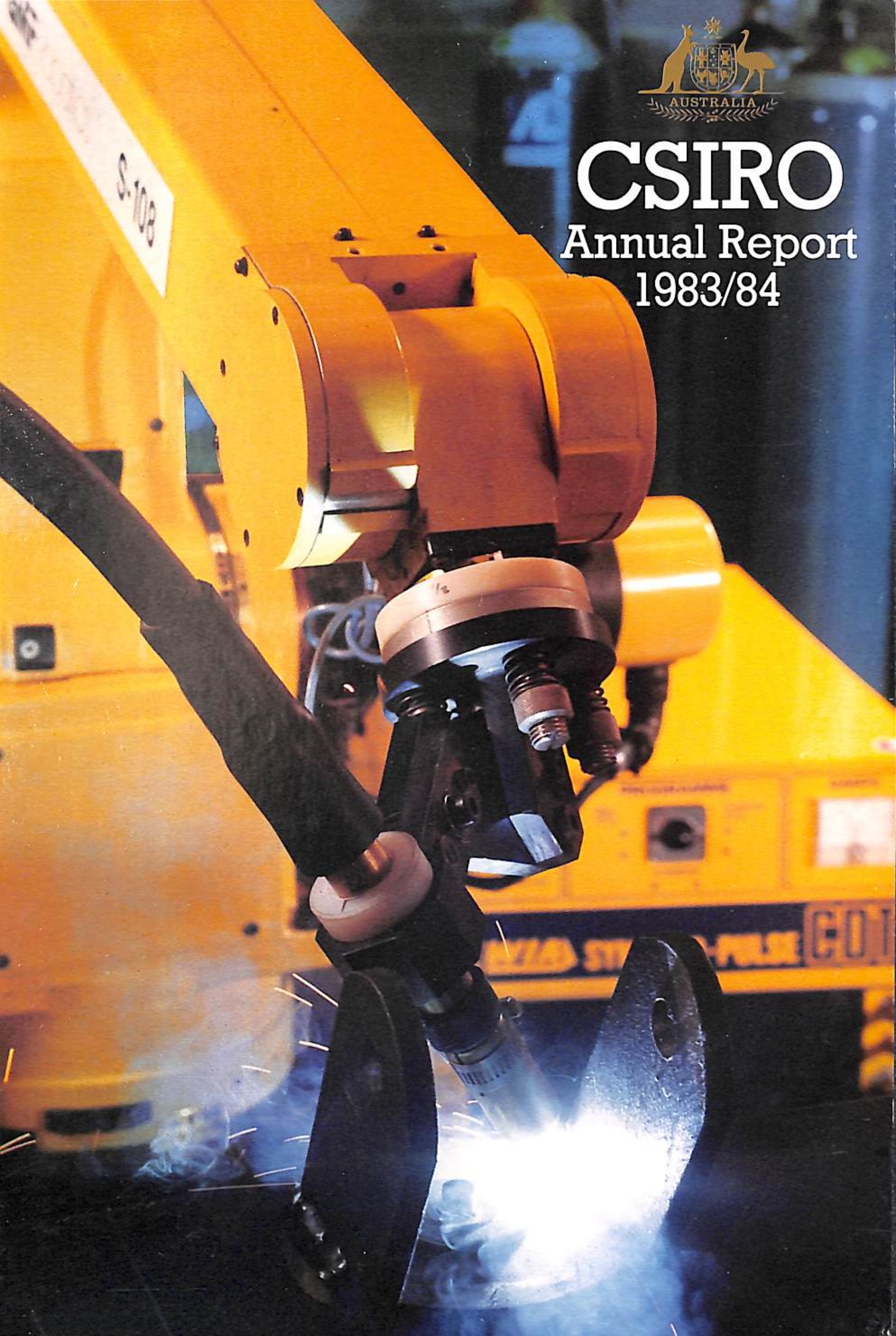
AUSTRALIA

CSIRO

Annual Report 1983/84



CSIRO is providing increasing support to Australian manufacturing industry. The cover photograph illustrates one example of such support. A novel pulsed arc welding machine, developed in a collaborative project between the Division of Manufacturing Technology and Welding Industries of Australia Pty Ltd, has been integrated with a robot from John Hart Pty Ltd to form a fully automated welding facility. Applications of such facilities to improve productivity and manufacturing competitiveness are being actively explored by CSIRO in conjunction with industry.

CSIRO
Annual Report
1983/84

Commonwealth Scientific and Industrial Research Organization, Australia

The Role and Functions of CSIRO

CSIRO is a statutory corporation whose main role is to plan and carry out a comprehensive program of research on behalf of the Commonwealth for the benefit of the people and industries of Australia.

The Organization is Australia's largest and most diversified research body, carrying out its research predominantly in the physical and biological sciences, supported by other disciplines where necessary. All forms of research are undertaken, but the emphasis is on strategic research.

A comprehensive and open planning and review process seeks to ensure that CSIRO's programs are the best possible public research contributions to Australia's welfare. Achieving the transfer of research results into commercial use or other beneficial applications is being given increased emphasis.

In summary form, CSIRO's statutory functions, as contained in the Science and Industry Research Act as amended in 1978, are:

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

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Commonwealth Scientific and Industrial Research Organization, Australia

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

The Executive of CSIRO has pleasure in submitting to you, for presentation to Parliament, its thirty-sixth annual report, which covers the period 1 July 1983 to 30 June 1984. The report is submitted in accordance with section 57 of the Science and Industry Research Act 1949.

J.P. Wild (Chairman)
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D.P. Craig
M.D. Kirby
S.B. Myer
G.G. Spurling
G.H. Taylor
P.D.A. Wright

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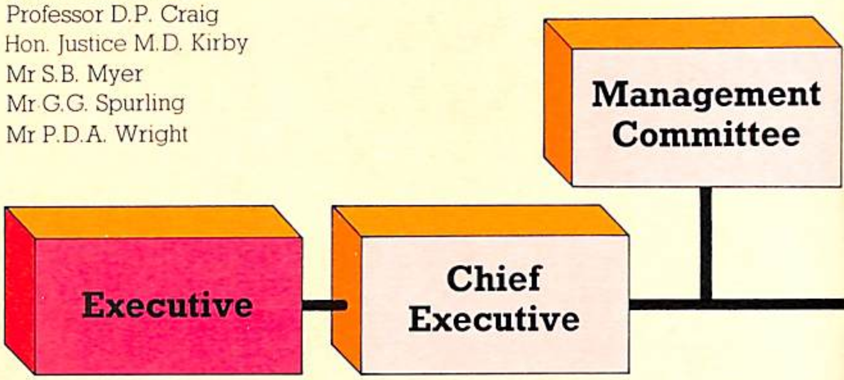
Full-time Members
Dr N.K. Boardman *
Dr G.H. Taylor †
Part-time Members
Professor D.P. Craig
Hon. Justice M.D. Kirby
Mr S.B. Myer
Mr G.G. Spurling
Mr P.D.A. Wright

Management Committee
Chief Executive
Full-time Members
Directors
Secretaries



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Dr P.G. Alfredson
Energy Technology
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Fossil Fuels
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Dr D.E. Smiles
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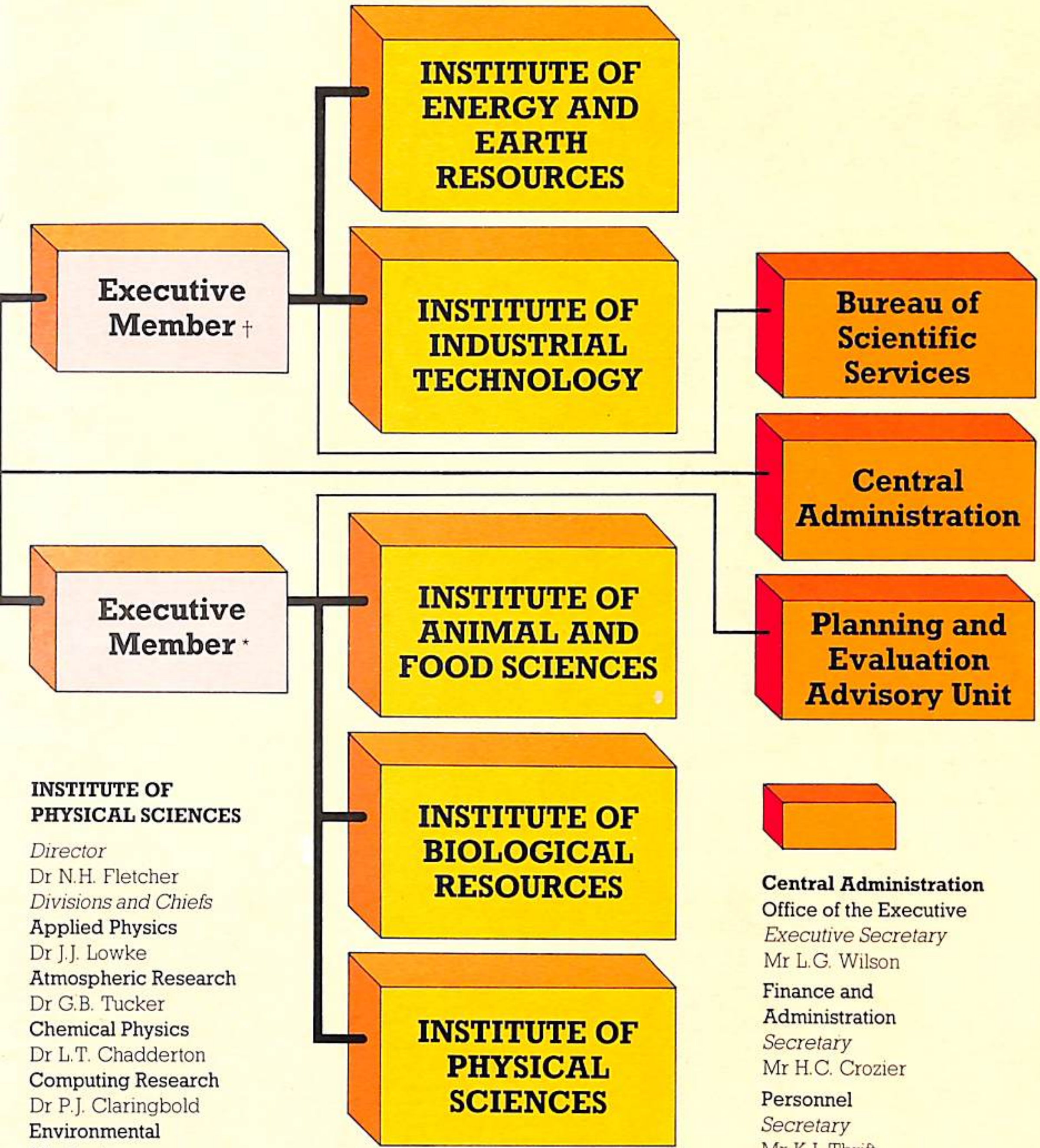
Dr R.J. Millington
Wildlife and Rangelands Research
Dr A.D. Wilson (*Acting*)
Unit and Officer-in-Charge
Centre for Irrigation Research
Dr D.S. Mitchell

Organization Chart

The chart shows the structure of CSIRO as at 1 July 1984.



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Atmospheric Research
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Chemical Physics
Dr L.T. Chadderton

Computing Research
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Dr J.R. Philip

Materials Science
Dr J.R. Anderson

Mathematics and Statistics
Dr T.P. Speed

Oceanography
Dr A.D. McEwan

Radiophysics
Dr R.H. Frater

Unit and Officer-in-Charge

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Executive Secretary
Mr L.G. Wilson

Finance and Administration
Secretary
Mr H.C. Crozier

Personnel
Secretary
Mr K.J. Thrift

Planning and Evaluation Advisory Unit
Director
Dr D.E. Weiss

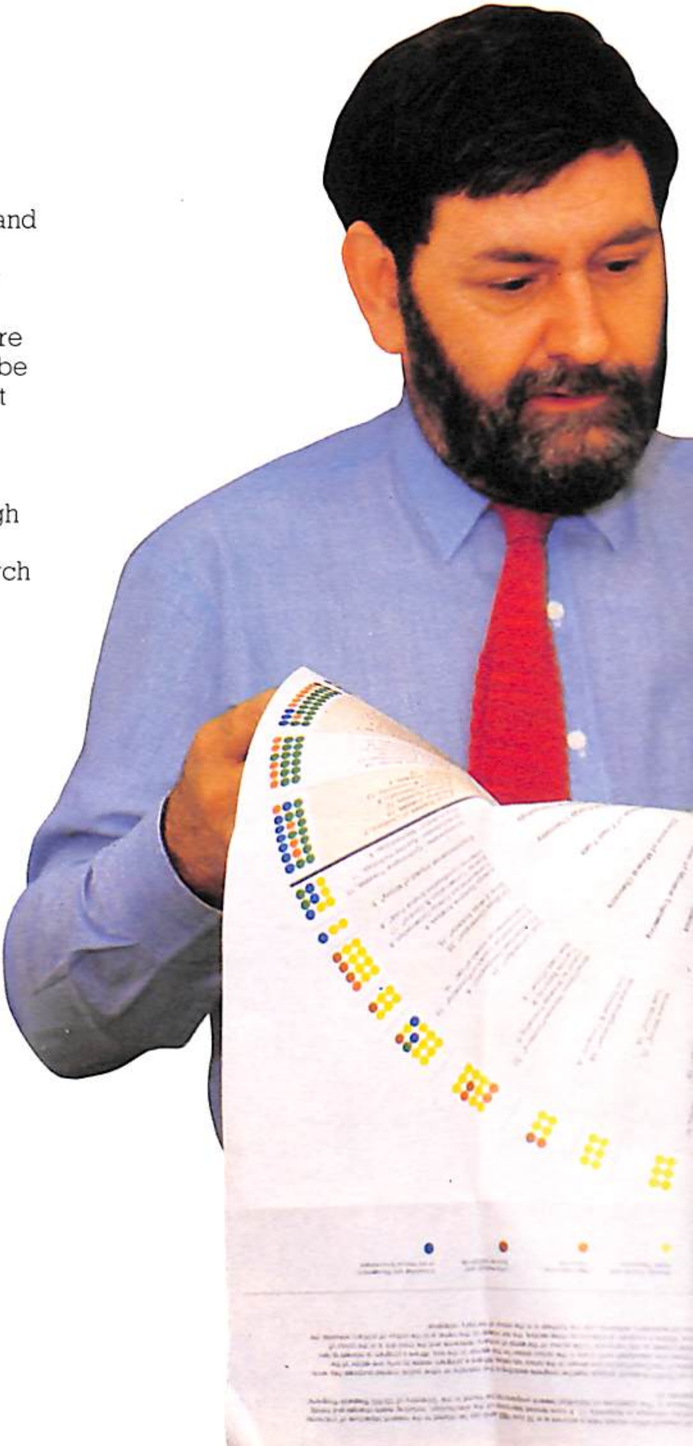
Bureau of Scientific Services
Director
Mr S. Lattimore

Chairman's Review

The year of this annual report marks the first five years of the restructured CSIRO which came into being with amendments to the Science and Industry Research Act in 1978. They have been years of sweeping change, designed to modernize the Organization and bring it closer to the industries and community which it serves.

To recognize this landmark, I issued a booklet called *CSIRO 1978–83: Years of Change.** To increase public and staff awareness of the significance of these changes, and what the Organization has been achieving, an Executive colleague and I traversed the country from Brisbane to Perth, from Darwin to Hobart, addressing groups of industry and community representatives as well as almost the entire staff of the Organization. The message to be imparted was loud and clear: CSIRO must adapt and provide scientific and technological leadership in a changing world. Yet, whatever the changes, one characteristic must remain inviolate: a high standard of excellence and originality. Without excellence and originality, research achieves nothing.

* Copies of the booklet and a video tape version are available.



During the period since July 1983 the following actions have been taken by the Executive.

- We have formed a new commercial company, SIROTECH Ltd, to bring marketing and industrial expertise to bear on the problems of transferring CSIRO technology into industry and to communicate the real research needs of industry to CSIRO scientists.
- We have implemented new criteria for promotion of our scientists, giving greater emphasis to research achievements of direct benefit to industry and the community.
- We have issued a new policy on manufacturing industry research, emphasising the need for increased short-term tactical research to support our main role of long-term strategic research.
- We are forming a new Division of Information Technology to conduct research on the acquisition, storage, processing and dissemination of information by computer technology and other means for the benefit of industry and the community.
- We have formed a research unit to stimulate the development of a space-technology industry in Australia.
- We are encouraging industry groups and individual firms in the manufacturing sector to express the strategic research needs of their industries; discussions have taken place at top level with a number of major companies, including members of the Federal Chamber of Automotive Industries and of metal and chemical industries.

In these ways we are increasing our interaction with industry. The number of significant consultative and collaborative arrangements with industry, current or recently completed, totalled 798 at last count. Of these, 269 were with manufacturing firms.

Pressure is frequently brought to bear on the Executive for our scientists to concentrate on the problems of the moment. Our response is that we should indeed be doing part of our work on short-term tactical problems so that we can get to know industry and its needs, but the majority of such problems should be tackled by industry itself, with any advice we can give. Our main role is strategic (not fundamental) research. We are charged with laying the foundations for technologies and industries for the future and for managing the conservation and exploitation of our natural resources. This role, often not fully understood, is endorsed and strongly advocated by the Minister for Science , Mr Barry Jones.

Research areas designated by the Executive as growth areas for 1983/84 were:

- biotechnology,
- advanced materials,
- generic manufacturing technologies,
- information technologies,
- water and soils,
- plant pathology, and
- oceanography.

One of the prime responsibilities of the Executive is to ensure that the Organization's research programs are optimally attuned to national needs. This means that changes should continually be taking place in our research programs and areas. These changes must be made decisively and sensibly: our main task of long-term strategic research requires change to be implemented with care and sensitivity; change for the sake of change must be avoided.

Most changes take place at the Division or Institute level as Chiefs and Directors reorient their programs internally. I believe that even more determined efforts need to be made at these levels to concentrate our work into fewer programs, all of visible national significance. A more forbidding task falls to the Executive and its Management Committee to change the total balance of our research between main sectors and areas, often crossing Divisional and Institute boundaries. This is achieved at present by (1) nominating growth areas (as listed above), (2) reducing the level of all other areas by X% and (3) re-allocating those resources to the growth areas.

The resources may be transferred by two methods. The method employed until now has been to rely on staff wastage — transferring vacant positions to growth areas. However, the maximum rate at which this method can proceed without seriously distorting our research structure is determined by the wastage rate of tenured scientists, which is only 3.5% per annum. The scope for transferring resources by this method is further reduced by any budget cuts. The second method is to transfer scientists from one area to another, often involving retraining. In research, where the need for excellence is paramount, this method has obvious limitations, but we shall pursue it vigorously in the coming year.

Responsible management practices and public employment policies preclude the dismissal or retrenchment of staff except in rare circumstances. Voluntary early retirement provides a small source of increased flexibility. We are examining in consultation with the Public Service Board and relevant departments the possibility of introducing financial incentives to encourage early retirement. Another source of flexibility is our increasing use of the short term appointment: nevertheless this carries with it human problems related to insecurity.

It is important that the many people who offer us advice, solicited and unsolicited, be fully aware of these constraints.

Turning now to the future, the Executive has identified five specific corporate questions that need to be tackled as top priority matters in 1985. Each of them relates to topics I have already mentioned. They are:-

- a clearly stated strategy to determine the balance of our research effort between industry sectors, research areas and technologies,
- a plan to ensure that our effort is concentrated into fewer programs and projects, all of national significance,
- a plan to ensure most effective use of our human resources, including concerted efforts towards retraining, redeployment and mutually acceptable arrangements for early retirement,
- identification of processes for systematic, quantitative evaluation of the benefits of CSIRO contributions to industry and the community in Australia, and
- examination of the most effective means of transferring the results of CSIRO research to industry and the community and making national research needs known to the Organization.

Each of these questions is being explored by a small working party led by a member of the Executive. We intend to formulate statements on each of these topics before July 1985 and thence to develop a corporate strategy to guide the Organization in the years ahead.

J.P. Wild
Chairman

December 1984

Highlights

Some of the more notable outcomes of research and research policy developments of CSIRO in the 1983/84 financial year are summarized here.

Advanced Materials

Research and development continued on zirconia-based ceramics, including the tough engineering ceramic, partially stabilized zirconia (PSZ). CSIRO's licensee, Nilsen Sintered Products (Aust.) Pty Ltd, formed the NILCRA consortium with CRA to exploit this development. CSIRO and ICI Australia have entered into a contract to manufacture high purity zirconia suitable, among other uses, for the manufacture of PSZ.

Artists in Residence

In early 1984 the Division of Applied Physics in Sydney was the venue for an Arts, Science and Technology Program sponsored by the Australia Council and the Australian Film Commission. Four artists, chosen competitively, spent three months in residence at the Division, investigating the various aspects of the arts and science interaction.

Moya Henderson, one of the artists chosen, worked on the development and fine-tuning of the alemba, a new keyboard percussion instrument that she has invented.

Moya Henderson is seen playing the treble alemba; the base alemba is in the background.

SIROTECH

Signifying CSIRO's determination to ensure that its research achieves positive benefits, the formation of SIROTECH, a company to facilitate the use of CSIRO findings in industry, was announced in September 1983. SIROTECH will negotiate licence agreements and arrange for the development of research results towards commercialization. It will also assist CSIRO Divisions to identify and undertake research of more immediate relevance to particular firms by advising them on commercial matters and helping to arrange contracts for CSIRO to undertake research for private companies. Details are in Chapter 3.

Genetic Engineering

The isolation by CSIRO of a transposable DNA element or 'jumping gene' in maize opened the way for genetic engineering of high yield and drought resistant crops. The US biotechnology company, Agrigenetics, was nominated as CSIRO's licensee for maize commercialization outside Australia. CSIRO retains the rights for development in other crop varieties.

Welding

A unique pulsed-arc welder was put on the market by Welding Industries Australia after development by CSIRO. The method permits better control of the weld pool, better weld penetration and weld bead shape and enhances the physical properties of the weld. Robotic use of the welder is dramatically illustrated on the Annual Report cover and further details can be found in the Research Reports section.

Manufacturing Industry Policy

To ensure that its research policies and priorities for the vital manufacturing industry sector remain positive and relevant, CSIRO's policies were revised in close consultation with manufacturing industry. CSIRO will conduct longer-term research which can be utilized widely by firms for development of new products and processes. Initially however, there will be an increased effort on tactical research to increase linkages with manufacturing industry. Collaborating firms will be expected to make available funding or other resources to ensure that the work is considered to be high priority. Selection of research topics will be based on the utility of the work. Details are in Chapter 1.

COALSCAN

The SIROASH techniques developed by CSIRO to measure the ash content of coal in bulk coal streams have been commercially developed and installed by Mineral Control Instrumentation Pty Ltd under the trade name COALSCAN. The potential savings in the coal and power industries are very high.

Counterfeit-proof Banknotes

A number of unique, optically variable, security devices have been developed for banknotes, with the aim of deterring forgers. The new types of banknotes have been produced in experimental batches by the Reserve Bank for assessment.

Division of Applied Physics Industrial Program

An innovative program of collaborative projects has been pioneered by this major Division. It is one of a range of measures aimed to increase the interaction between strategic researchers and industry. The Research Reports section contains further details.

Satellite Imagery

CSIRO remains at the forefront of development of techniques to enhance satellite imagery and improve its analysis and utilization. During the year CSIRO demonstrated the enhancement of night-time imagery, using the infrared, internal radiation of the ground itself to reveal underground topography of areas of Western Australia through the sand cover. The potential benefits for exploration are significant. CSIRO researchers also developed a technique at short notice to pinpoint volcanic ash clouds from the Indonesian region which posed a hazard to aircraft.

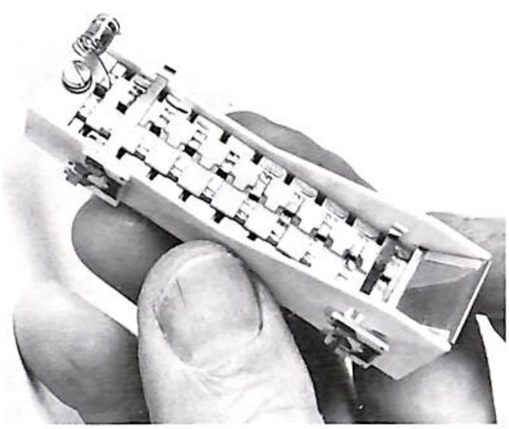
Dairy Technologies

Processes based on the application of ultrafiltration to milk were commercialized, appreciably increasing the yield of cheddar and similar cheeses. Together with four Australian and Japanese companies, CSIRO has also developed a dairy biotechnology process producing palatable liquid dairy products with less added sugar, providing health and economic benefits.

Electron Multiplier

The new compact electron multiplier, developed collaboratively by the Division of Chemical Physics and ETP Pty Ltd has no equal on today's market. It is less than 10 cm long and comprises a linear array of dynodes (electrodes) which can easily be replaced as they wear out. Electron multipliers are used for detecting and measuring electron currents and ions, and have application in mass spectrometry, medicine, space technology and other areas.

An electron multiplier.



The electron multiplier production area at ETP Pty Ltd.

Micronode

In collaboration with Office Automation Pty Ltd, CSIRO has developed a microcomputer-based node for use in computer communication networks. It offers a larger memory and greater reliability than existing nodes, does not need airconditioning and has an inbuilt monitoring facility. The micronode is soon to be commercially available. It is in use on the CSIRONET system which has also been enhanced by some of the most advanced laser printing equipment in the world.

Equal Opportunity

A number of advances in staffing practices were recorded during the year. After a comprehensive survey of the status of women conducted by the CSIRO Consultative Council, the Organization declared its position as an equal opportunity employer and started to rectify some deficiencies in the approach it formerly used. Details appear in Chapter 14.

Occupational Safety and Health

The death of a staff member and injury or illness among others drew severe criticism of facilities and safety standards in many CSIRO laboratories. After review, the resources devoted to improving health and safety in the CSIRO workplace were increased substantially and these issues have been given far greater prominence in decision making. Details appear in Chapter 14.

QEM*SEM

CSIRO has decided to proceed to the manufacture and sale of the QEM*SEM computer controlled scanning electron microscope. This automated instrument for analysis of the constituents of mineral particles is expected to contribute markedly to cost reductions and quality improvements in mineral processing.

Fecundin

The lamb twinning vaccine Fecundin, developed by CSIRO with Glaxo Australia, has been released commercially by Wellcome Australia Ltd. In practice, used correctly, Fecundin has increased lamb yields by between 20 and 30 per cent. Further details appear in the Research Reports section.

Information Technologies

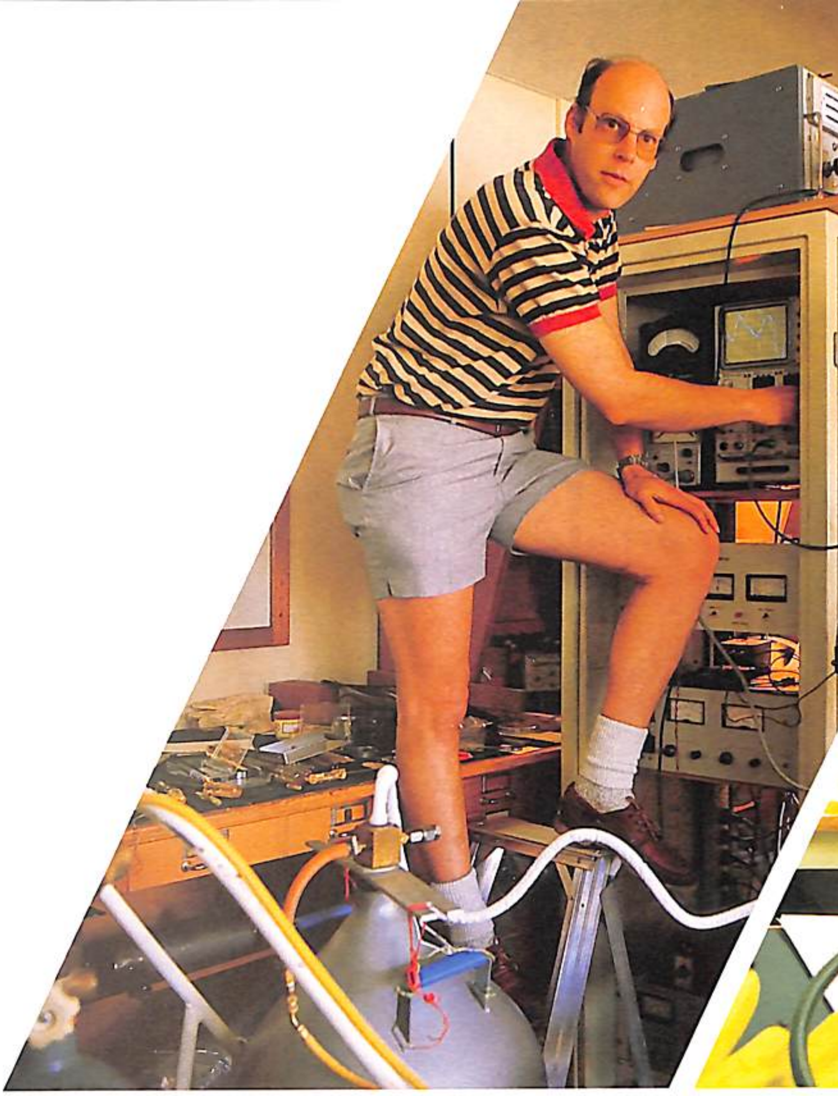
A unique Australian example of technology transfer neared reality at the year's end as final approvals were given for the formation of a private company which, as intended when the program began in 1981, will employ most of the staff of the Very Large Scale Integration (VLSI) group at the completion of their term contracts with CSIRO. The aim is to achieve rapid commercialization of the world-class multipurpose chip and VLSI designs developed by the CSIRO group. CSIRO is now moving towards establishing a Division of Information Technology to give further emphasis in this important field. Further details of policy developments are in Chapter 4.

Expansion in Western Australia

Staff from the Surface Chemistry Section of the Division of Mineral Chemistry moved from Melbourne to Perth to establish a CSIRO mineral processing research laboratory in Western Australia. The laboratory is situated on the campus of the Western Australian Institute of Technology and CSIRO staff will liaise closely with WAIT researchers.

Review of Administration

During the year a major review of the Organization's administrative arrangements was concluded. The review considered and made recommendations on the distribution and location of all administrative functions and on new systems to accommodate changed centres of administrative concentration and data base needs of managers at all levels of the administrative system. The Review also embraced the externally imposed requirement for transferring the Organization's account system to an accrual based one.

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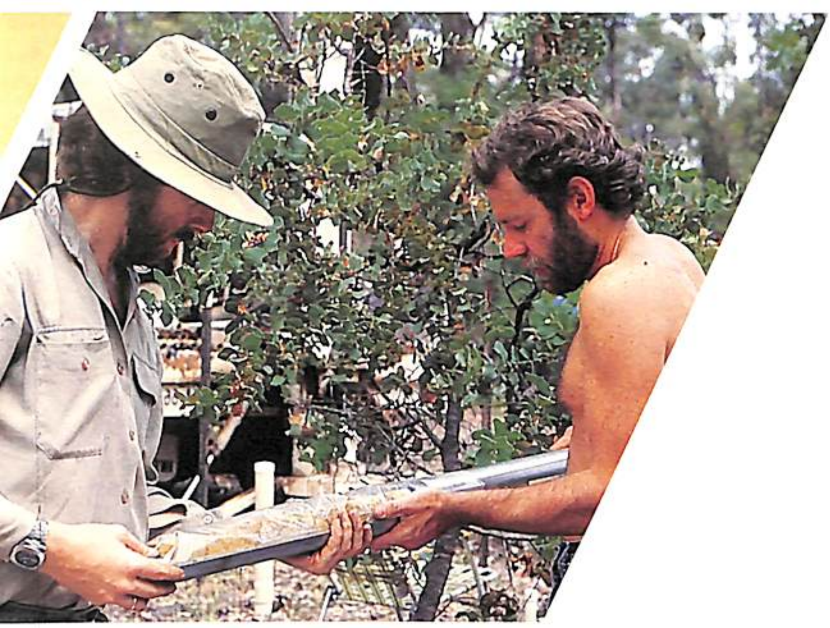
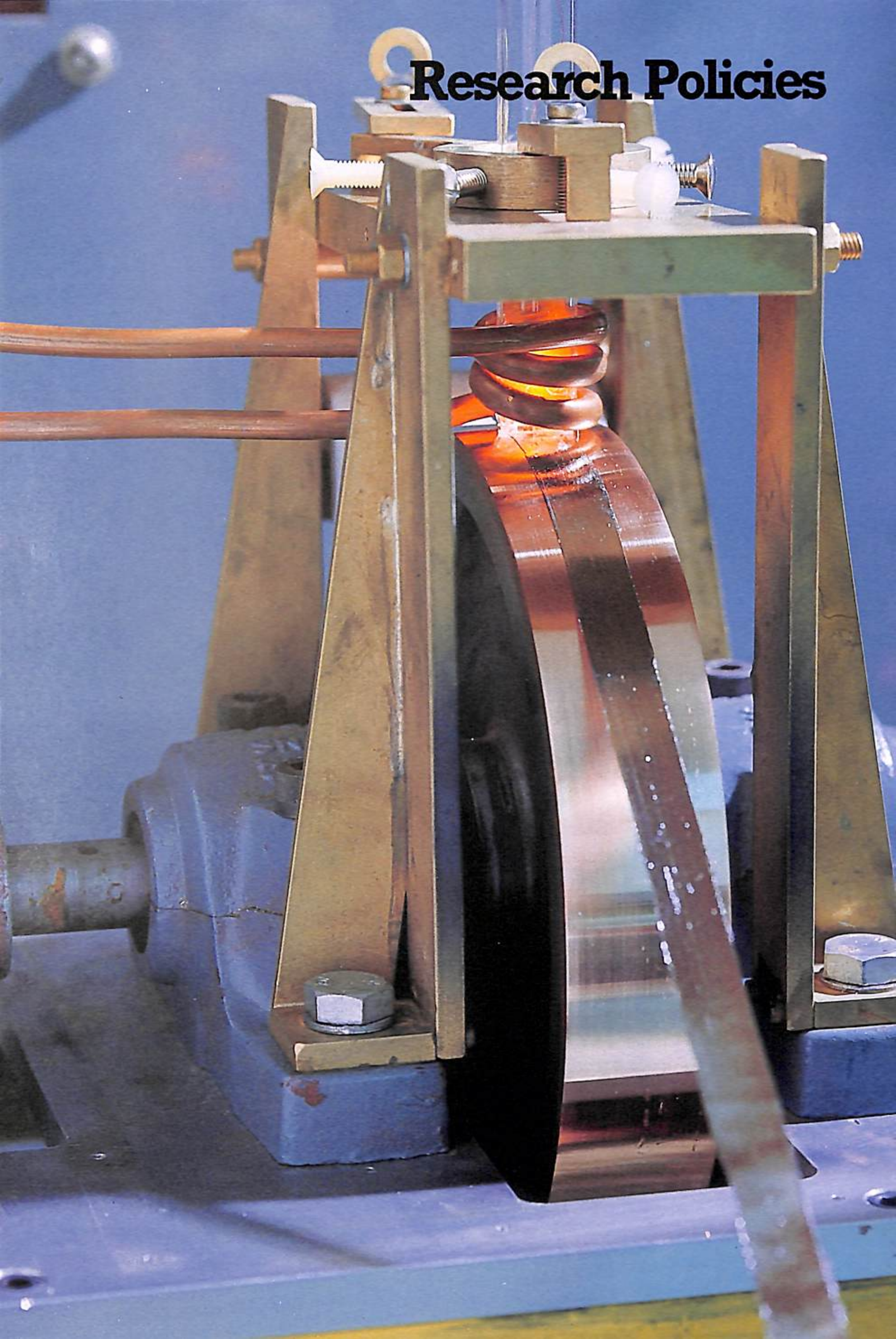


Research Policies



Producing glassy-metal ribbon. Metallic alloys containing particular elements can be converted to a glassy state by extremely rapid cooling. This is accomplished by melting the alloy, contained in the silica tube at the top of the picture, in the output coil of an electric induction furnace and forcing it through a narrow slit to cool against a rapidly rotating cold metal wheel. The glassy metal is spun off as a ribbon which can then be used for a variety of purposes such as to make laminations for improved transformer cores. The rotation wheel has been stopped for the photograph so that the ribbon can be seen more clearly.

1. Manufacturing Research Policy and Priorities

Introduction

The development of a dynamic and competitive manufacturing sector of the economy has been re-emphasized in recent years as a common goal of the community and governments, both Federal and State. The need for such development was pointed out in the Jackson Committee's report on policies for manufacturing industry in the mid-1970s. However, during the following years there was continued reliance on production of minerals and rural products to generate wealth and export revenue, and a questioning in the community of the broad social impact of the rapid and extensive technological change that would necessarily form the basis of a revitalised and competitive manufacturing sector.

By the start of the 1980s, however, the fall in world demand and prices for minerals and rural products demonstrated the dangers of over-reliance on growth in the natural resources sectors of the economy to generate wealth. Following the Myers Committee's report, there was also wider community acceptance that, without technological change, the decreasing competitiveness of manufacturing industry would lead to a continued restriction on the overall wealth and employment generating potential of the economy.

New attitudes also became apparent in industry and government, partly in recognition of the importance of technological advances to economic development and to industry restructuring. Recent legislation encouraging venture investment in new technology-based firms typifies the changing climate, as does the increased interest of State governments in technology development for manufacturing industry.

CSIRO's policies for its manufacturing research — outlined in the Organization's annual report for 1980/81 — have been re-examined and expanded against this changed climate and in the light of their application over the past few years.

The Executive also commissioned its Planning and Evaluation Advisory Unit to undertake a detailed planning study of research needs and opportunities in the manufacturing sector. The study was conducted in close consultation with industry, CSIRO scientists and the CSIRO Advisory Council. While this study was under way, criteria were developed to assist in determining priorities among the numerous needs and opportunities emerging from the planning study. These criteria are summarized below.

CSIRO's Role and Policy

CSIRO's research in support of manufacturing industry is based on:

- an increasing recognition that Australian industrial research is essential for the prosperity of the manufacturing sector and of the Australian economy as a whole;
- the acknowledged need for increased research and development activity in both industry and government, together with effective linking of these activities; and
- the need for CSIRO's research in support of manufacturing industry to be both useful to industry and appropriate for a predominantly government-funded agency.

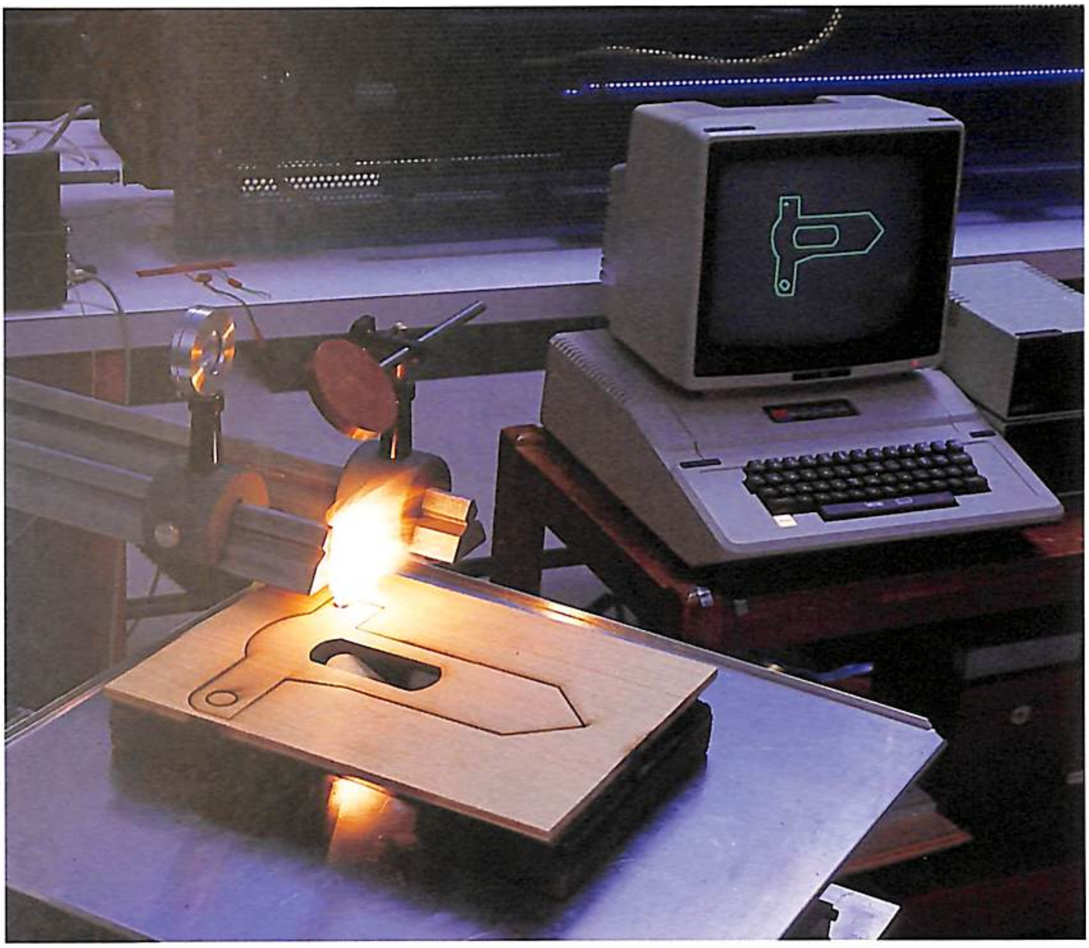
The Executive has reaffirmed that CSIRO's primary contribution to manufacturing industry should be the conduct of longer-term research which can be utilized widely by firms for the development of new products and processes. It has recognized, however, that for such research to contribute effectively to the technological capacity of Australian manufacturing industry, significant resources need to be devoted to a range of supporting activities.

CSIRO needs to work closely with individual firms. CSIRO must appreciate industry's more immediate requirements as well as longer-term needs and aspirations. Mutual confidence and respect must be generated. Direct assistance to firms on their current problems is the best way to gain such confidence, besides helping industry to remain competitive.

For these reasons CSIRO devotes significant resources to work on the current problems and needs of industry through the conduct of tactical research.

Requirements for such tactical research vary from industry to industry. There would be little merit, and considerable danger, in allocating a fixed proportion of CSIRO's resources for manufacturing research as a whole to such tactical work. Accordingly, the Executive has directed that each CSIRO Division and Institute engaged in research in support of manufacturing should examine, identify and monitor the balance and effectiveness of its research.

The Executive also confirms its existing policy promoting increased industry financing of tactical work to supplement the Organization's Appropriation-funded core strategic research effort. This support encourages effective interaction and, more importantly, it ensures that the problems under investigation are indeed those of high priority for industry. Such a measure



is particularly important where the work is company-specific. However, it does require an awareness on the part of industry of the benefits of research and a willingness to devote funds to its prosecution.

Effectiveness of research performed is the underlying theme for the criteria developed by the Executive for selection of priority topics and more specific research projects. These criteria can be categorized under two broad headings: utility and feasibility. Both types of criteria need to be satisfied.

These criteria are set out in a more detailed statement of CSIRO's policy and priorities for manufacturing research that will be available on request. In summary, the potential utility is determined largely by the likelihood of adoption of research results leading to Australian manufacture of new devices and products, or use of new processes, either by existing industry or by emerging new industries. Assessment of feasibility involves judgement of the likelihood that significant advances will actually be made through research, and practical assessment of the existence of the necessary skills within CSIRO or of the possibility of acquiring them by appropriate staff recruitment.

The Sirostep laser cutting system developed recently by the CSIRO Division of Applied Physics has been readily adopted by the industry because of its low cost, versatility and convenience. It is easy to program, cuts through materials ranging in hardness from polystyrene to steel, and the workpiece is manoeuvrable. The laboratory version shown here has been upgraded to larger industrial versions by an Australian company operating under a licence agreement.

CSIRO's manufacturing research effort is supported by other more general policies of the Organization. For example, the Executive has recently issued new guidelines for promotion of research scientists which emphasise activities leading to practical achievements. The Executive has also established a business-oriented company, SIROTECH Ltd, to improve the Organization's commercial evaluation of research results and to encourage their exploitation by Australian industry.

CSIRO's Research for Manufacturing Industry

CSIRO's research for manufacturing industry has shown a gradual increase in recent years. In 1979/80 (the first year in which personnel information was categorized in the form currently used), some 26% of the Organization's professional staff working in research programs were employed on research supporting the manufacturing sector. About 630 staff were involved. By 1983/84, using the same basis for classification, this had increased to some 710, or 28.5% of the Organization's professional staff working in research programs. This year, and for future years, the basis for classifying CSIRO's research has been changed to emphasize the purpose for which the research is undertaken. These changes are discussed in Chapter 2 and in Table 3 this new approach is compared with the previous method of classification.

Of greater significance than the absolute growth in research in support of manufacturing, however, has been the shift over the past five years in the balance within the Organization's manufacturing research. During this relatively short period, there has been a marked shift towards research in support of technology-based manufacturing, with professional staff working on such research increasing by 140. Additional resources provided by the Government in 1983/84 for such high technology research topics as biotechnology, information technology, advanced materials and manufacturing technologies with broad industrial application have contributed to this shift in the balance of the research effort towards technology-based manufacturing.

Manufacturing Research Priorities

The Executive has determined eight highest priority research topics for the Organization's manufacturing research. These priority topics were selected in accordance with the criteria summarized earlier in this chapter. Specific programs and projects within each topic will be selected through more detailed application of the criteria.

The highest priority research topics are:

- application of computer technology and microelectronics to industrial processes;
- integrated engineering manufacture, particularly flexible manufacturing systems;
- advanced technologies for process and quality control, including new industrial measurement systems;
- advanced materials for new applications and for improved performance characteristics in existing applications;
- new technologies for processing minerals to produce materials with special characteristics and to improve production efficiency;
- instruments and technologies for environmental monitoring and mineral exploration;
- selected microelectronic devices and communication technologies, particularly devices for satellite communications; and
- agricultural chemicals, veterinary vaccines and selected medical pharmaceutical products.

Details of these topics are set out in the statement of CSIRO's policy and priorities for manufacturing research referred to earlier.

Already more than 300 of the Organization's professional staff — representing almost half of those engaged in research in support of manufacturing industry — are working on programs within these highest priority topics.

While the topics embrace research programs in support of both technology-based and resource-based industries, the emphasis is towards the former, many of which have been inadequately supported in the past. However, important work remains to be conducted for other existing industries, including resource-based industries, to enable Australia to capture greater gains from its natural resource endowments. These industries are textiles and leather, cellulose and forest products, food processing, industrial mineral processing, and metal products. In particular, the Organization is placing a greater emphasis on research into new technologies and processes for upgrading raw materials prior to export.

Implementation of Priorities

There has already been a significant increase in effort in some of these highest priority topics through changes in Divisional emphasis, Executive-initiated redeployment of resources and, most recently, the Government's 1983/84 Budget allocation referred to above. CSIRO, in consultation with potential users of its research results, is now examining what action should be taken to increase research effort in the selected highest priority topics. This examination aims at identifying:

- specific new programs and projects which should be undertaken by CSIRO either from core funding or jointly with industry;
- the extent to which additional resources required could be made available through intra-Divisional and intra-Institute redeployment of funds or people; and
- further resources judged necessary which would be candidates for Executive reallocation of resources or for approaches to Government for additional resources.

The priority topics, and the work within each, will be kept under review and modified where necessary in the light of emerging needs and opportunities.

Table 1 Highest Priority Manufacturing Research Topics

Research Topic	Divisions	Level of Research Effort (Professional Staff Numbers)	
Application of computer technology and microelectronics to industrial processes	Computing Research	11.0	
	Manufacturing Technology	13.5	
	Chemical and Wood Technology	1.4	
	Textile Physics	1.0	
			26.9
Integrated engineering manufacture, particularly flexible manufacturing systems	Manufacturing Technology	9.5	
			9.5
Advanced technologies for process and quality control, including new industrial measurement systems	Applied Physics	18.0	
	Manufacturing Technology	9.5	
	Mineral Physics	9.0	
	Mineral Engineering	4.0	
	Textile Physics	8.0	
			48.5
Advanced materials for new applications and for improved performance characteristics in existing applications	Manufacturing Technology	3.5	
	Mineral Chemistry	7.0	
	Mineral Physics	2.0	
	Materials Science	46.0	
	Applied Organic Chemistry	11.0	
	Chemical Physics	7.0	
	Applied Physics	15.0	
	Fossil Fuels	2.0	
	Chemical and Wood Technology	2.5	
			96.0

Table 1 (cont.)

Research Topic	Divisions	Level of Research Effort (Professional Staff Numbers)	
New technologies for processing minerals to produce materials with special characteristics and to improve production efficiency	Mineral Chemistry	2.0	
	Mineral Engineering	10.0	
	Manufacturing Technology	2.5	
			14.5
Instruments and technologies for environmental monitoring and mineral exploration	Manufacturing Technology	1.0	
	Mineral Physics	13.0	
	Mineralogy	4.0	
	Chemical and Wood Technology	0.5	
	Atmospheric Research	3.0	
	Environmental Mechanics	1.0	
	Chemical Physics	4.0	
			26.5
Selected microelectronic devices and communication technologies particularly devices for satellite communications	Radiophysics	3.0	
	Applied Physics	5.0	
	Manufacturing Technology	0.5	
			8.5
Agricultural chemicals, veterinary vaccines and selected medical pharmaceutical products	Animal Health	8.9	
	Molecular Biology	14.5	
	Tropical Animal Science	12.1	
	Protein Chemistry	9.5	
	Applied Organic Chemistry	17.0	
	Chemical and Wood Technology	13.2	
	Animal Production	16.7	
	Food Research	3.3	
	Wheat Research Unit	2.0	
			97.2
			327.6

2. Distribution of Research Effort

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

CSIRO has developed a classification scheme which is used to present and describe its research effort. The scheme was originally prepared for strategic planning purposes and now involves five major sectors progressively broken down into sub-sectors and research areas. It was introduced during 1979/80 and is now widely used in the Organization to meet management and reporting needs. It continues to evolve in line with changes in these requirements. Table 2 shows the distribution of resources to research areas as at 30 June 1984 according to the classification scheme. A version of Table 2 has appeared in each annual report since the reporting year 1978/79, and subject to the comments in the following paragraph, it is intended that year-to-year comparisons of Table 2 figures should provide an indication of shifts in the allocation of CSIRO research resources between broad sets of national objectives. Table 2 contains

Table 2 CSIRO Research Areas 1983/84

Rural Industries	% of Total Research Expenditure		% of Total Direct Professional Staff	
Agriculture — plants				
Plant improvement	3.2		2.9	
Plant physiology and biochemistry	3.1		3.0	
Soils and plant nutrition	3.4		3.4	
Crop and pasture pests and diseases	2.8		2.7	
Not specifically allocated	0.4		0.4	
		12.9		12.4
Agriculture — animals				
Livestock production	5.3		4.2	
Livestock health	5.7		3.9	
Wool textiles	2.9		2.0	
Not specifically allocated	0.1		0.1	
		14.0		10.2
Agricultural systems				
Agricultural systems	2.7		2.2	
		2.7		2.2
Forestry				
Forest science	3.0		2.9	
		3.0		2.9
Fishing				
Fisheries biology	2.2		1.9	
Marine biology	1.2		0.9	
Not specifically allocated	0.1		0.1	
		3.5		2.9
Not specifically allocated				
	0.6		1.0	
		0.6		1.0
Total — Rural Industries		**36.7**		**31.6**

Table 2 (cont.)

Mineral, Energy & Water Resources	% of Total Research Expenditure		% of Total Direct Professional Staff	
Mineral resources				
Exploration	2.5		2.8	
Mining	0.8		0.8	
Mineral beneficiation	1.6		1.9	
Not specifically allocated	0.2		0.3	
		5.1		5.8
Energy resources				
Coal	2.4		2.6	
Petroleum, gas and oil shale	1.0		1.1	
Substitute liquid and gaseous fuels	2.5		2.6	
Energy storage and conservation and renewable energy	2.3		2.6	
Not specifically allocated	0.1		0.2	
		8.3		9.1
Water resources				
Water management	2.8		3.0	
Water technology	0.5		0.6	
		3.3		3.6
Not specifically allocated	0.7		1.1	
		0.7		1.1
Total - Mineral, Energy and Water Resources		**17.4**		**19.6**

Table 2 (cont.)

Manufacturing Industries	% of Total Research Expenditure		% of Total Direct Professional Staff	
Resource-based manufacturing industries				
Food processing	3.6		4.4	
Textiles and leather	2.5		2.4	
Cellulose and forest products	2.0		2.0	
Industrial mineral processing and basic metal products	1.6		2.0	
Not specifically allocated	0.1		0.1	
		9.8		10.9
Technology-intensive industries				
Instruments and electronic equipment	3.7		4.0	
Advanced materials and specialty polymers	4.1		4.8	
Agricultural chemicals, pharmaceuticals and veterinary products	3.9		3.5	
Materials fabrication	1.8		1.8	
Not specifically allocated	0.5		0.4	
		14.0		14.5
Standards and measurement				
Standards: industrial measurement	1.5		1.3	
		1.5		1.3
Not specifically allocated	0.1		0.1	
		0.1		0.1
Total - Manufacturing Industries		**25.4**		**26.8**

Table 2 (cont.)

Knowledge and Management of the Natural Environment	% of Total Research Expenditure		% of Total Direct Professional Staff	
Flora and Fauna				
Flora	1.0		0.9	
Fauna	2.4		2.1	
Not specifically allocated	0.2		0.3	
		3.6		3.3
Land				
Land	1.8		1.9	
		1.8		1.9
Oceans				
Oceans	1.3		0.7	
		1.3		0.7
Atmosphere				
Atmosphere	1.8		2.1	
		1.8		2.1
Environmental protection and rehabilitation				
Environmental protection and rehabilitation	1.3		1.2	
		1.3		1.2
Extra-terrestrial				
Astronomy	2.4		2.9	
		2.4		2.9
Not specifically allocated	0.1		0.1	
		0.1		0.1
Total - Knowledge and Management of the Natural Environment		**12.3**		**12.2**

Table 2 (cont.)

Information and Service Industries	% of Total Research Expenditure'		% of Total Direct Professional Staff	
Information				
Mathematics and statistics	0.5		1.0	
Information, communications and computing services	3.4		3.8	
		3.9		4.8
Construction				
Building and construction	2.0		2.3	
		2.0		2.3
Health				
Public Health	2.3		2.7	
		2.3		2.7
Total — Information & Service Industries		**8.2**		**9.8**
CSIRO — Research Total		**100.0**		**100.0**

figures for professional staff directly involved in programs of research and for expenditure. The figures for professional staff are a more reliable guide to research policies than the expenditure figures because they do not suffer as much from coincidental factors such as the acquisition in one year of items of equipment intended for use over many years. However, caution is still required with staff figures because it may take many months to recruit suitable staff to new programs or to replace those who leave.

In the annual report for 1982/83, attention was drawn to the need for caution in year-to-year comparisons because programs of research were assigned only to the single research area to which the work was primarily relevant. In collecting data for Table 2 this year, programs have been assigned proportionally to up to three research areas in an attempt to take into account the direct benefit a program of research may bring to a number of diverse industries or other community interests. At the same time, as a result of formal advice from the CSIRO Advisory Council on the Organization's statement of policies and priorities for manufacturing research, the basis for assigning programs to research areas has been revised. Past assignments have been based on types of products or processes being investigated. This year, and for the future, the assignments have been made on the basis of the purpose for conducting the research or the direct Australian beneficiary. The combined effect of these two fundamental changes to the philosophy of classifying CSIRO's research effort is compared in Table 3 with the same data classified by the type of products or process criterion at sector level only. The effect is readily demonstrated using the example drawn on by the Advisory Council: CSIRO's textile research. In this example, the research in the Division of Textile Industry, which was previously recorded wholly as part of CSIRO's manufacturing industry effort, is now split between research areas in the manufacturing industries and rural industries sectors. This is because the intent of much of the

Table 3 compares the sector distribution of CSIRO's research effort under the new system introduced this year (proportional allocations on basis of purpose or beneficiary) with that used in previous years (single allocations on basis of type of product or process being investigated). The left-hand column presents overall sector allocations on the old basis and the bottom row the overall sector allocations using the new classification system. The remaining rows and columns indicate the extent to which individual activities have multi-sectoral beneficiaries and how each sector draws on product or process investigations in other sectors respectively.

Table 3 Distribution of Research Effort 1983–84

(Direct Professional Research Staff)

Programs allocated totally to individual sectors on the basis of type of process or product under investigation \ Programs allocated proportionally to sectors on the basis of purpose or direct Australian beneficiary		Manufacturing Industries	Rural Industries	Mineral, Energy & Water Resources	Information & Service Industries	Knowledge & Management of the Natural Environment
Manufacturing Industries	713 28.5%	569 22.7%	87 3.5%	31 1.3%	25 1.0%	1 0%
Rural Industries	741 29.7%	40 1.6%	644 25.7%	19 0.8%	19 0.8%	19 0.8%
Mineral, Energy & Water Resources	479 19.1%	40 1.6%	6 0.3%	406 16.1%	3 0.1%	24 1.0%
Information & Service Industries	258 10.3%	20 0.8%	27 1.1%	28 1.1%	177 7.1%	6 0.2%
Knowledge & Management of the Natural Environment	311 12.4%	2 0.1%	26 1.0%	6 0.3%	21 0.8%	256 10.2%
Total	2502 100%	671 26.8%	790 31.6%	490 19.6%	245 9.8%	306 12.2%

work is to improve the marketability of woollen textiles, most of which are manufactured overseas, through new or improved manufacturing processes, which assures a continuing demand for the primary product — wool. Benefits also flow to Australian manufacturing industry, although to a lesser extent. In Table 3 this research is incorporated wholly in the Manufacturing Industries entry in the first column, but split between the Manufacturing Industries and Rural Industries entries in the first row in the proportions of 20% and 80%. Other programs classified as Manufacturing Industries on the basis of the type of process involved in column one are similarly now split among the five sectors on the basis of the direct beneficiaries of the research in the remaining entries in the first row of Table 3. The remainder of Table 3 is similarly constructed and leads to the totals for each sector shown in the final row. These equate to the sector totals in Table 2 which also contain details of similar proportional beneficiary allocations down to research area level.

Table 4 shows the allocation of financial and manpower resources to the Divisions and independent research Units which make up the CSIRO Institutes.

Table 4 1983/84

	% of Total Research Expenditure		% of Total Direct Professional Staff	
Institute of Animal and Food Sciences				
Animal Health	2.6		1.8	
Animal Production	4.8		4.1	
Australian National Animal Health Laboratory	1.4		0.6	
Fisheries Research	3.5		2.9	
Food Research	4.6		5.6	
Human Nutrition	1.3		1.5	
Tropical Animal Science	2.5		1.7	
Molecular Biology	1.2		1.1	
Project for Animal Research and Development	0.4		0.2	
Wheat Research	0.3		0.5	
Institute Total		**22.6**		**20.0**
Institute of Biological Resources				
Entomology	4.4		4.2	
Forest Research	3.6		3.4	
Horticultural Research	1.1		1.3	
Plant Industry	5.6		5.3	
Soils	2.9		3.2	
Tropical Crops and Pastures	4.0		2.4	
Water and Land Resources	2.2		2.7	
Wildlife and Rangelands Research	2.8		2.3	
Centre for Irrigation Research	1.0		1.0	
Institute Total		**27.6**		**25.8**

Table 4 (cont.)

	% of Total Research Expenditure		% of Total Direct Professional Staff	
Institute of Energy and Earth Resources				
Geomechanics	1.1		1.2	
Energy Chemistry	1.8		1.6	
Energy Technology	1.3		1.5	
Fossil Fuels	2.7		2.9	
Groundwater Research	1.1		1.1	
Mineral Chemistry	2.1		2.6	
Mineral Engineering	1.8		2.2	
Mineral Physics	2.5		3.0	
Mineralogy	1.8		2.1	
Institute Total		16.2		18.2
Institute of Industrial Technology				
Applied Organic Chemistry	1.6		1.8	
Building Research	2.7		3.2	
Chemical and Wood Technology	2.8		3.3	
Manufacturing Technology	1.6		1.6	
Protein Chemistry	1.9		1.9	
Textile Industry	2.7		1.9	
Textile Physics	1.7		1.6	
Institute Total		15.0		15.3
Institute of Physical Sciences				
Applied Physics	5.5		5.2	
Atmospheric Research	1.9		2.2	
Chemical Physics	1.9		2.3	
Computing Research	1.1		1.5	
Environmental Mechanics	0.5		0.5	
Materials Science	1.4		1.9	
Mathematics and Statistics	1.6		2.8	
Oceanography	1.9		0.9	
Radiophysics	2.6		3.2	
Australian Numerical Meterology Research Centre	0.2		0.2	
Institute Total		18.6		20.7
CSIRO — Research Total		100.0		100.0

Designated Growth Areas

The Executive periodically designates research areas where growth will be specifically encouraged. These broad areas do not necessarily coincide with the research areas specified in Table 2.

For 1983/84, the nominated growth areas were:

- biotechnology
- advanced materials
- broadly applicable manufacturing technologies
- information technologies
- water and soils
- plant pathology and
- oceanography

This list is to remain unchanged for 1984/85, but a revision is currently underway which will be adopted during 1985/86.

Significant Changes within 1983/84 Designated Growth Areas

The following paragraphs describe recent research activities within each of the Executive's designated areas for growth. Where appropriate, these descriptions have been augmented by graphs (Figures 1–6) showing how the research effort in each area has increased since 1980/81, and anticipated future expansions. The extent of future expansion is naturally dependent on the level of government funding and on the Organization's ability to redeploy staff. These uncertainties are represented by the coloured areas in each graph.

Biotechnology research continued to grow during 1983/84 (Figure 1). In the Institute of Animal and Food Sciences, the Division of Molecular Biology (created as a result of the review of the Molecular and Cellular Biology Unit, see Chapter 7) and others within the Institute, have expanded research on the production of vaccines and pharmaceuticals by genetic engineering and synthetic peptide methods. The principal targets for vaccines are rotavirus infections, sheep footrot, cattle tick fever and cattle tick. Additionally, effort was increased in a collaborative project involving several Divisions and The Australian National University on the use of pox viruses as universal vectors for vaccines. The Institute also has programs concerned with improvement of cheese starter cultures by rDNA methods; production of pharmaceuticals from abattoir by-products; genetic manipulation of the sheep genome; and synthesis of Epidermal Growth Factor (EGF) fragments and evaluation of EGF produced by genetic engineering. In the Institute of Industrial Technology, the Division of Protein Chemistry is collaborating with Divisions in the Institute of Animal and Food Sciences on the production of genetic engineering-based vaccines against ovine footrot, ovine intestinal worm infestations and avian viral disease and on the genetic improvement of cheese starter cultures by rDNA methods. The Division of Applied Organic Chemistry has increased its efforts on biologically active compounds, while the Division of Chemical and Wood Technology has established a new program to scale up processes in vaccine production and related areas in collaboration with other Divisions and with industry. This Division has terminated work

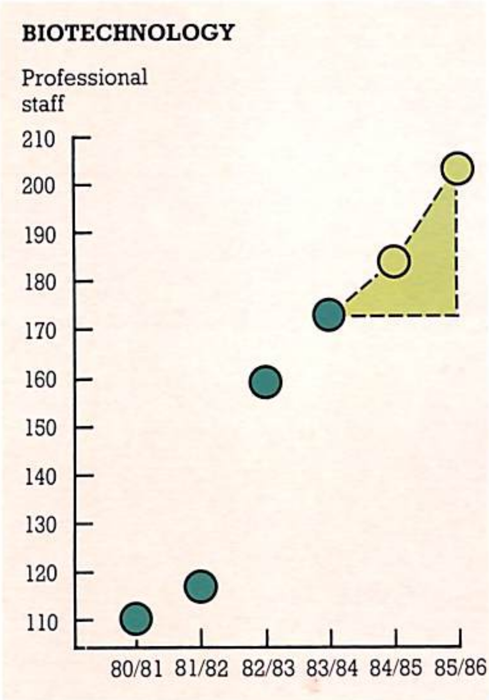


Figure 1

on liquid fuels from biomass in favour of the development of processes to produce high value chemicals from cellulose feedstocks. In the Institute of Biological Resources, biotechnology research in the broad area of plant agriculture is being actively pursued in several Divisions. In the Division of Plant Industry, new techniques for gene manipulation in maize ('jumping genes') are being developed to provide an avenue for genetic improvements in this species. It is expected that further research will lead to the development of gene transfer systems for cereal species of greater economic importance in Australia. The Division is applying recombinant DNA techniques to the diagnosis of viral diseases in pasture legumes and other crop species. This research is being carried out with support from the National Biotechnology Program in collaboration with the Biochemistry Department of the University of Adelaide. The Division of Horticultural Research is collaborating with this Department in the use of recombinant DNA probes to identify and/or characterize virus-like diseases in fruit trees and has projects concerned with the use of recombinant DNA techniques for plant improvement. Using a technique known as somaclonal variation, the Division of Plant Industry is selecting for enhanced disease resistance and other properties in economic crops, from the normal variation of these characteristics within species. Cell and tissue culture techniques are also being applied by the Division of Horticultural Research in selecting for disease and salinity resistance in grapevines and other horticultural crops, and to facilitate the storage of perennial plant germplasm. The Division of Forest Research is utilizing tissue culture techniques in seeking genetic improvements in *Pinus radiata* and eucalyptus species for commercial use. Also within the Institute, the Division of Entomology is studying the molecular genetics of insects as well as more applied biological control procedures such as the use of sex pheromones in the control of orchard pests, and the mass rearing of pathogenic nematodes for the control of insect pests.

Research into *advanced materials* expanded during 1983/84 (Figure 2) with increased effort being undertaken in polymer studies at the Division of Applied Organic Chemistry, where the work is concentrating on new free-radical processes for making polymers of controlled structure. The Division of Materials Science in the Institute of Physical Sciences has expanded work on transformation-toughened ceramics, including Partially Stabilised Zirconia (PSZ) and other promising structural materials, and on electrical ceramics. The further successful commercial development of PSZ made progress during the year with the establishment of a company, NILCRA, to continue development of the new ceramic. In addition, an agreement between CSIRO and ICI Australia Limited has been signed to develop a process for manufacturing high purity zirconia in order to establish a zirconia processing and manufacturing plant in Australia. This research is being conducted in the Division of Mineral Chemistry of the Institute of Energy and Earth Resources.

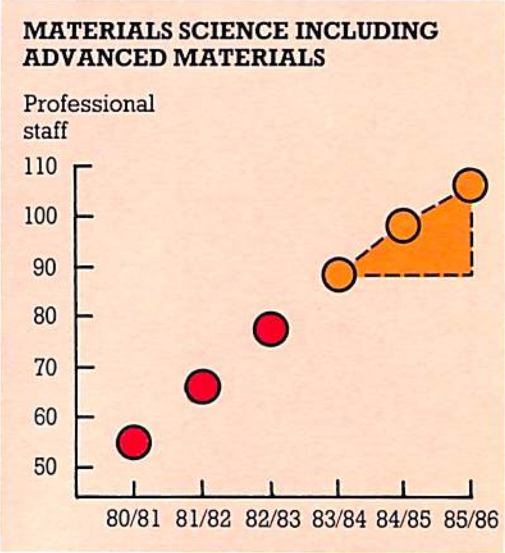


Figure 2

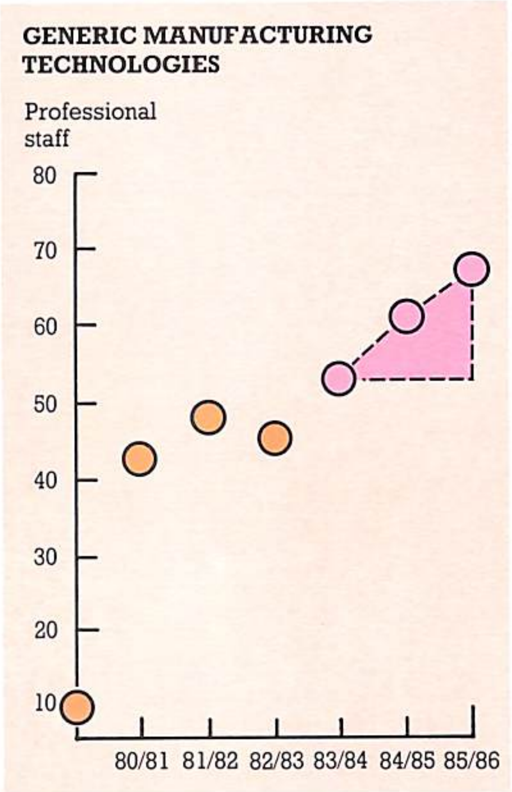


Figure 3

In the Institute of Industrial Technology, work has been expanded in the Division of Manufacturing Technology in support of the Executive's *manufacturing technologies* initiative (Figure 3). Research has doubled in computer-aided design and manufacture (CAD/CAM) techniques and in work on automation where the emphasis is on flexible manufacturing systems, vision sensing, simulation techniques and robotics. This research is closely associated with work on processes for manufacture, which in 1983/84 resulted in the commercial release of a unique Australian pulse welding system, and a diecast design software package to be marketed internationally by an Australian company. Research in the Division of Textile Physics into pre-charging and new designs for industrial filter bags is finding important applications in the smelting and power generating industries. To assist in landmark reform of wool marketing procedures, the Division is also going ahead with the commercial development of its computer controlled instrument (Atlas) to measure the staple length and strength of wool fibres in the Australian wool clip. In the Division of Applied Physics in the Institute of Physical Sciences, the applications of physics in manufacturing industry are steadily increasing with the establishment of the Applied Physics Industrial Program (see Research Reports section) and the continued support within the Division of work in such areas as arc technology, thin films and modern electronic distance measuring techniques.

During 1982/83, the Executive included *information technologies* in its list of growth areas in recognition of the area's increasing importance (Figure 4). In 1983/84, the Executive's Information Technology Study Group, established the previous year, identified five major areas for research in information technology. The report of this Group and the Executive's resultant initiatives are described in Chapter 4. One important decision was to form a new Division of Information Technology early in 1985. Equally important is the decision to set aside $0.5 million to be used for collaborative projects with industry and tertiary

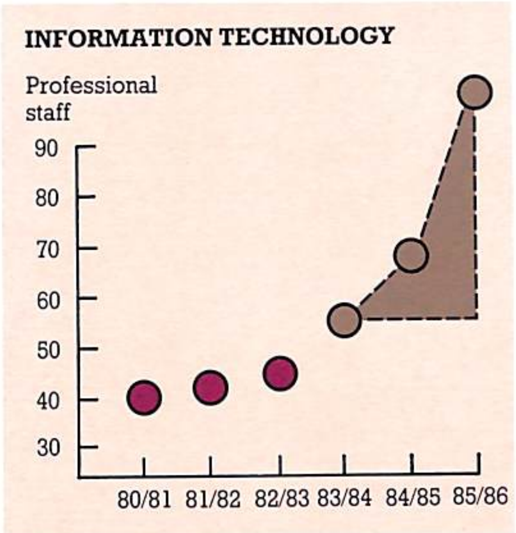


Figure 4

education institutions as part of the Information Technology Program during the 1984/85 financial year. In the Institute of Physical Sciences, the Division of Computing Research is continuing research in image analysis, while the Division's VLSI (Very Large Scale Integrated) chip project is being concluded and arrangements are underway to transfer the work to the commercial sector. In the Institute of Energy and Earth Resources, the Division of Mineral Physics is concentrating on developing portable systems incorporating geophysical modelling and image analysis for applications in industry. The Institute of Industrial Technology is applying information technology to the manufacturing environment in such areas as design, process planning, scheduling and simulation. In the Division of Building Research, a technique including artificial intelligence is being applied to improving optimization procedures for planning layouts for buildings and urban environments. In a major initiative to support local government, the

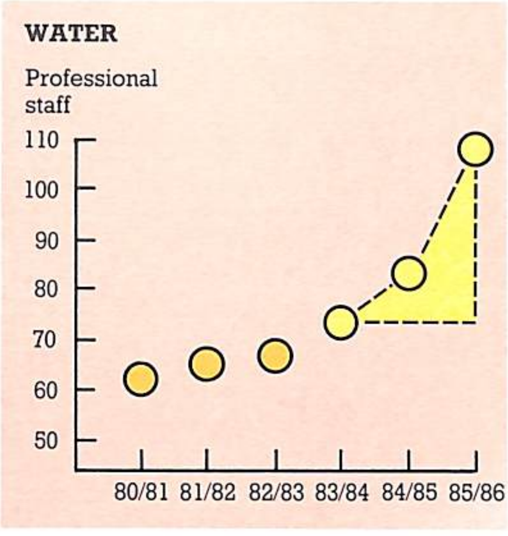


Figure 5

Division is also developing systems and databases for use with building regulations, and to enable automatic checking of plans and specifications.

Research in the nationally significant *water and soils* area (Figure 5) is concentrated in the Institutes of Energy and Earth Resources, Biological Resources, and Industrial Technology. The Division of Groundwater Research in the Institute of Energy and Earth Resources has increased its research into the physical and chemical processes in aquifers and on developing methods to predict quantitatively the behaviour of groundwater systems. In the Division of Mineral Physics, a groundwater emphasis has been included in remote sensing research. In the Institute of Biological Resources, the Division of Soils has strengthened work in hydrology of semi-arid and wet tropic soils, and in salt and water movement in soils and in the underlying groundwater in a range of situations in southern Australia. In the Division of Water and Land Resources, a general method has been developed for analyzing water movement in complex landscapes to predict the hydrological effects of alternative land management strategies. The method can be used to evaluate the most cost effective measures to reverse the onset of dryland salinity. Other methods have been formulated to analyze long-term trends in salinity and soil erosion as a basis for developing corrective management practices. In the Centre for Irrigation Research, where research is concentrating on soil and water management for improving irrigated crop yields, water re-use and limnology studies are being built up. In the Institute of Industrial Technology, the Division of Chemical and Wood Technology has broadened its water purification research to encompass the treatment of industrial wastewaters. Research is continuing on upgrading low quality natural waters through the establishment and operation of commercial installations in association with industrial collaborators.

In *plant pathology*, research into crop and pasture diseases in the Institute of Biological Resources increased slightly during 1983/84. However, further progress awaited more detailed decisions by the Executive on the plant pathology review and in particular on the areas most suitable for research by CSIRO. These decisions have now been made and are described more fully in Chapter 7.

In the area of *oceanography* (Figure 6) there has been a steady increase in staff numbers in the Institute of Physical Sciences' Division of Oceanography. With the occupation of the new Marine Laboratories complex in Hobart about to take place, and delivery of the new research vessel expected early in 1985, Australian marine science is poised to make a significant impact on international research in this area. During 1983/84, research has concentrated on large scale oceanography related to climate change, and a group concerned with the application of oceanographic principles to the maritime industry has been established.

Redeployment

Resources to undertake expanded activity in the Executive's designated growth areas come mainly through redeployment of existing resources. However, in 1983/84, the Budget provided an extra $4 million for the Executive's initiatives in information technology, biotechnology, advanced materials and manufacturing technologies. Growth in these areas was therefore possible through a combined injection of resources made up from these extra funds and resources redeployed by the Executive from within CSIRO. The remaining growth has been possible through redeployment either specifically by Chiefs and Directors limiting resources in one area to support growth in another, or less specifically through the redirection of vacancies arising out of the normal processes of staff turnover.

In the Institute of Animal and Food Sciences, work has been reduced on brucellosis and myco-plasmosis in the Division of Animal Health, on gene characterization and on the utilization of nutrients in the Division of Animal Production, and on food structure and on biological aspects of meat research in the Division of Food Research. Work has been terminated on Johne's disease and on reproductive inefficiencies in cattle in the Division of Animal Health, on the assessment of steroids as defleecing agents and on fleece rot control in the Division of Animal Production, and on vascularization of the wheat ear and on the early generation assessment of wheat quality in the Wheat Research Unit.

In the Institute of Biological Resources, the leader of the new soil and plant research group in Western Australia has transferred from the Australian Capital Territory, and recruitment of the group is proceeding. In the field of biotechnology there has been an increase in work at the Division of Plant Industry on nitrogen fixation, tissue culture and somatic cell genetics, and in the Division of Entomology on gene cloning of sheep blowfly. In water and soils research, an algal physiologist has been recruited for the Centre for Irrigation Research and a physical hydrologist for the Division of Water and Land Resources. A start was made on strengthening plant virus research in the Division of Plant Industry. Research on forest growth, crop management and plant breeding has been consciously scaled down.

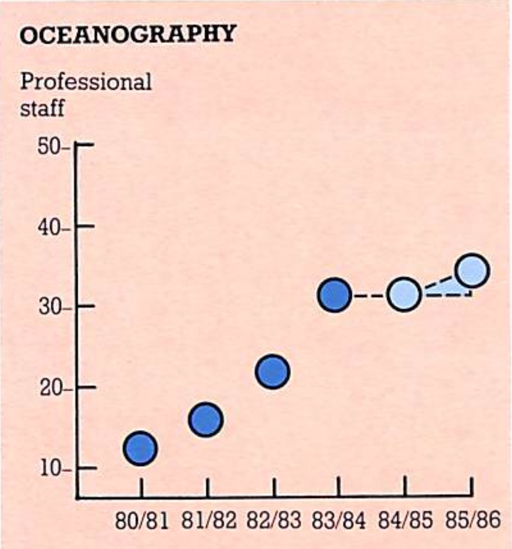


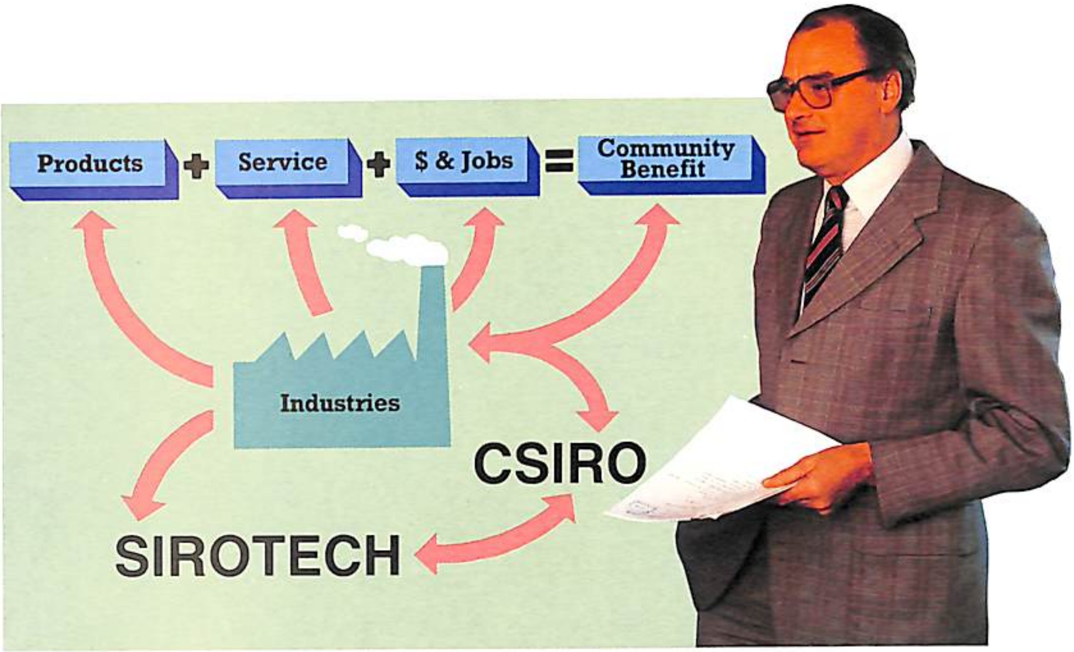
Figure 6

In the Institute of Energy and Earth Resources, major changes resulted from the reviews of the Divisions of Fossil Fuels and Geomechanics, notably in the Institute's mining program where research on the basic scientific aspects of geomechanics has been strengthened. Particular areas where research has been reduced or terminated include fossil fuels exploration, coal mining and coal conversion studies. Four new positions were made available to the Institute to support new initiatives in industrial mineral processing research relating to the manufacture of zirconia.

In the Institute of Industrial Technology, 9% of the Institute's professional scientists were redeployed to other areas of work as opportunities and expertise permitted. In the Division of Applied Organic Chemistry, work on the hydrogenation of coal has been reduced, while in the Division of Chemical and Wood Technology the main reduction has been in research into alternative liquid fuel sources. In the Division of Textile Industry, work on wrinkling in textiles and moth proofing has been stopped. At the Division of Textile Physics, research into the fine structure and mechanical properties of wool fibres, once a major activity of the Division, has been steadily reduced, with a transfer of activity to fabric performance, comfort and aesthetics. In the Division of Protein Chemistry, work on the biotechnological production of veterinary vaccines has been strengthened by redeployment within the Division and the Institute.

In the Institute of Physical Sciences, research in numerical meteorology applied to weather forecasting, and some aspects of climate research, have decreased as a result of the reduction of activities of the Australian Numerical Meteorology Research Centre prior to the closure of the Centre planned for the end of 1984. Numerical meteorology research for operational forecasting will be continued by the Commonwealth Bureau of Meteorology, while other aspects of the Centre's research will be taken up in the Division of Atmospheric Research. As a result of the review of the Division of Computing Research, the biological systems modelling group is being disbanded. Numerical taxonomy research in the Division will also be terminated. In the Division of Radiophysics, solar radioastronomy research has been reduced in favour of work on the Australia Telescope.

3. SIROTECH and Commercialization of Research Results



Mr Lindsay Cuming, Foundation Chairman of SIROTECH Limited

It was recorded in the CSIRO Annual Report 1981/82 that the Executive was reviewing CSIRO's commercial activities. In consequence, the Executive decided to form a company, SIROTECH Ltd (hereafter referred to as SIROTECH). The role of SIROTECH is to give the best possible commercial support to the Divisions of CSIRO by facilitating transfer of CSIRO's research results to Australian industry. It will do this by providing access to expertise CSIRO does not have and undertaking tasks which were previously beyond the Organization's capabilities.

SIROTECH's functions are as follows:

(i) assisting and advising CSIRO staff on commercial and related matters;

(ii) arranging for the development of CSIRO's research results to the stage where decisions on commercialization can be made, through:
  - contracting out to industry the requisite development work, and
  - arranging with firms for collaborative development work to be undertaken;

(iii) facilitating the transfer of CSIRO research results to industry through:
  - bringing together companies and appropriate CSIRO Divisions,
  - undertaking or contracting for market analyses,
  - negotiating licensing agreements with firms commercializing research results, and
  - participating in the management of manufacturing companies set up to commercialize products arising from SIROTECH-sponsored development activities;

(iv) assisting Divisions in identifying and undertaking research work of more immediate relevance to particular firms by:
  - bringing together companies and appropriate CSIRO Divisions,
  - relaying to Divisions information on technological and market requirements, and
  - arranging for appropriate contract work to be undertaken by CSIRO Divisions on behalf of individual firms;

(v) providing CSIRO with a patents and licensing service, both for agreements negotiated directly with industry by Divisions and for agreements negotiated by SIROTECH.

More specifically, SIROTECH will be CSIRO's:

(i) principal commercial agent for marketing CSIRO research and technology, and will play a prominent part in negotiating commercial arrangements with industry,

(ii) patent adviser, including manager of CSIRO's industrial and intellectual property portfolio,

(iii) business consultant for matters not covered above, including undertaking and arranging special market research or investigatory projects relating to technology transfer, and

(iv) agent for allocating and advising on funds spent in industry and within CSIRO for further development of CSIRO research results.

In appropriate circumstances SIROTECH will also become:

(v) head licensee of particular CSIRO industrial or intellectual property,

(vi) manager and/or coordinator of selected major projects agreed between CSIRO, SIROTECH and industry parties, and

(vii) a CSIRO representative on the boards of companies established to commercialize CSIRO-generated technology.

SIROTECH is about to be incorporated and will become operational early in 1984/85. It will be a non-profit company, limited by guarantee and governed by a board comprising nominees of CSIRO and its partners.

SIROTECH's finances will come mainly from an annual service fee negotiated with and paid by CSIRO to cover day-to-day commercial and intellectual property advice, and fees or commissions negotiated on a case-by-case basis where SIROTECH is actively involved in specific technology transfer initiatives. It is anticipated that as SIROTECH becomes established, the annual service fee will come to account for a decreasing proportion of the company's total budget.

SIROTECH will be a small specialist company under the control of CSIRO, having a highly professional business-oriented team with an emphasis on marketing skills. Initially it will have offices in Melbourne and Sydney but it is planned to operate in all States and Territories, perhaps at first through liaison offices in relevant State or Territory instrumentalities. The staff will spend a great deal of their time in close contact with industry and with CSIRO Divisions throughout Australia. Establishing the right contacts and gaining the right perspectives in both these quarters is vitally important for SIROTECH's success.

The Executive is strongly committed to the SIROTECH concept as the most effective means of providing CSIRO staff and industry with the skills, experience and awareness required if industry is to make the best possible use of CSIRO-generated technology. However, SIROTECH will be a successful venture only if the Organization's management and staff succeed in developing more commercial awareness within CSIRO. Some of the Executive's other main decisions arising from the review of commercial activities reflect this need, for example:

- CSIRO staff's and management's responsibility for development and transfer of research results will be emphasized.
- CSIRO staff and management will have better access to commercial and marketing skills to enable commercial assessments to be made. This will aid in the evaluation of research results and engender higher levels of commercial awareness.

Other decisions taken by the Executive in response to the review of commercial activities include:

- In selected cases, CSIRO's activities will encompass the 'predevelopment' phase of R&D; development proper will normally be carried out in industry, with industry meeting a major share of the costs, and with CSIRO assisting as appropriate. CSIRO will seek increased industry involvement in, and financial support for, its R&D.
- A statement of policies and procedures for CSIRO's patenting, licensing and related day-to-day commercial dealings will set out CSIRO's patenting, licensing and commercial strategy. This should stipulate the basis for allocating proprietary rights resulting from research contracts sponsored by industry, arrangements within the Organization for meeting patent costs, and who is responsible for selecting industrial partners. There is also a need to consider the commercial implications of open publication of CSIRO research results.

The Executive has not yet taken decisions on a number of key recommendations of the review committee relating to such matters as the fundamental aim of CSIRO's commercial activities and the conditions normally to be adopted in licensing the use of CSIRO proprietary rights. These will be finalized early in 1984/85 and reported in next year's annual report. However, even the limited number of decisions taken to date have resulted in major changes to CSIRO's technology transfer and commercial practices and mechanisms. A special allocation by the Government in the 1983/84 Budget enabled funds for contracting out work aimed at further development of CSIRO research results to be doubled. Procedures have been developed to provide research Divisions with access to revenue derived from commercial transactions, rather than having these funds revert to CSIRO revenue. In addition, a number of novel joint ventures with industy have begun, with CSIRO either as an equity partner or as a contributor of technology.

Ministerial Direction

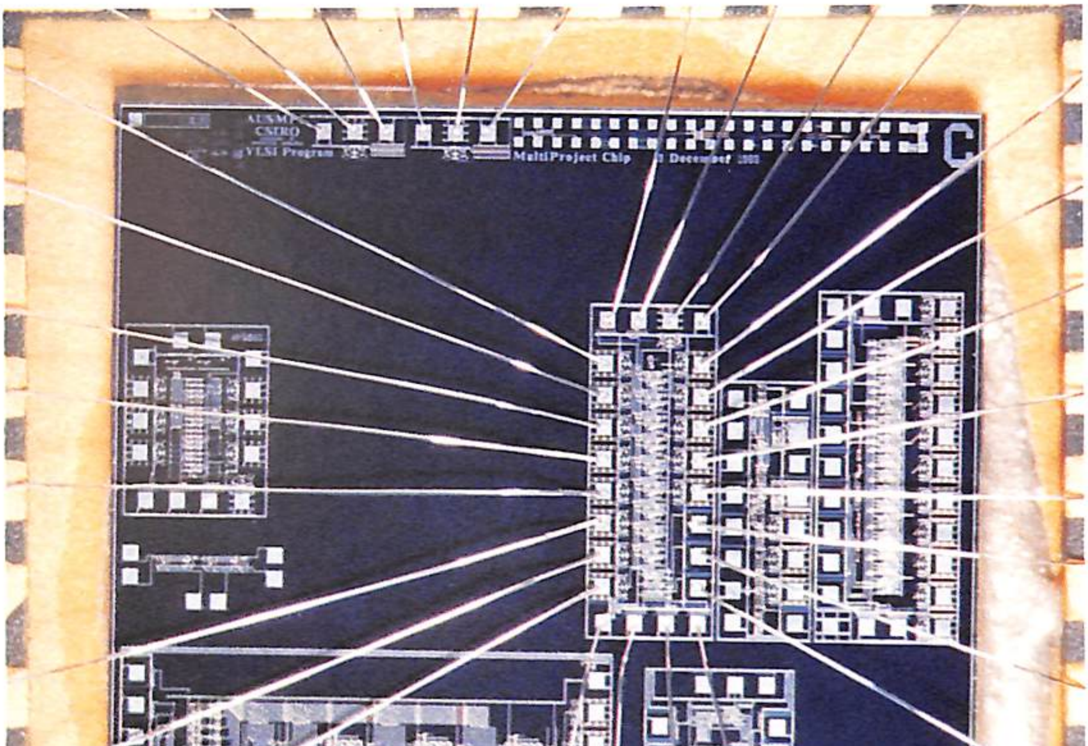
The Science and Industry Research Act 1949 provides that the Minister may give a direction to the Executive in relation to any exercise of the Organization's power to join in the formation of a partnership or company for the purpose of the commercial development of a discovery, invention or improvement the property of the Organization. In 1979 the then Minister directed the Executive to seek formal comments from the Secretary of the Department of Finance prior to any exercise of this power and to provide these comments to the Minister. This direction was reported on page 50 of the CSIRO Annual Report 1978/79 and has continued in force since it was given. In the course of consultation about the formation of SIROTECH the Minister decided that the 1979 direction should not be continued and it has therefore lapsed.

4. Information Technology

In February 1984 the Executive considered the report of an Information Technology Study Group established to propose a strategy for enhancing the Organization's involvement in research and development in the broad area of information technology.

The term 'information technology' represents an aggregate of the technologies that can be applied to the acquisition, processing, storage, display, transmission and dissemination of data by means of a microelectronics-based combination of computing (data processing techniques) and telecommunications. Any data that can be converted to digital form may be included, such as speech, pictures, text, measured quantities and normal numerical data. The generic technology is microelectronics and its facilitation of the introduction of digital techniques which are compatible with modern data processing and communications technology.

The convergence of data processing and telecommunications has been catalysed by the availability of increasingly powerful, reliable and cost-effective microelectronic components and



The fifth in the series of multi-project chips (AUSMPC) fabricated as part of the VLSI program of the Division of Computing Research. Seven independent designs shared the same fabrication run. The centre design has been bonded (input-output connections wired). Other copies of the same chip would be bonded for the other designs. The row of test structures along the top of the chip is used as a check on the production process.

equipment, and by the prospects now offered by satellite transmission, coaxial cables and optical fibres to reduce significantly the cost of data transmission.

New technologies, particularly those based on microelectronics are looked upon by industrially advanced and industrially advancing nations alike as a major contribution to prosperity for the foreseeable future. In some countries, vast sums of money are being applied to information technology research and its application in an attempt to attain or maintain industrial competitiveness. In Australia such sums are not available, and the Study Group emphasized the need for Australia to select carefully and focus on specific aspects of the technology in which Australia might have or might generate an advantage.

The report emphasized the special nature of information technology and the special demands it places on organizational arrangements, with the short time-scales from research to commercialization demanding close cooperation between research, development and marketing, and a high degree of commercial involvement from the outset.

The report set down the following strategy for developing information technology research in CSIRO:

- a different approach is required to organizational arrangements and structures within which research and development are conducted;
- arrangements are required that will ensure a high degree of integration of research and development and commercialization;
- careful selection must be made of projects to be pursued within areas of priority and of partners and markets, and maximum collaboration established with Telecom and other government research laboratories; and
- continuing support is needed for pre-competitive research and development.

The Executive endorsed this strategy and agreed to:

- the formation of a Division of Information Technology in the Institute of Physical Sciences to perform advanced core research and participate in collaborative projects in information technology;
- the establishment of an Information Technology Fund within CSIRO to promote collaborative projects on an Organization-wide basis between CSIRO, Australian industry, tertiary education institutions and other government bodies such as Telecom; and
- the appointment of a Manager, Information Technology Program, to provide a focus and coordinate information technology activity, and to distribute the Information Technology Fund within CSIRO and between CSIRO and its collaborators. Consideration would be given to the Manager, Information Technology Program and the Chief, Division of Information Technology, being the same person.

The Executive also endorsed the following recommended activities for special attention:

- software technology and related hardware
- man-machine interface
- information management
- computer networking
- device and systems hardware technologies

and specific areas within the priority groups as shown in the table.

Table 5 Priority Groups for Research and Development

Software technology and related hardware

1.
- Open Systems Interconnection (OSI) layers — physical, data link, and networks from the seven-layer International Standards Organization (ISO) model
- educational software
- software tools, methodology and environments
- very large scale integration (VLSI) software tools

Table 5 (cont.) Priority Groups for Research and Development

2. - software technology in distributed and/or concurrent systems
   - office integration and software and systems design
   - software for flexible manufacturing and robotics
   - software for existing industry

3. knowledge-based systems, cognitive systems

4. adaptation of operating systems and languages to locally-made systems (e.g. in collaboration with SIROMATH)

Man-machine interface

1. - computer graphics and signal processing
   - devices for handicapped people
   - distributed information display systems

2. - display of 3-dimensional time-varying data
   - problem-oriented interfaces

3. computer-aided design

Information management

1. geographic information systems (including satellite and aircraft)
2. intelligent database design

Computer networking

1. development of standards and protocols
2. computer network design (OSI layers 1 to 3)
3. network and data security

Device and systems hardware technologies

1. development of hardware appropriate to the above groups
2. specialist information devices and transducers
3. gallium arsenide technologies (analogue microwave integrated circuits in collaboration with other laboratories)
4. optical information systems
5. hardware appropriate to man-machine interface.

5. ANAHL and Live Exotic Animal Disease Viruses

The Australian National Animal Health Laboratory (ANAHL), Australia's new maximum security laboratory for the diagnosis and study of exotic animal diseases, has been completed at a cost of approximately $157 million. It is located on a 36 ha site, 1.5 km east of the Geelong, Vic., city centre. Construction started in March 1978, under the direction of the Department of Housing and Construction, with John Holland Constructions Ltd as construction managers.

When fully operational, the Laboratory, the world's most advanced microbiologically-secure facility for the study of animal diseases, is expected to have an annual salary and operating budget of about $8 million and approximately 180 staff.

The CSIRO annual reports for 1981/82 and 1982/83 referred in detail to the Laboratory and the importation of live exotic animal disease viruses for the purpose of research.

On 24 May 1983 the Minister for Science and Technology announced that Caucus had adopted Recommendation 4 of the Australian Science and Technology Council (ASTEC) Report 'ANAHL: The Use of Live Exotic Animal Pathogens' with amendments. The Caucus decision was reported in the following terms:

- 'that live FMD virus not be imported for use at ANAHL for a period of five years, that is until the end of 1987 after which the matter will be re-examined by the Government;
- that the research programs of ANAHL give priority to the development of new or improved procedures for the identification of Foot-and-Mouth Disease virus which do not require access to the live virus;
- that as a matter of urgency, CSIRO initiate discussions with appropriate authorities with a view to locating for an agreed period, and with appropriate costs borne by Australia, a small ANAHL research group within an overseas animal health laboratory which has access to live Foot-and-Mouth Disease virus;
- that when this overseas group is established, its main responsibility be to assist in the ANAHL research program, specifically by checking the efficacy of both standard and newly developed procedures and materials in use in Australia using the live virus where appropriate, and by preparing inactivated reagents for use at ANAHL; and
- that this arrangement be entered into as soon as possible for an initial period ending three years after completion of the setting-to-work program at ANAHL.'

Cabinet subsequently accepted with some amendment the recommendations made to it by Caucus and in so doing confirmed that live Foot-and-Mouth Disease (FMD) virus should not be imported before the end of 1987, after which time the matter would be reexamined by the Government.

On 22 September 1983 the Minister for Science and Technology announced that:

- 'a Ministerial Committee comprising the Ministers for Trade, Defence, Primary Industry, Health and Science and Technology met on 20 September to consider the future role of ANAHL at Geelong;
- the Prime Minister has agreed to the recommendations of the Ministerial Committee that the commissioning and setting-to-work of ANAHL as a diagnostic facility should proceed without delay, with planning for the limited research function necessary to complement the diagnostic capability;
- the Committee also recommended, and the Prime Minister has agreed, that exotic animal viral disease agents already held in Australia should be relocated to ANAHL as soon as its microbiological security has been proved, and that consideration should be given to extending ANAHL's function to include studies of endemic animal viral diseases at the highest level of professional competence;
- the Ministerial Committee also wished to seek further technical advice before deciding whether ANAHL will continue essentially as a diagnostic facility serving the primary export trade and quarantine function or whether the research function will be significantly upgraded;
- a decision regarding incorporation of the inactivated viral vaccine production unit will be delayed pending the provision of the Advisory Committee's advice;
- after receiving advice from the Advisory Committee the Government will decide the future operation of ANAHL and whether it should remain within the portfolio of the Minister for Science and Technology or the Minister for Primary Industry.'

Following this announcement, the Advisory Committee was appointed under the Chairmanship of Professor F.J. Fenner.

On 25 January 1984 the National Farmers' Federation called on the Government to bring the diagnostic facilities of ANAHL into operation ahead of schedule. This followed anonymous threats to release FMD virus. The Australian Agricultural Council, which consists of Federal and State Ministers for Primary Industry/Agriculture, met on 6 February 1984 and agreed that contingency plans for handling exotic disease threats should be developed. It also agreed that the microbiological assessment of ANAHL should be accelerated and an FMD diagnostic capacity (not involving live virus) should be developed without delay. Accelerated commissioning of a limited diagnostic capability at ANAHL was undertaken at a cost of $160 000. Also, inactivated FMD diagnostic reagents were imported from the UK with the agreement of the Australian Agricultural Council. The reagents are held in bond at ANAHL and have not been used.

The Advisory Committee reported on 29 February 1984, and on 9 March 1984 the Minister for Science and Technology announced that the ANAHL Ministerial Committee had accepted the report's recommendations with some amendments.

Two staff members of ANAHL began their program on inactivated reagents to be used in Australia in the diagnosis of FMD at the Animal Virus Research Institute at Pirbright, UK, on 1 June 1984. They are expected to be there for 13months.

The Government's response to the Advisory Committee's report and the remaining three recommendations of the ASTEC report is expected in the forthcoming Budget Session of Parliament. The Government's decision will determine the future operations of the Laboratory and also the conditions of its access to any live pathogens — which, in any case, cannot be imported until microbiological security of the Laboratory has been demonstrated.

The ANAHL Consultative Committee has initiated consultation with the Australian Agricultural Council, the National Farmers' Federation and the Australian Veterinary Association about candidate pathogens for import.

Commissioning of ANAHL is nearing completion and most areas of the Laboratory have been handed over to CSIRO by the Department of Housing and Construction. Microbiological security is expected to be demonstrated by the end of 1984, after which time application will be made to the Government for the importation of exotic animal disease pathogens.

Prompt and accurate diagnosis, control and/or eradication of any exotic disease of livestock are important for Australia's economic welfare, and the operation of ANAHL will contribute to that end. Its role will be particularly important in the 1980s and the years ahead when, even given stringent quarantine precautions, the likely greater use of international transport and international exchange of animal genetic material will pose threats to the health and security of Australia's livestock and the important industries built upon them.

Engineering staff carrying out routine maintenance work on part of the liquid waste treatment plant at ANAHL. Heat is used to destroy any potentially harmful disease organisms that may be present in the waste.

6. Medical Research

Following the election of the present Government in 1983, the Executive re-examined its existing policy on medical research in the light of the Australian Labor Party policy platform:

> 'A Labor Government will, while recognizing the priority of NH&MRC, lift any arbitrary exclusion of CSIRO from pursuing areas of biological research which have human health implications.'

In its examination, the Executive took into account the responsibilities for medical research of other Commonwealth authorities, the scope of CSIRO's research activities in health and biomedical research, and reviews within the Organization on health and medical research.

CSIRO's main contribution to research in human health has been in the field of human nutrition. The principal applications of these studies are in the prevention of ill health through provision of improved knowledge on the interaction between metabolism and growth, and diet and disease, and in the improvement of food quality and safety. This research is undertaken in the Divisions of Human Nutrition and Food Research. Other research with implications for medical research and health services arises in biological and physical sciences programs directed to other ends, for example, veterinary health and veterinary medicine.

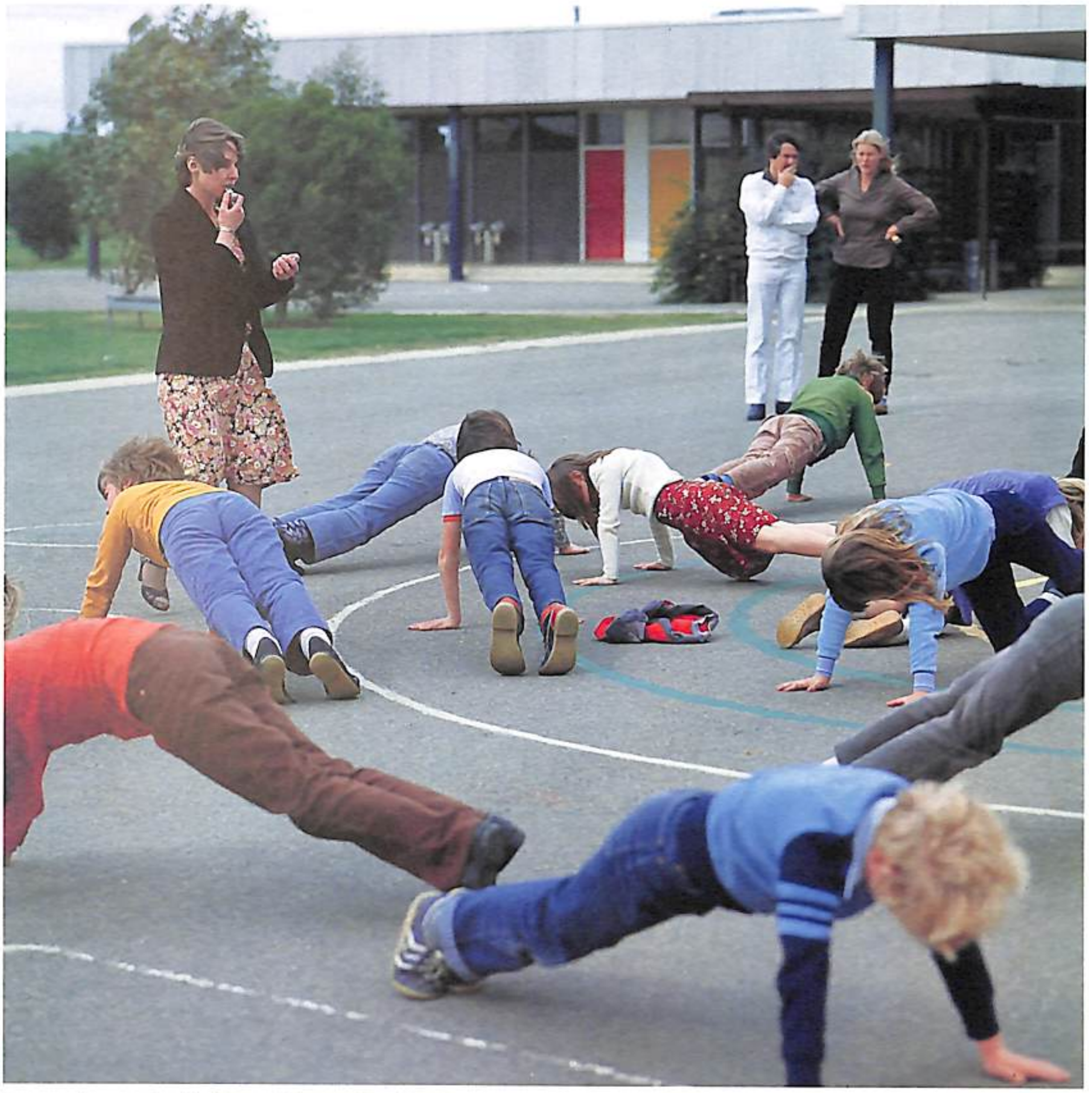
Medical Research Policy

The Executive believes that the Organization is making nationally important contributions to research on the causes and prevention of disease in the fields of human nutrition and safety of foods. CSIRO has sufficient expertise in these areas to enable it to determine priorities for research which has the prime objective of solving problems in human health. CSIRO also undertakes a broad range of research into the fundamental biology of animal systems, which covers similar ground to fundamental biomedical research in experimental techniques, research material and disciplinary expertise. The physical sciences also contribute to the alleviation of disease, especially through the development of instrumentation for diagnosis and treatment. However, CSIRO research in the biological and physical sciences is directed primarily to industry and community aims other than human health. In this situation CSIRO is not in a good position to determine research priorities, and the Executive considers that new studies directed to human health problems should be initiated only in consultation with medical scientists. Where it is considered that CSIRO's research results might be relevant to human health, the Organization will seek collaboration with medical research workers in developing that research.

The Executive has concluded that its existing policy on medical research should be revised to include reference to food safety research and to give greater emphasis to collaboration with medical research scientists. The Executive has also seen a need to formalize procedures that have been adopted by CSIRO to ensure selectivity when applying for research grants from funding bodies concerned principally with medical research.

The following policies have been adopted for the conduct of medical research and for the selection of research grant applications to the National Health and Medical Research Council and other funding bodies which are principally concerned with medical research.

- CSIRO will carry out research in the fields of human nutrition and food safety with the prime objective of solving human health problems.
- In other areas of biological and physical sciences the Organization will consult with medical scientists on criteria to be used in determining priorities for research related to human health.
- Where it is considered that the results of CSIRO's research could have direct relevance to human health, the Organization will seek collaboration with medical research scientists for the further development of the findings, utilizing, where appropriate, advice from the CSIRO Medical Research Liaison Committee.
- CSIRO will become involved in clinical studies on a collaborative basis only.



Researchers at the Division of Human Nutrition, in collaborationwith the Physical Education Branch of the South Australian Education Department, have found that physical activity programs in schools have long term beneficial effects on health in adolescence and adult life.

7. Research Reviews

Completed Reviews of Divisions and Units

Review of the Division of Materials Science

As foreshadowed in the previous annual report, the Executive took decisions on the recommendations of the committee reviewing the Division of Materials Science in the latter part of 1983.

As a result of a recommendation from the Divisional review committee, the Executive has commissioned a subject review to study CSIRO's role in the development of materials science and technology in Australia.

Additional support has been given to this activity in the light of the Divisional review committee's favourable assessment of the Division's work on the engineering ceramic, partially stabilized zirconia (PSZ), and of notable steps towards industrial exploitation of PSZ taken by CSIRO's licensee, Nilsen Sintered Products Ltd, in collaboration with CRA Pty Ltd. This was made possible by the Government's allocation in the 1983/84 Budget of special resources to CSIRO for a series of initiatives in research in support of Australia's manufacturing industry.

Review of the Division of Textile Physics

As foreshadowed in last year's annual report, the Executive made decisions on the recommendations of the committee reviewing the Division of Textile Physics in August 1983.

The Executive noted the review committee's high assessment of the Division's contribution towards attaining the Australian wool industry's objectives of sale of wool by sample and, ultimately, sale by description. It also noted that the bulk of the Division's work in this area should be completed within three years. Some resources will then be available for redeployment to other research of higher priority. Such redeployment will take place in consultation with the Australian Wool Corporation which supports research in this area.

The Executive agreed with the review committee's assessment that there is considerable scope for using the Division's skills and resources to make a wider contribution to Australian industry. Consequently, in the future the Division will place more emphasis on industrial applications for fibres, yarns and fabrics, and research for other areas of Australian manufacturing industry. This decision has been reflected in the establishment of a new 'Industrial Applications' research program, in redeployment of resources to this program from elsewhere in the Division and within the Institute of Industrial Technology, in the attraction of funds from industry for this program, and in recruitment to the Division since the review.

Division of Protein Chemistry and the Molecular and Cellular Biology Unit

As recorded in previous CSIRO annual reports, a joint review of the Division of Protein Chemistry and the Molecular and Cellular Biology Unit was initiated in January 1982. The review committee submitted its report to the Executive in August 1983, and the Executive endorsed most of the recommendations.

The main issue arising from the review was the continuation of the Division of Protein Chemistry and the Molecular and Cellular Biology Unit as separate entities within CSIRO. The disciplinary basis of both the Division and Unit means that many of their programs are complementary to the work of other Divisions. After examining the advantages and disadvantages of combining elements of the Division and Unit with the appropriate industry-oriented Divisions, it was decided that both would continue as separate entities but with the Unit upgraded to a Division to be known as the Division of Molecular Biology.

The new Division will continue to be a centre of expertise in molecular genetics and cell biology, with particular emphasis on animal cells. However, linkages with the animal industry-oriented Divisions of the Institute of Animal and Food Sciences, and with the Division of Protein Chemistry will be strengthened.

The Division of Protein Chemistry's research will continue to be focused on work in support of the wool processing and leather industries. Work for the agricultural production industries is also important. The Division's role as a centre for protein chemistry research will be maintained.

Division of Human Nutrition

As previously reported, a review of the Division of Human Nutrition was carried out in 1983 in anticipation of the retirement of the present Chief of the Division in mid-1985.

The Executive considered the review committee's report in June 1984, noting its major conclusions that:

- the Division had made significant contributions to knowledge of human nutrition since its formation in 1975; and
- its programs were generally appropriate to Australia's needs, the Division's skills and resources, and opportunities for collaboration with medical authorities.

The Executive decided to continue the Division and its present research programs with only minor variations. The Division will thus continue to concentrate on the investigation of nutritional and lifestyle factors in chronic disorders that account for the bulk of illness, disability, suffering and death in Australia — coronary heart disease, cancers, stroke and alcohol-related problems.

Division of Computing Research

The report of the committee for the review of the Division of Computing Research was presented to the Executive in July 1983. Executive consideration of the report was deferred until the report of the Information Technology Study Group, which had been established by the Executive in April 1983, was available. The reports were considered jointly in February 1984.

The Executive decided that:

- The CSIRONET computing network would be separated from the Division of Computing Research and become an independent Unit known as CSIRONET.
- A revised CSIRONET charter would be prepared on the advice of the Organization's Policy Committee on Computing. The Policy Committee would also explore ways in which CSIRONET could become more commercially independent, advise on the future operation of CSIRONET, and report back to the Executive.
- A Division of Information Technology would be established to perform core research in information technology and to participate in collaborative projects with industry, government establishments, universities and other research groups. The objectives of the new Division would be as endorsed by the Executive's response to the report of the Information Technology Study Group (see Chapter 4) which includes a listing of priority areas for core research and project development. The Division will come into operation early in 1985.
- CSIRONET, for the time being, and subject to the revised charter, would report to the Director, Institute of Physical Sciences.

Divisional Review in Progress

Divisions of Mineralogy and Mineral Physics

In December 1983 the review committee commissioned to review the Divisions of Mineralogy and Mineral Physics submitted its report to the Executive. Extensive discussions with all interested parties have followed and the Executive expects to release its decisions in the latter part of 1984.

Completed Subject Review

Plant Pathology

In 1981, the field of plant pathology was designated by the Executive as having high priority for expansion. As reported previously, a review of plant pathology was commissioned by the Executive early in 1982 in order to develop specific research proposals. The review committee submitted its report in February 1983.

The review examined the scope of existing plant pathology research in Australia and CSIRO's present involvement in plant pathology research, and identified specific areas appropriate to CSIRO which should be undertaken or strengthened.

The committee's main recommendation was that the Organization should make a commitment to research in plant pathology either by establishing a Division of Plant Pathology or by developing an identifiable plant pathology program within the Institute of Biological Resources. The committee also made recommendations about areas of high, medium and low-priority research and, in addition, classified current research activities as those to be strengthened, those to be maintained at the present level, and those to be reduced.

The Executive has broadly accepted the committee's report and has reached decision on many of its recommendations, but has deferred final decision on implementation until reviews of the Divisions of Horticultural Research, Plant Industry, and Tropical Crops and Pastures are completed.

While the Executive recognized that many of the problems and areas identified by the review were amenable to research by the Organization, it would be difficult, with limited resources, to make an effective additional contribution in plant pathology if an attempt was made to implement all of the committee's recommendations. The Executive therefore decided to convene a meeting, in February 1984, of specialists with close involvement with plant pathology problems, from universities, State departments and CSIRO for the purpose of assisting the Executive in assessing and further refining the priorities assigned by the review committee.

The Executive will not establish a separate Division of Plant Pathology because in most cases the research of plant pathologists in CSIRO is linked closely with the programs of Divisions in which the scientists are located. However, to give a focal point to the discipline in CSIRO and to ensure that dispersion of plant pathologists does not lead to a lack of interaction between them or with their colleagues in other organizations in Australia, the Executive has agreed to the appointment of a senior plant pathologist. The appointee will assist the Director, Institute of Biological Resources in coordinating plant pathology research in CSIRO and in liaising with State departments, universities, and other research institutions.

For new or expanded initiatives in plant pathology research in CSIRO, the Executive assigns the highest priority to molecular biology approaches, root diseases, tropical plant diseases, and biological control of weeds by pathogens. It also sees a need for longer-term development of strategic research on crop loss assessment and epidemiology.

Subject Review in Progress

Soil Conservation Research

As previously reported, a special CSIRO study and review of needs and opportunities for water resources research was made in 1981. One of the topics identified for further research by the study was soil erosion.

In spite of the existence of erosion-control measures, soil stability is still seen as a national problem. CSIRO has the skills necessary to contribute towards solving some of these problems and, to develop further the possible future role of the Organization in this important area, an internal review and study is being conducted to determine particular areas where research might be strengthened by CSIRO.

The Executive will consider the outcome of this study in developing its research strategy plan for soil conservation.

Research Reports

Dr. Warwick Wilson designing the prototype VLSI chip for the Australia telescope digital correlator.

8. Institute of Animal and Food Sciences

Introduction

The Institute of Animal and Food Sciences carries out scientific and technological research aimed at improving the efficiency of livestock production, the management and productivity of Australia's fisheries resources, the conservation of its marine ecosystems, and the quality and safety of human foods; and at obtaining a better understanding of the relationships between human diet and health.

The Institute's activities include research on:

- control of indigenous and exotic animal diseases;
- nutrition, reproduction, genetics and management of livestock;
- marine ecosystems and the ecology and population dynamics of the ocean's harvestable resources;
- methods of processing, handling and storing meat, fish, dairy foods, fruit, vegetables and grain;
- identification of nutritive imbalances and deficiencies in the diets of Australians and investigation of their effects on human health; and
- molecular and cellular biology and its application in the livestock and pharmaceutical industries.

The Institute continues to expand its efforts in biotechnology and the following pages give a short resume of the work in progress.

Fecundin, a product designed to increase the fecundity of sheep, was released commercially in October 1983. This was the culmination of many years of basic research on the endocrine control of ovulation rate by the Division of Animal Production and a three-year collaborative R&D program with Glaxo Australia Pty Ltd.

The Division of Fisheries Research discovered two more commercially important scampi grounds in deep waters off the north-west shelf. Present estimates value this new resource at \$10–\$20 million a year.

Research by the Division of Food Research led to the patenting in Australia and 16 other countries of a counter current extractor. The first full-scale commercial plant came onstream during January at Loxton, SA, and proved the ability of the equipment to give significantly higher yields of more flavoursome juice from apples and pears. It has a wide range of applications including impregnation, leaching, heat exchange and freeze concentration.

During the year the review of the Division of Human Nutrition was completed. The major recommendations of the review committee, which were strongly supportive of the contributions of the Division, were accepted by the Executive.

Advances in Biotechnology

The biotechnology industry — using living organisms to carry out industrial (chemical) processes or to produce high value products — is in the process of a rapid worldwide expansion. The primary impetus for this expansion is the advent and continuing development of recombinant DNA technology, which allows the isolation, modification and transfer of genes from one host organism to another. This relatively simple statement has profound implications in terms of the possibilities for manipulating the genetic information and characteristics of a wide range of organisms, from viruses to animals.

Essentially, genes code for proteins, which in turn control the chemistry, structure, development and behaviour of living cells and organisms. Some proteins, for example, act as enzymes which catalyze the breakdown of foods into usable energy and chemical building blocks, whereas others are involved in the synthesis of cellular components, including other proteins and the replication of the DNA itself. Some gene products (i.e. proteins) are structural, such as those constituting hair and muscle fibres. Still others, like hormones (e.g. insulin), are involved in physiological regulation and cell communication; some act as transports or carriers for small molecules (e.g. haemoglobin), and some are involved in defence against diseases (e.g. antibodies). Traditional biotechnology has involved the use of natural organisms and their genetically-selected variants to produce a range of natural products, such as antibiotics and amino-acids, or simple chemicals, such as alcohol. The ability to transfer genetic material from one host to another allows the introduction of new functions into a cell, which may be designed and used for a wide variety of biotechnological purposes, such as the production of clinically important vaccines and hormones, or the construction of improved strains of microbes, plants and animals. The genetic and functional repertoire of nature is therefore at the disposal of a rapidly expanding and flexible biotechnology.

Recombinant DNA or 'genetic engineering' technology, whose first (and simplest) applications are now coming into view, is being complemented and accelerated by recent advances in a range of associated technologies. These include the development of hybridoma technology for producing monoclonal antibodies, as well as rapid methods for the chemical synthesis of DNA, and enzymatic procedures for the large-scale production of biologically active peptides and proteins.

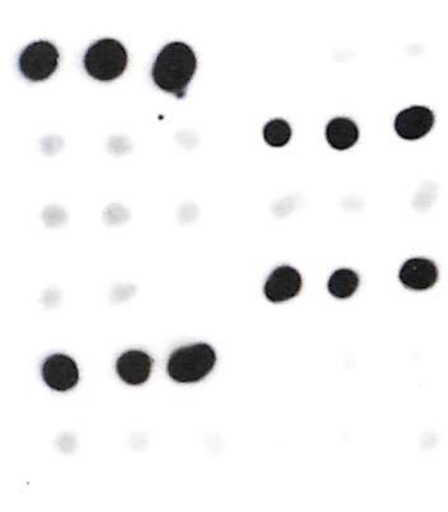
Although the Australian biotechnology industry is in its infancy, there is an established and expanding local research base, and widespread agreement that the industry has considerable potential in this country. CSIRO, despite recent limitations in funding, has nominated biotechnology as an area of high priority, with developments occurring in the Institutes of Biological Resources and Industrial Technology as well as within the Institute of Animal and Food Sciences. In the latter, experience in areas such as animal health and the food industry is being combined with expertise in recombinant DNA and associated technologies, to devise new solutions to outstanding problems.

One of the best examples of this interaction between experience and the new technology is taking place in vaccine development, an area which has attracted considerable interest, both domestically and internationally. Traditional vaccines consist of fractions of killed cells or harmless variants of disease-causing organisms, whose primary function is to stimulate an antibody response against antigens (proteins), usually located on the surface of the invading cell. Vaccination acts as an 'early warning' to the immune system so that a rapid and effective, response can be mounted to combat a genuine infection. However, there may be significant problems associated with the production and use of some conventional vaccines, either because of the costs of producing the infective agent or because the preparations are contaminated with other undesirable or toxic substances. Many, if not all, of these problems may be avoided by the use of recombinant DNA technology, which makes possible the transfer of the genes coding for the important protective antigens into a new host, where they may be produced in large amounts, at relatively low cost and free from undesirable components.

The Institute of Animal and Food Sciences has substantial programs in this area, which include the research and development of new vaccines against a wide range of diseases affecting the Australian livestock and poultry industries, such as ovine footrot and helminth parasites, cattle ticks and tick fever, rotaviral diarrhoea, bluetongue and akabane virus, and infectious bursal disease and laryngotracheitis virus of chickens.

These projects are in various states of development; many involve collaboration with other institutions such as universities and State Departments of Agriculture or Primary Industry, as well as local biotechnology and vaccine companies. The Institute is keen to encourage and develop collaborations of this nature, both to accelerate the research and development, and to maximize the returns to Australian primary and secondary industries.

Some CSIRO vaccine projects have advanced to the stage of commercial development and field testing. For example, the Division of Molecular Biology is working with Biotechnology Australia Pty Ltd to optimize the production of surface antigens from cloned genes from rotaviruses (which cause severe diarrhoeae disease in humans and animals). The genes coding for the protective antigens associated with the fimbriae (or pili) of *Bacteroides nodosus*, which causes footrot in sheep, have also been cloned and the antigens expressed in a new bacterial host, which is cheaper and easier to grow. This research is being carried out by interdisciplinary teams from the Divisions of Molecular Biology and Animal Health, in collaboration with the University of Sydney and the Division of Protein Chemistry in



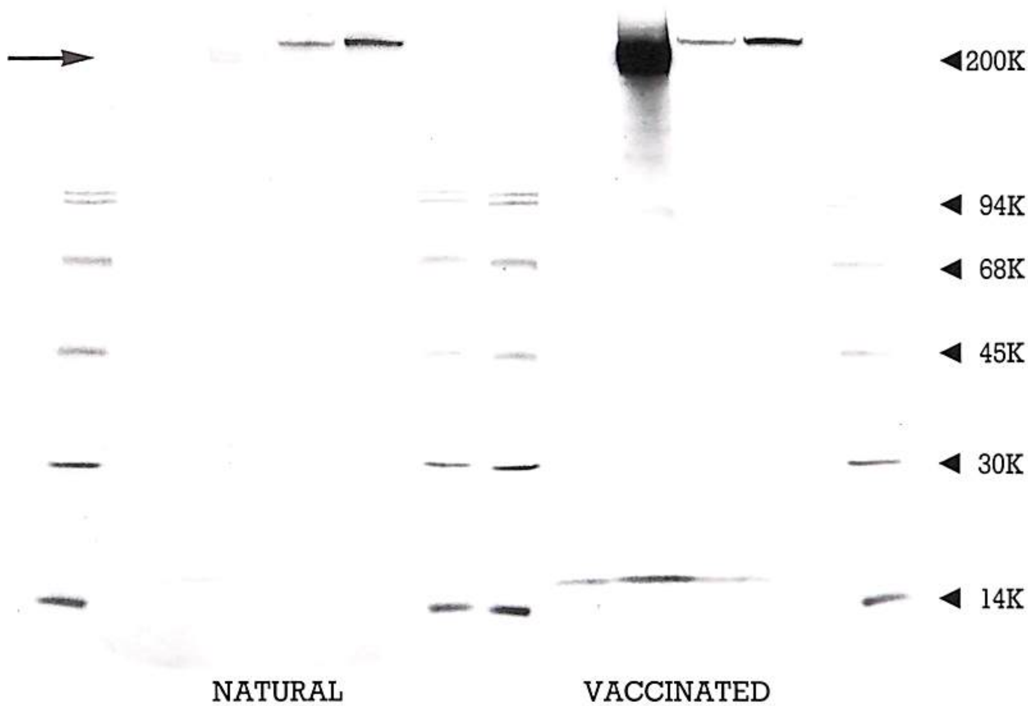
Recombinant bacterial clones producing the protective fimbrial antigen of *Bacteroides nodusus* which is the causative agent of ovine footrot. The positive clones are dark, the negative controls are light.

the Institute of Industrial Technology. Although further development is required, the rapid progress in this project has attracted considerable commercial interest and contracts are currently being negotiated. The outlook is also very promising for the development of a recombinant DNA-based vaccine against infectious bursal disease of chickens, with worldwide market potential, which is being investigated by the Division of Animal Health in conjunction with the Division of Protein Chemistry.

A prerequisite for the design and production of genetically engineered vaccines is identification of the important protective antigens as the actual targets for gene cloning and expression. This can be a difficult and complex task, especially with some of the more sophisticated cases, such as those involving parasitic infections. The Division of Animal Health, in collaboration with the Division of Protein Chemistry and Biotechnology Australia Pty Ltd, is investigating recombinant DNA approaches to the development of vaccines against the helminth parasites of ruminants, with support from the National Biotechnology Programme. The Division of Tropical Animal Science is examining antigens associated with *Babesia bovis*, a protozoan parasite which causes tick fever in cattle, in an attempt to define protective antigens for gene cloning and vaccine production. In addition, the Division is exploring the possibilities for developing vaccines against ticks themselves, such as the cattle tick *Boophilus microplus* (which carries *Babesia bovis*), and the paralysis tick *Ixodes holocyclus*. Identification of protective antigens is also well advanced for a number of viral diseases, including infectious laryngotracheitis virus of chickens by the Division of Animal Health, and the bluetongue and akabane virus by the Australian National Health Laboratory (ANAHL). Characterization of these antigens, and isolation of the corresponding genes, should provide a sound basis for the application of genetic engineering techniques to the production of effective and economic vaccines against these important diseases.

A number of alternative biotechnological strategies for vaccine production and delivery are being pursued within the Institute of Animal

Immunological analysis of the major antigens of strains of *Babesia bovis*, causative organism of tick fever in cattle.



and Food Sciences. For some disease-causing organisms, purified antigens may be far less effective in stimulating proper immunity than actual infection with the whole organism. To address problems of this type, a major program has been initiated by the Divisions of Animal Health and Molecular Biology, in conjunction with the Australian National University, to investigate and develop the use of Vaccinia virus as a living vector for immunization purposes. The strategy (see Figure 7) involves the insertion of genes encoding protective antigens into harmless variants of the Vaccinia virus, which are then used to infect the host. The antigen gene may be manipulated and engineered so that the protein product is expressed in an appropriate form *in situ*, and provokes a suitable immune response in the host.

This type of approach is being facilitated by recent advances in laboratory techniques for the analysis and synthesis of DNA molecules. Cloned gene sequences may be rapidly sequenced to provide information about the primary structure of the protein product, and the control of its expression. Such analyses yield considerable basic information, which is invaluable both for fundamental research, and for its subsequent biotechnological exploitation. The advent of rapid chemical methods for the synthesis of DNA molecules in the laboratory has added another powerful weapon to the genetic engineering arsenal, whereby gene sequences may be designed or modified as desired. Such facilities have been recently acquired by the Division of Molecular Biology, and are now being actively applied in a variety of genetic engineering projects.

Rapid advances have also been made in the technology available for the direct synthesis of proteins themselves. The Division of Molecular Biology, in collaboration with Carlsberg Biotechnology Inc. of Copenhagen, is utilizing advanced enzymatic techniques to synthesize fragments of the hormone EGF (epidermal growth factor), whose potential for the artificial defleecing of sheep is being investigated by the Division of Animal Production. This technology of protein synthesis has considerable potential for the production of a broad range of biologically active peptides and proteins, including enzymes, hormones and vaccine antigens, which should complement, and perhaps in some cases replace, recombinant DNA-based protein products.

The expansion in molecular biological research and its biotechnological applications has led to an increased demand for more

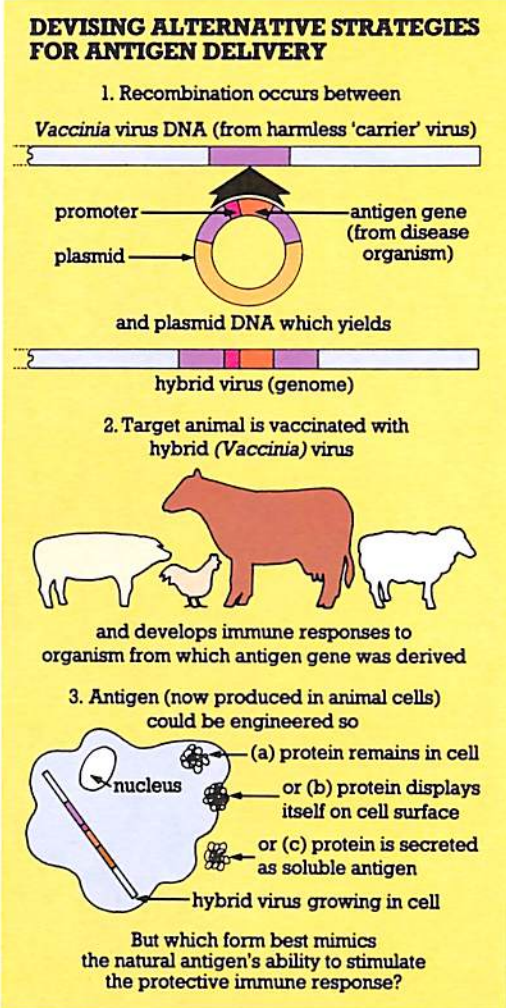


Figure 7

advanced equipment for the large scale purification of proteins from complex mixtures. The Wheat Research Unit has been developing preparative electrophoretic/semi-permeable membrane systems for this purpose.

Another new technology with important clinical implications is the production in cell culture of monoclonal antibodies, highly specific immunological reagents which may be used for a variety of diagnostic and analytical purposes. In this case, antibody-producing cells (usually from mice) are fused with immortal cells lines. The resulting hybrids (or 'hybridomas') may be selected, cloned and maintained indefinitely in culture, as a source of antibodies against particular target molecules. This technology is

A typical DNA-sequencing ladder from which detailed genetic information can be read.

widely employed throughout the Institute for research purposes, as well as for the development of commercially-important diagnostic probes. For example, the Division of Molecular Biology, in collaboration with the Garvan Institute for Medical Research at St Vincents Hospital in Sydney, and Bioclone Australia Pty Ltd, has produced a range of monoclonal antibodies for the detection of clinically-important human pituitary hormones, such as prolactin, hCG and hGH. The Division of Molecular Biology has also developed monoclonal antibodies for the detection of hepatitis B antigens in a collaborative project with the Red Cross Blood Transfusion Service in Sydney. The Wheat Research Unit has assisted in the development of antibodies against certain food components, for example gluten, as a means of identifying truly gluten-free foods for special diets. The Australian National Animal Health Laboratory is also developing monoclonal antibodies, along with clones gene sequence probes, for the diagnosis of a range of exotic diseases which may affect Australian livestock.

Perhaps the most exciting area of the new biotechnology, and the one with the greatest potential, is the application of genetic engineering to the modification and improvement of commercially important organisms, ranging from industrial microbes to pastoral animals. The Division of Molecular Biology has recently established a joint project with the Research Division of Mauri Foods aimed at developing, through the use of gene cloning and manipulation, improved strains of baker's yeast, which have greater activity and/or stability than those available at present. A major area of strategic research within the Institute is the application of genetic engineering techniques to animal breeding. Although a longer-term project, the Division of Animal Production is already investigating the transfer of cloned gene systems into embryos for this purpose, and the Division of Tropical Animal Science is considering a similar program. The success of this strategy is dependent upon selecting the correct genes for insertion, and upon understanding how gene activity is regulated in animals. The Division of Molecular Biology has major programs in the area of animal cell growth and development, and the regulation of gene expression during these processes.

The Institute of Animal and Food Sciences is attempting to maintain a proper balance between applied and basic research in the area of genetic engineering and associated biotechnologies, for the benefit both of Australian primary and secondary industry. The rural industries in Australia have had to continuously improve their productivity to maintain a competitive position in the world market. Biotechnology will help to further improve this productivity, as well as provide the means for adding further value to agricultural products, as a result of processing by secondary industries prior to export.

The Role of Long Chain Fatty Acids in Human Nutrition

The rise and fall of mass epidemics of infectious diseases are dramatic chapters in medical history but, to the communities affected, the trends are often imperceptible at the time. In modern times, the epidemic of cardiovascular diseases — atherosclerosis, coronary heart disease and stroke — has also been insidious in the perception of its onset, although it now accounts for over half the deaths in most developed countries. In some countries such as Australia and the USA, the epidemic is now declining but is still the major cause of death; in other countries such as Sweden, mortality is still increasing.

In contrast to infectious epidemics which can be controlled by mass vaccination, the control of cardiovascular diseases requires changes in the national diet, which are far more difficult to define and achieve. A number of interacting dietary and genetic factors, still under investigation, affect the development of these diseases over a long period.

Epidemiological research has shown a close correlation in different countries between death from coronary heart disease and blood cholesterol level (Figure 8). Experimental research has shown that the nature of dietary fat has a major influence on the level of blood cholesterol as well as on other factors which influence the development of cardiovascular diseases.

The subject interests not only the Division of Human Nutrition but also the Divisions of Food Research, Animal Production, Tropical Animal Science and Fisheries Research because national dietary changes have implications for the food producing and food manufacturing industries. Accordingly, the Institute of Animal and Food Sciences is coordinating an inter-Divisional program on the role of dietary fats in cardiovascular disease, the composition of fats in various foods, and means of altering this composition.

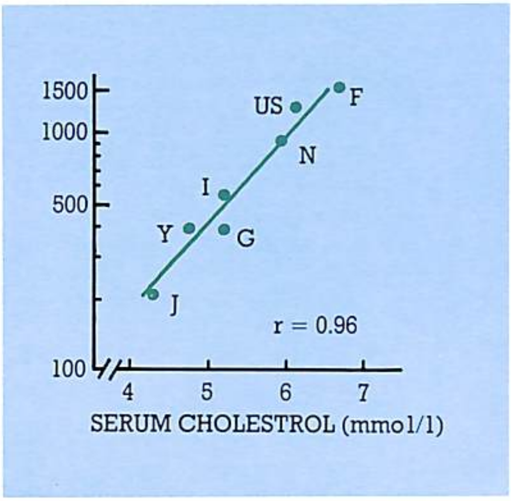


Figure 8. Results of a seven- country study of deaths from coronary heart disease as a function of cholesterol levels in the blood. F = Finland; US = United States; N = Netherlands; I = Italy; G = Greece; Y = Yugoslavia; J = Japan. The vertical axis shows number of deaths per annum per 100 000 males aged between 55 and 74 years.

Fats and oils are the major forms in which energy is stored in animals and plants. They are mainly triglycerides composed of three fatty acid molecules. The fatty acids are of various chain lengths, generally from 12 to 22 carbon atoms, and containing up to six unsaturated bonds. Foods also contain phospholipids in which the third fatty acid of a triglyceride is replaced by a phosphoryl choline group. Saturated fatty acids can be synthesized from carbohydrate in the body but polyunsaturated fatty acids (PUFA) must be provided in the diet. They are required as essential constituents of the phospholipids of tissue membranes particularly in the brain and as precursors of prostaglandins, a complex group of metabolic regulators.

There are two families of essential PUFA. Linoleic acid C18:2(n-6) and its metabolic derivatives constitute the (n-6) family; (C18 refers to the number of carbon atoms, 2 to the number of unsaturated bonds, and (n-6) to the position of the first double bond counting from the methyl end. The (n-3) family is similarly derived from α-linolenic acid C18:3(n-3)

Linoleic and α-linolenic acids in the diet come principally from oilseeds and green leaf lipids. Their desaturation and elongation to longer chain PUFA depends on the activity of enzymes that catalyze the conversion. Preformed C20 and C22 PUFA in the diet occur in the triglycerides and phospholipids of meat and fish.

It is now well established that saturated fats increase blood cholesterol levels and the risk of cardiovascular disease, while PUFA have the opposite effect. However, much of the early research and the dietary recommendations based on it did not distinguish between the (n-3) and (n-6) series of fatty acids which are not interconvertible. Vegetable oils and margarine rich in linoleic acid were promoted as the source of PUFA; meat and dairy products were advised against, being sources of saturated fats.

The realization that (n-3) PUFA in the diet might be important was sparked off by the finding of Danish workers that Greenland Eskimos have only about a fifteenth of the incidence of cardiovascular disease occurring in most European countries including Eskimos living in Denmark. The traditional diet of Eskimos is rich in meat and blubber from whales and seals as well as fish and wildfowl. The fat of these foods is rich in triglycerides and phospholipids containing the PUFA's C20:5(n-3) and C22:6(n-3) derived from phytoplankton at the start of the arctic marine food chain. Subsequently, these fatty acids in the diet were shown to produce a stronger cholesterol lowering action than linoleic acid, as well as reducing blood pressure, blood viscosity and thrombogenesis and increasing the dilatation of small blood vessels. It was shown that these actions were mediated by the series-3 prostaglandins and the inhibition of some of the effects of the series-2 prostaglandins.

It was apparent that the optimum diet may require a balance between the (n-3) and (n-6) fatty acids in the fat. There was also evidence that the conversion of linoleic and α-linolenic acids to their longer chain derivatives and prostaglandins may depend on other dietary factors such as the trace elements zinc and selenium. Vegetarian diets, while adequate in 18:2 and 18:3 PUFA, may not provide for adequate synthesis of the longer chain PUFA. Meat and fish provide the longer chain PUFA preformed, although meat may also be rich in saturated fats.

The Division of Human Nutrition is exploring the fatty acid content of meat from different breeds of sheep and cattle reared under different conditions. Considerable genetic and environmental variation has been found in the content of the longer chain PUFA. Already, ways of reducing the saturated fat content of ruminant meat, such as earlier slaughter, choice of leaner breeds and leaving males entire, are available to farmers. Also, the Division of Animal Production is exploring the stimulation of growth and reduction of fat deposition by immunization against somatostatin, an inhibitor of growth hormone secretion. In the Division of Food Research, control of the enzymes which mobilize depot fats is being investigated.

The Division of Fisheries Research is well placed to study the distribution of long chain PUFA in the food web of marine species in environments ranging from tropical to antarctic. Apart from determining the nutritional value of different fin fish, crustacean and molluscs, this research may lead to commercial sources of marine oils useful as dietary supplements.

The Division of Human Nutrition has a long experience in the study of trace elements and has turned its attention to the influence of zinc on the metabolism of PUFA. Zinc deficiency produces symptoms similar to those of essential fatty acid deficiency. The Division is also studying the influence of dietary fatty acids on cardiac function and has found marked influences on cardiac rhythm. Cardiac arrythmia is a common cause of heart attacks.

Other research deals with the transport of fatty acids in the blood and their metabolism in the liver, especially as they relate to the composition of dietary fat.

Australia has been successful in reducing the incidence and mortality of cardiovascular diseases in Australia over the past two decades. However these diseases still account for the greater part of the $12.4 billion spent on health care costs each year. Further research is needed to refine dietary recommendations and to enable the food production and food processing industries to best meet these recommendations.

Vaccines to Increase Lambing

Traditionally, vaccines have been used to control diseases in the livestock industry. More recently, a new immunization concept, based on immunophysiology, has emerged, in which the immune system is manipulated to produce physiological effects. While the research potential of this approach has been recognized for some time, its practical use only became a reality towards the end of 1983.

At the Division of Animal Production, a multi-disciplinary team of scientists set themselves the ambitious goal of increasing the

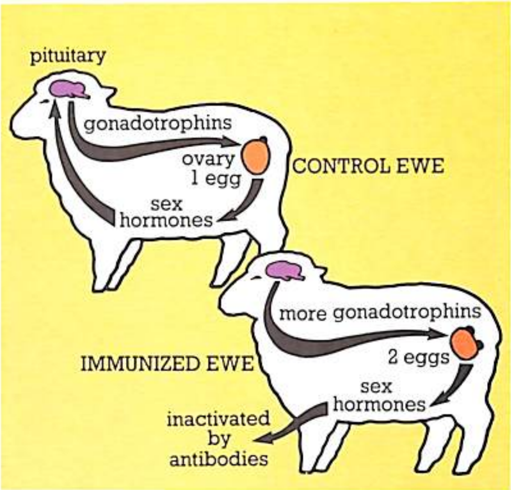


Figure 9. Vaccines to increase lambing. Links between the brain (pituitary) and ovary are indicated by lines. Immunization causes a change in hormonal balance which stimulates the function of the ovary.

lambing rate in flocks of ewes, a goal with great economic benefits. Using immunophysiological techniques, they aimed to influence reproductive processes in ewes by challenging the immune system to produce an unnatural type of antibody that would neutralize the activity of sex hormones normally circulating in the blood. The crucial step was to induce the immune system to function in a way that nature did not intend. The team's chemists synthesized special molecules consisting of steroid hormones linked to proteins which, on injection into ewes, acted as immunogens and incited the immune system to produce antibodies against steroid hormones. In this way, animals could be made selectively immune to their own hormones without deleterious effects.

The reproductive cycle is regulated by the delicate balance of a number of different hormones. Immunization of ewes against the sex steroid androstenedione altered the pattern of circulating hormones in a way that stimulated the ovary to shed two eggs rather than one, with the result that treated ewes tended to produce more twins than usual. Limited field trials over 3 years indicated that the procedure might have commercial potential.

Under license to CSIRO, Glaxo Australia Pty Ltd undertook large-scale field tests in Australia and New Zealand which showed that the number of lambs could be increased by 25%. The results with Merinos were more variable than those with British breeds and cross-breeds. Glaxo Australia Pty Ltd then proceeded with large-scale production of the immunogen, Fecundin, the product being distributed in Australia by Cooper Animal Health (Wellcome Australia Ltd).

It may be possible to extend the principle of hormone immunoneutralization, illustrated in the development of Fecundin, to other areas. It is conceivable that future technologies for livestock production will include new vaccines to manipulate fat deposition, muscle development, animal size, onset of puberty, wool production and suppression of male sexual activity (immunocastration offers the possibility of retaining the superior growth rate of the intact male without the associated aggressive characteristics).

9. Institute of Biological Resources

Introduction

Research in the CSIRO Institute of Biological Resources is directed to improvement of the productivity of Australia's rural industries and conservation of its biotic resources, recognizing that the two are highly interdependent. Studies of plants, pests, the land, soil and water, agricultural, pastoral and forestry activities, and Australian ecosystems all fall within the ambit of the Institute's research.

Plants are sources of timber, fibre and fuel, and the start of all human food chains. Research to optimize plant production is therefore of fundamental importance, and is directed to producing increased quantities of usable plant material of better quality and with least disruption to water resources, soils and fragile ecosystems. Work to increase plant productivity is complemented by research to improve our understanding of the Australian environment.

Many of these fields of study overlap, and their results are enhanced by an increasing trend for projects to involve collaboration between the various Divisions of the Institute. Much research is also conducted in cooperation with State Government departments, industry groups, and organizations such as international aid agencies.

A major development in recent years has been increased commitment to molecular biology, and the Division of Plant Industry is now one of the most highly regarded centres for this work in the world. Among other developments, a $1.8 million agreement has been signed with the US Agrigenetics Corporation to study a system of introducing new characteristics into maize using transposable DNA elements or 'jumping genes'. Molecular biology is being applied to research on seed problems, nitrogen fixation, plant hormone action, detection of plant virus diseases, and gene transfer in insects.

Biological control continues to be an important topic for research in the Institute. A weevil imported from Brazil has been used to control the world's worst water weed, salvinia, on the Sepik River in Papua New Guinea, following demonstration of its use to control the plant near Mount Isa, Qld. There is evidence, too, that biological control of spotted alfalfa aphid has reduced the pest to the point where little spraying is needed. Other programs continue on a number of noxious weeds.

Much of the Institute's effort is devoted to research on water catchments, soils and erosion. Projects include study of the effect of extensive felling of trees on hydrology and erosion in water catchments; effects of irrigation on soil structure and porosity; no-till farming systems to reduce erosion and maintain soil structure; detection of areas of saline soils; and study of plant nutrition.

The trace element boron is essential for plant growth, but is unusual among nutrients for the narrowness of the range between deficient and toxic concentrations in plant tissues. Boron toxicity is an area of plant nutrition under study in the Institute of Biological Resources. Leaf blotch symptoms of barley (above) caused by boron toxicity.

Many sections of the Institute have an interest in bushfires. Project Aquarius continues as a major study of bushfires and their control. In central and northern Australia it has been shown that fire can be used to manage plant communities, determining the kinds of plants that grow. A number of projects study the ecological effects of fire.

Other projects on the Australian environment and its conservation include study of endangered species of plants and the experimental basis for management of areas such as Kakadu National Park in the Northern Territory, control of kangaroo populations in southern Australia and the adequacy of patches of native vegetation isolated by land clearing, to be used as reserves of the original flora and fauna.

An important feature of much of the research in biology is the use of computing in various forms. This is described in more detail below.

The appearance of a mature barley crop (above) affected by boron toxicity. The darker patches are due to discoloration by boron toxicity symptoms. At 50 cm depth, the soil of these patches contained 25 times the soluble boron content of the soil under healthy (light-coloured) barley.

Three CSIRO scientists, J. Leigh, R. Boden and J. Briggs, have produced a book *Extinct and Endangered Australian Plant Species* (Macmillan Australia, 1984) which provides a detailed account of what has happened to the Australian flora in the 200 years since European settlement. Seventy-six species are presumed to have become extinct and 200 or more are on the endangered list. Almost 85% of the native plant species recorded so far in Australia are found only in this country, and any of them rendered extinct, either deliberately or through neglect, becomes lost to the world.

A large section of the book is devoted to a description of each endangered species, its habitat, distribution, cultivation and threatening agencies. A major aim is to stimulate greater conservation efforts to ensure that no further species become extinct, either wittingly or through ignorance or neglect.

The photograph, which is one of the illustrations in the book, is of *Gastrolobium appressum* C.A. Gardner; family: Fabaceae, an endangered species, commonly known as Scale-Leaf Poison. It is now confined to small populations on road verges, railway easements and private land in the northern wheatbelt of Western Australia. Extensive clearing of land for agriculture, followed by special eradication measures to prevent poisoning of domestic stock, has been the major threat in the past. The surviving populations are now threatened by road maintenance activities, firebreak construction and continuing deliberate eradication measures. This species, like most *Gastrolobium* spp., contains the monofluoroacetate acid commonly known as '1080', which is lethal to domestic animals.

Using Computing in Agricultural and Biological Research

During the past decade a revolution has taken place in agricultural and biological research: computers and microprocessors are now essential research tools. This is so for nearly all programs in the Institute of Biological Resources, and the same is true throughout CSIRO. Data collecting and analysis are activities central to experimental science. Computing and information technology have had an enormous impact on experimental science because of their ability to analyze immense amounts of data in creative ways, and so provide solutions to practical problems. We can think of information as ordered data, and current technology is allowing degrees of ordering previously undreamt of. Scientists working in the agricultural and biological sciences have been quick to exploit these developments.

Computer Management in Agriculture

The Division of Plant Industry has been researching and promoting computer-based management systems for use in agriculture. The most successful of these has been SIRATAC for the management of cotton crops, but considerable progress has been made in the much more complicated area of management of grazing systems, and the newly initiated irrigated crop management system, SIRAGCROP, being developed at the Centre for Irrigation Research.

The development of SIRATAC, an acronym for *CSIRO* and Department of *A*griculture *TAC*tics for cotton growing, has been well supported by the cotton growing industry. It was based on multidisciplinary, collaborative research conducted initially by the Division and the New South Wales Department of Agriculture and more recently with the University of Queensland and the Queensland Department of Primary Industries. The system has now been made available commercially via a non-profit company, SIRATAC Limited, and is being used to manage about a third of Australian cotton production, which has an annual value of some $300 million.

Computer-based management systems such as SIRATAC offer financial benefits to the cotton grower by allowing fewer and more economical spraying schedules. There is also a significant ecological and biological impact. By concentrating on the use of 'soft', less persistent insecticides, environmental pollution is minimized and the development of insecticide resistance is minimized.

Another benefit from SIRATAC is the substantial database of information on crop growth and development, and insect abundance, damage and control which is being accumulated. Although irrigated cotton is a relatively new crop in Australia, this database is probably larger than for any other Australian crop.

The SIRATAC system is being developed and improved on a number of fronts. The program is being continuously updated and advanced by user feedback flowing from regular meetings of researchers, SIRATAC Ltd, technical officers, and farmers (SIRATAC clients). Research is being done on different versions of SIRATAC to explore, for example, the use of dynamic instead of static pest thresholds or even dispensing with thresholds and determining spraying from the economic consequences predicted by simulating the economic effects of insect damage on yield, quality, and timeliness of the crop. A significant research effort is being directed to improving the SIRATAC boll development model so that it responds to different levels of nitrogen and water. This will enable SIRATAC to be used for the developing dryland cotton industry.

A logical extension of SIRATAC is to other, more complicated, agricultural systems. This is being attempted in SIRAGCROP which, although initially directed to the management of irrigated wheat, aims to provide crop management systems for irrigated areas of south-eastern Australia.

Like SIRATAC, SIRAGCROP has broad ecological and national objectives which it seeks to achieve by providing farmers with alternative cropping systems that use water more efficiently and reduce problems associated with rising water tables and increasing salinity. The SIRAGCROP project, which began in 1983, uses standard commercial microcomputers to provide farmers with up to date information from a minicomputer at the Centre for Irrigation Research at Griffith, NSW, via a modem (telephone/computer interface).

A suite of programs called the SIRAGCROP Farmer Service is being tested at the moment by a small group of farmers. The service comprises the Irrigation Scheduling module of the SIRAGCROP Irrigated Crop Management Model, a news release service, a coming events calendar, an electronic mail service, and current and historical weather data. The service is already enabling farmers to schedule irrigations for individual paddocks and to communicate with other farmers on the system.

The SIRAGCROP Irrigated Crop Management Model will eventually contain the components for irrigation scheduling, fertilizer requirements, timing of pre-irrigation in relation to paddock trafficability, and control of diseases and weeds. As soon as these components are completed and tested they will be made available to farmers through the SIRAGCROP Farmer Service.

Researchers at the Centre and local agronomists from the New South Wales Department of Agriculture will be able to communicate with the farmers through the news release and mail services. They will also be able to monitor the performance of farmers' paddocks throughout the season, and gather the on-farm data needed to develop the other components of the Irrigated Crop Management Model. These data will also be useful for general research purposes as a large database develops.

An on-line service such as this will enable the researchers at the Centre to communicate more easily with the farming community. The time lag between completion of research and dissemination of information will be virtually eliminated. Also, as a more interactive feedback process with the farmers is developed, new developments and recommendations will be adopted sooner.

Computer-based management of an even more complicated system is being attempted through the development of models that assist in grazing management. When this research began, it was recognized that management decisions made by graziers were of two kinds: strategic decisions on long-term policy, aimed at improving grazing systems as a whole; and tactical decisions on day-to-day feeding policy. The Division of Plant Industry is developing models that will help graziers to make both sorts of decisions more effectively.

The strategic model would be used to select, for any particular environmental and farm conditions, the best type of animal, the best stocking rate and mating policy, and the optimum system of grazing management and feed supplementation, and to test the possible benefits of innovations or technological changes to the system as a whole. This calls for a large model capable of integrating all of these factors. It will consist of a number of sub-routines, each simulating a particular biological system and its responses to natural events and management decisions.

A simpler model is being developed that the grazier can use for the day-to-day management of stock — in a somewhat similar fashion to SIRATAC. This consists of the animal nutrition and animal production sub-routines of the larger model. When the user supplies a description of current pasture and animal conditions, the model predicts the expected animal performance and the additional food needed to raise animal production to a desired level. This is a much better way of applying feeding standards to grazing animals than the conventional use of tables of energy requirements of animals and nutritive values of foods. The model not only simplifies the job but also simulates the complex effects of pasture conditions on diet selection and food intake and the effects of supplementary feeding on the intake of pasture. In this way the farmer can make rapid decisions about moving stock or changing the level of supplementary feeding. This model is currently being validated by field experiments.

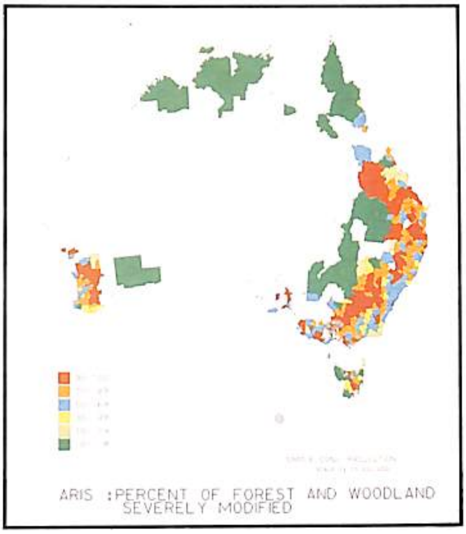
For the future, it is hoped that irrigation systems based on computers can be used to increase irrigation efficiency by using the computer to control water flows on to the land.

Computers and Classification

Explorations into the New World in the 18th and 19th centuries brought such a wealth of biological specimens to Europe that taxonomists had to devise a formal classification system to describe the material. The result was the binomial naming system credited to Linnaeus. Traditionally, taxonomists have looked intuitively for relationships between groups of organisms. Today the requirement in taxonomy is not only for subjective descriptions but also for objective measures that demonstrate evolutionary and ecological relationships between species. Numerical taxonomy was developed to help fill that need. Numerical taxonomy is a branch of the biological sciences that uses mathematical techniques to cope with a problem that is common to all biology, namely, dealing with many species, characterized by many attributes, each attribute being the expression of many past events in the environment. It is a field ideally suited to computer aid.

The application of computer-based techniques to plant and animal taxonomy and identification is an area of major development in the Institute of Biological Resources. These advances will greatly improve routine identification of plant specimens and exchange of information among a national network of databases. This will reduce the current burden of loans processing, and will allow generation of local floristic lists, geographic distribution maps, and the like from databases. The Australian National Herbarium, located in the Division of Plant Industry, is commencing database construction with a stand-alone computer compatible with larger national networks, and is participating in workshops organized to standardize database methodology.

A significant development in computer-aided taxonomy is the application of the DELTA system, developed by the Division of Entomology. DELTA (*DE*scriptive *L*anguage for *TA*xonomy) is a versatile system for computer coding of taxonomic descriptions. It allows input of any types of characters used by taxonomists in a way that suits the taxonomist rather than the computer. Once entered, the data can be analyzed in any desired fashion and used to generate identification keys for the specimens. It can also be converted into natural-language descriptions by the program CONFOR, producing immediate taxonomic manuscripts in any language in which the character words are entered. It can also be converted by the Division's TYPSET automatic typesetting program into camera-ready copy for printing.



A taxonomic research worker with access to a computer keyboard and telephone line. Taxonomic observations about biological speciments, for example insects or plants, can be recorded directly into a computer. Away from the laboratory, or in other locations without a permanent connection to the computer, this can be done through a telephone line. The data so collected can then be manipulated to provide, for example, species descriptions or identification keys. If the researcher wishes to publish the material, it is a simple matter to direct it to the computer's typesetting unit which will make up printed pages ready for running off as a book or report. The telephone line also allows the scientist to access much of the world's scientific literature, which is now stored in computerized data-bases.

The DELTA system is equally suitable for insects or plants or indeed any group of organisms about which taxonomic information has been gathered. It is being used in the Australian National Insect Collection and the Australian National Herbarium, and by many other groups around Australia and in Europe and the United States.

The Division of Entomology is also developing a system for interactive on-line identification of insects. From a database similar to DELTA, the computer puts a series of questions to a user with a biological specimen until it has sufficient answers to identify it. The computer system considers all known information about the organism at all stages of identification, making it tolerant of error, whereas conventional, binary key systems go through a series of steps, each one calling for a choice between alternatives, and a single error can send a user drastically wrong. The same program has been applied by the Division of Forest Research to the identification of eucalypts.

Many of the species being developed by the Division of Tropical Crops and Pastures as pasture cultivars are new to domestication. When first introduced there is little or no background information on their likely performance or detailed physical characteristics. The species may contain forms or types suited to very different soils, climates or management practices. Before their agricultural value can be assessed, they must be described in a meaningful way to those involved in selection or improvement programs. This can be difficult with a collection of say 250 plants. For each of them, up to 50 characteristics may have been recorded, giving 12 500 pieces of information and providing millions of potential combinations of characteristics.

To aid in plant selection, computer-based classification programs have been developed that can group plants according to their overall similarities. After interpretation by a biologist, such groups can be used to define and describe various types of plants in ways useful to scientists concerned with plant introduction, taxonomy and agronomy. Other computer-based programs can be used to relate plant performance in Australia to the types of climate from which the plants were collected or to particular characteristics of the plant such as growth form, or quantity of leaf and stem. This information helps in planning future plant collection and improvement programs.

Computers in Molecular Biology

In the rapidly-advancing field of molecular biology, there has been an explosion of information on molecular structure of genes and proteins. Storage, analysis and management of these data are not possible without the aid of computers.

Cloning of genes and determination of their nucleotide and amino acid sequences are now routine procedures. Computer programs for matching nucleic acid or protein sequences allow the molecular biologist to compare an unknown sequence with every sequence in a database in a very short time.

A frequently used program is that for automatically translating a DNA sequence into a protein sequence. When a DNA fragment is sequenced, it is often not known where the starting point of the gene is located, or in which direction the gene extends. Using computers, it is now standard practice to translate the sequence into all six possible reading combinations; the translation specifying the longest stretch of amino acids is the most likely candidate for the gene product.

Microcomputers

Microcomputers have great practical application in biological research, especially in the area of data acquisition. In this area, electronic data sheets have been developed for manual input of data by a field observer. The information is keyed into a battery powered, hand held data-logger as the observer makes the records, then at the laboratory the data-logger is plugged into a larger computer and the information transferred for analysis, storage or printing. A second invaluable application is for data acquisition from remote areas. In this case automatic data-loggers record the data on cassette; the site need only be visited every few weeks for cassette replacement.

CMOS (complementary metal oxide silicon) chips have enabled the construction of microcomputers requiring only a tenth the power of earlier models, and data-logging systems using these can run on solar power, making them even less dependent on human beings.

The storage of results in digital form in computers has meant that it is now possible to manipulate the data to enable previously unavailable interpretation. For example, in experiments at the Division of Horticultural Research, visualization of the fine detail of transcience in chlorophyll fluorescence has shed light on the response of photosynthesis to environmental stress. Similarly, the construction of three dimensional simulations of cell components based on the digitization of electron microscope cross-sections has enabled greater insight into form and function at the organelle and cellular level. The division of chloroplasts has been studied in this way at the Division of Horticultural Research.

Continental Databases

The Australian Resources Information System (ARIS) is a continental scale computerized information system being developed at the Division of Water and Land Resources for storing, recalling and searching data on the biophysical and socio-economic resources of Australia. It aims to provide a central store of resource data, a computerized mapping system, and bibliography of sources of resource data.

One recent application has resulted in the preparation of maps showing the changes that have occurred in woody vegetation cover across the continent since European settlement. Information on the original cover was based on the *Atlas of Australian Resources* (1976), while the current picture was gained from the Landsat satellite. Among other things, the maps show that about half of tall- and medium-height forest has been cleared or severely modified since settlement.

ARIS was also used during the year to store, process and map data from a survey conducted by the Division of which land use issues were seen as important by both rural and urban local governments. The five issues most frequently cited as major by rural local governments were: the effects of subdivision of prime agricultural land; the impacts of current agricultural practices (clearing, irrigation, cropping, stocking rates); population changes; natural disasters; and soil erosion. For urban local governments, the issues most frequently cited as major were: the visual quality of residential areas; the density and size of allotments; recreation facilities; changing demands for inner city land; and supply of and demand for residential land.

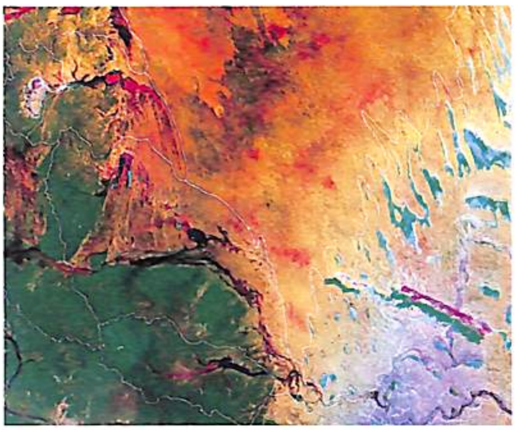
The Institute is looking at the possibility of developing a computer system to estimate changes in particular localities, based on weather input, local terrain and local levels of fuel for a bush fire.

A major use of computing by several Divisions in this and other Institutes is for interpretation of satellite data of the land and sea surfaces. A particularly successful development has been for preparation of maps of the Great Barrier Reef region.

Apart from these specific uses of computers, microprocessors are now used widely in scientific equipment to cut out much routine calculation and facilitate collection of experimental results.

The Challenge

These examples indicate the importance of computers in biological research in CSIRO. The continuing challenge to biologists is to make use of the new opportunities offered by more versatile computers and improved programming.



Landsat picture of the southern Simpson Desert in South Australia with the boundaries of ecological associations overlain. Ecological associations are groupings of terrain units, soils and vegetation, that reflect the basic ecological functioning in this very arid environment. They are delineated at a scale appropriate to land allocation and management.

10. Institute of Energy and Earth Resources

Introduction

The broad objective of the Institute of Energy and Earth Resources is to conduct and foster scientific and technological research aimed at contributing to the better definition, use and management of Australia's mineral, energy and groundwater resources, with due recognition of the environmental implications of these activities.

Approximately half of the Institute's research effort is in support of the minerals and related industries, and extends from mineral exploration through mining to smelting and refining of metals. The remainder is directed to the development and utilization of Australia's energy and groundwater resources. Energy research includes improved recovery of coal, substitute liquid fuels (oil from coal and oil shale), methods of improving efficiency of energy use (combustion, urban transportation and energy systems analysis), and storage batteries. The Division of Groundwater Research is developing better methods for quantitative prediction of aquifer behaviour and management of groundwater resources.

The Institute is further strengthening its links with the industry sectors it serves, particularly through the Australian Mineral Industries Research Association (AMIRA). Illustrations of these links are: a collaborative project with 10 mining companies to develop and demonstrate new instrumentation and apply computational mechanics to rock support and reinforcement; a jointly managed project with ICI Australia Ltd to produce high purity zirconia and zirconium chemicals; a multi-Divisional project in collaboration with Aberfoyle Ltd to develop schemes to process a major new mineral deposit; and the commercialization of the SIROSMELT process for the high-intensity smelting of ferrous and non-ferrous materials in conjunction with various companies. On the energy side, the Division of Energy Technology has established an Industrial Awareness Program under which staff are seconded to work in companies and power utilities for periods of three to six months.

New developments this year include the commissioning of the Heavy Ion Analytical Facility for elemental analysis of surface films and minerals at the parts per billion level, together with isotope analysis; and the establishment of the Surface Chemistry Section of the Division of Mineral Chemistry in Perth.

Research effort is being redirected into coal preparation and coal combustion, rock material science, oil from oil shale and new concepts in raw materials processing derived from systems analysis and mathematical modelling. Increasing emphasis is being placed on tackling larger collaborative projects with industry, using multi-disciplinary teams drawn from a number of Divisions. The Institute brings to bear a wide range of scientific, engineering and technological expertise, examples of which are illustrated by the projects described below.

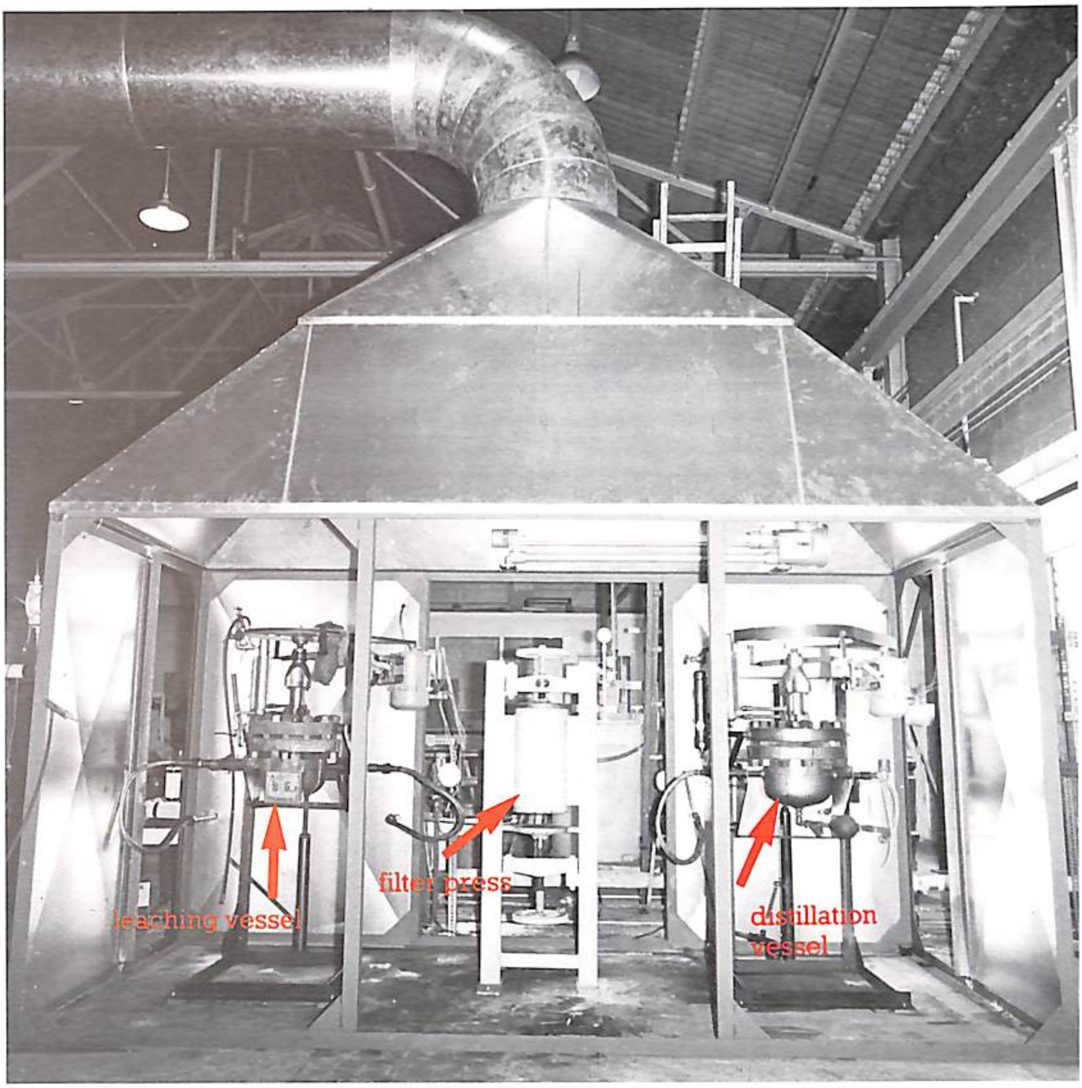
Winning High Grade Fertilizer from Phosphate Rock

North-western Queensland contains some of the world's largest known deposits of phosphate rock, comprising as much as four billion tonnes of sedimentary rock with an average grade of 16% phosphate (as phosphorus pentoxide).

At current prices, deposits of this grade are uneconomic, especially when transport costs for the 900km haul to the port of Townsville are included. At present the bulk of Australia's phosphate need is met by the high-grade rock mined on Christmas Island and Nauru. By the end of the decade those supplies will be nearly exhausted and Australia will have to look for alternative imports or exploit its own reserves. Upgrading those reserves is therefore an important consideration, and a number of ways of concentrating the phosphate have been explored.

Some years ago the British Phosphate Commission, which is responsible for the Christmas Island deposits, sponsored research in the Division of Mineral Chemistry to investigate ways of exploiting the low-grade phosphate rock found on the island. The Division looked at a variant of sulphur dioxide leaching, using sulphonic acid made by mixing together water, acetone, and sulphur dioxide. Unfortunately it didn't work on the Christmas Island deposits, but when tested on some of the low-grade ore from Duchess in Queensland, which has a somewhat different mineralogical composition, it proved very effective.

Queensland Phosphate Ltd has been mining a rich but limited lode at Duchess and was, naturally, interested in this discovery. It has collaborated with a research team within the Division in developing a process based on sulphonic acid to treat the remaining low-grade rock.

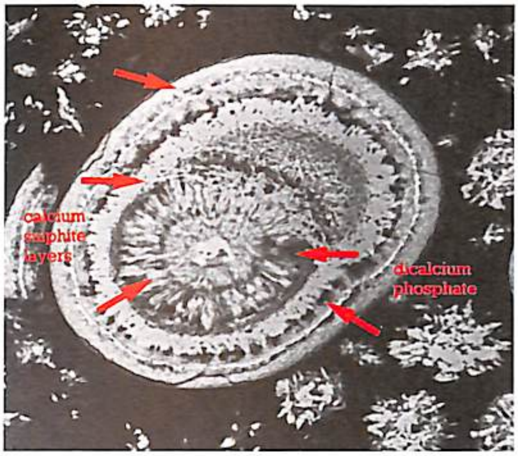


The technical scale plant for the production of Dical-Super

The Process

In the new process, the sulphonic acid dissolves about 95% of the phosphate present in the rock within 2–5 hours at room temperature. The residue, which is mainly silica, is then filtered off and the remaining solution is distilled. Depending on temperature, the product contains either dicalcium phosphate or a mixture of dicalcium phosphate and calcium sulphite. Both can be used directly as fertilizer. Also, the process can be refined to remove contaminating fluoride. The final, purer product can then be used in feed mixes for poultry and cattle.

An essential consideration in the whole process is that 99.7% of the acetone, and part of the sulphur dioxide, can be recovered and recycled. Laboratory-scale processing of 1 kg samples was used to optimize the variables involved in what is, despite the simple recipe outlined above, a complex engineering exercise. For example, efficient methods of heat recovery and recycling of the acetone and sulphur dioxide — which substantially affect the operating and capital costs of any plant — were developed from these tests.



An electron micrograph Dical-Super. The light areas are layers of calcium sulphite, while the dark areas are dicalcium phosphate.

Formulation is important in any fertilizer as it influences handling practices, spreading, and availability to the target plant. At first the group aimed at producing a high analysis dicalcium phosphate containing 50% phosphate and offering substantial savings on transport costs. However, this involved an extra step in the distillation process and it was more cost-effective to produce a mixed fertilizer containing about 33% phosphate and 8% sulphur, the latter being particularly useful in many Australian soils where sulphur is deficient.

The performance of a phosphate fertilizer depends on more than just the amount of phosphate it contains — particle size, strength, and solubility are also important. Superphosphate, while having only a 22% phosphate analysis, is water soluble and its large (2–4mm diameter) dust-free granules are ideal for bulk handling. Dicalcium phosphate is not so immediately soluble and the best compromise, taking into account the demands of manufacture, transport, and distribution, as well as the all-important agronomic response, is a 'sandy' product with crystals about 150 microns in diameter.

Agricultural Testing

A range of studies on the product, conveniently called Dical-Super, are now in progress, and early results are encouraging. For example, the Victorian Department of Agriculture has compared the effect of Dical-Super against that of an equivalent quantity of superphosphate on the growth of subterranean clover in five soils known to respond to phosphate applications. Dical-Super produced superior performance in most cases and, in the others, was at least equal to superphosphate.

In related studies, the Dical-Super proved to be less harmful to the important *Rhizobium* bacteria (nitrogen fixing) when both were mixed with clover seed, presumably because of its lower acidity. When Dical-Super was blended with seed, many more *Rhizobium* nodules developed on each seedling than when superphosphate was used. In essence, Dical-Super is just as productive as superphosphate, but kinder to plants.

Studies on a much larger scale will be needed to define fully the value of Dical-Super and, in turn, the potential of Australia's huge phosphate reserves. As the conventional phosphate sources diminish, this new Australian product looks increasingly more attractive.

Site Investigations for Mining

The Institute's mining program is aimed at improving resource recovery in metalliferous and fossil fuel mines. Once an ore or coal deposit has been proved economic by drilling, the first stage in the development of a mine is to obtain as much information as possible about the types, strengths and faults of the rock that contains the wanted material. Information about the presence and behaviour of groundwater is also needed. The Division of Geomechanics has been developing techniques for obtaining this information, and some of the technology it has developed is now available for industrial use.

For many years, oil companies have used hydraulic fracturing to crack tight oil-bearing rock strata and improve the flow from their wells. A similar technique, in which fluid is pumped into a sealed length of borehole until hydraulic pressure cracks the surrounding rock, has been used to study rock stresses. The Division of Geomechanics has designed and built a trailer-mounted rig and novel hydraulic fracture tool that has been used in collaboration with industry to measure rock stress prior to mining. It works well, provided the rock mass is initially free from fractures.

Borehole penetrometry is being investigated as a means of determining rock strength. In this technique, a plunger is pushed into the wall of a borehole and the force-displacement response indicates the strengths of the rock strata tested.

An improved borehole camera that photographs 360° around the wall of an exploratory drill hole and a modified instrument for obtaining a mould of the wall of a borehole are being used to identify geological features that influence rock behaviour. Arrangements for the commercial development of these two instruments are under way.

Studies of the distribution of rock types and groundwater and the identification of physical, chemical and mineralogical properties of coal seam and rock sequences are being used as a basis for predicting instability in spoil piles (piles of waste rock) and highwalls of deep-surface mines. The causes of collapse in spoil piles are being investigated at several mines by field observations and theoretical analyses. Equipment has been developed to measure shear strength of spoil pile materials and to monitor stress changes inside the piles.

Physical models of jointed rock masses are being used to simulate in the laboratory the structures of rock masses and pre-mining stresses, with attention being paid to the scaling of geometry, strength, friction and gravitational forces. Progressive mining of these structures can also be simulated, enabling the feasibility of techniques such as underground coal extraction by the longwall method to be tested in the laboratory.

New Smelting Technology

In its mineral processing program, the Institute aims to improve existing technology or develop new processes by which metals can be extracted from their ores. Over the past ten years, improvements to the traditional process of smelting have been developed to increase production and reduce energy use. One of the most promising outcomes of this research is the development of a new smelting process, Sirosmelt, by the Division of Mineral Engineering.

In this physical model of a rock caving, specially developed small blocks of rock-line materials are excavated (mined) while under load in order to simulate underground coal extractions by the longwall method. Here, a higher layer of coal has been extracted, resulting in major roof collapse. A second, lower coal seam is being extracted. Roof collapse into the resulting underground space has not yet reached the stage of penetrating upwards to the region of the higher level collapse.

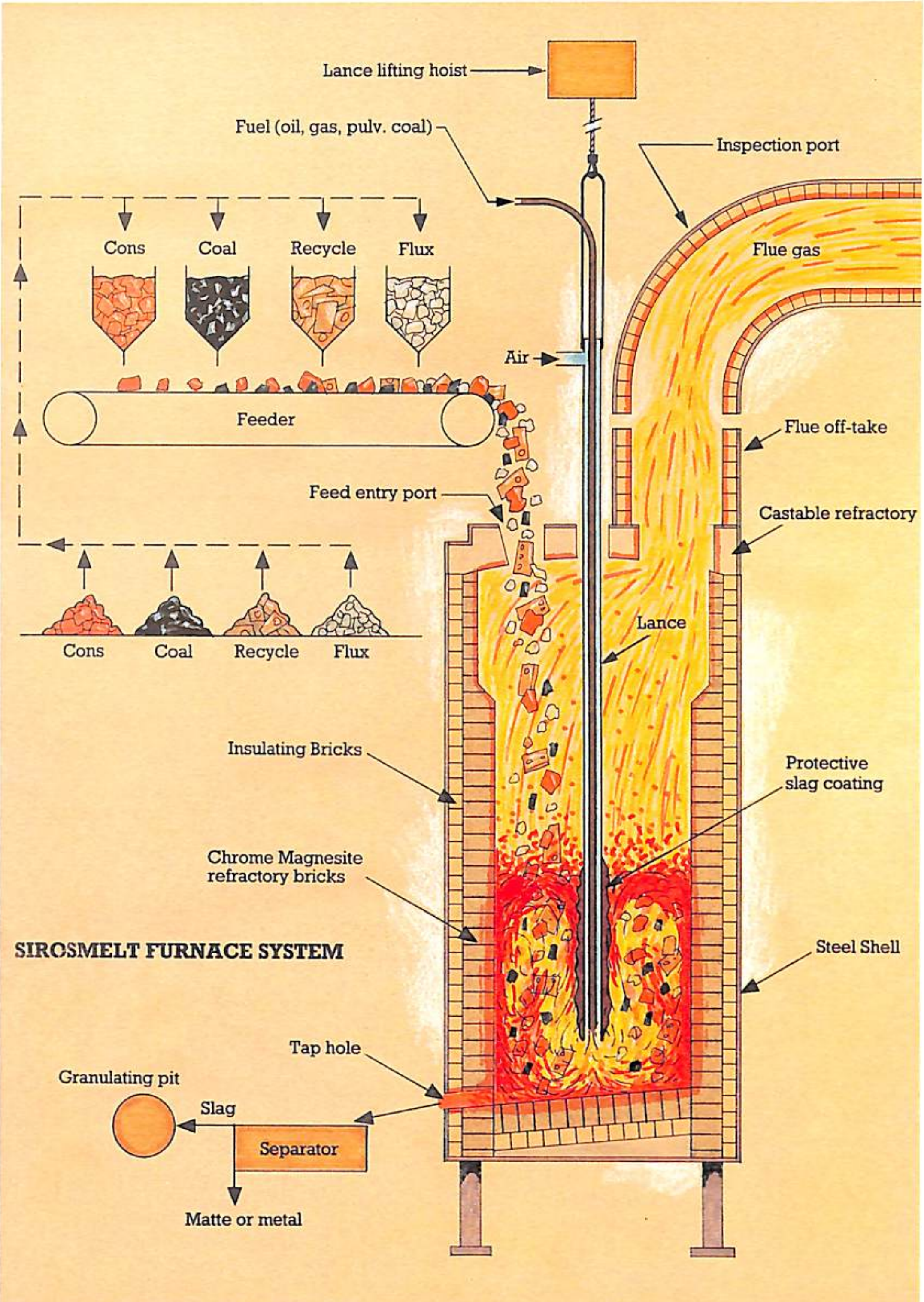
Traditional smelting methods for the production of non-ferrous metals such as copper, tin, lead and zinc are now being superseded by modern intense smelting processes which use small, energy-efficient furnaces designed to contain emissions of noxious gases and to operate automatically at high production rates.

The Sirosmelt process is an example of this emerging technology. It is carried out in relatively small reactors of simple design, with fuel and air delivered below the surface of the molten slag through simple air-cooled lances. The resulting submerged flame supplies the heat required for the process, while the large volume of combustion gases supplies the intense stirring required for rapid mixing of the reactants.

Sirosmelt is especially valuable for operations of some tonnes or tens of tonnes per hour, for example for smelting of concentrates mined at remote sites or for secondary smelting operations around existing smelters. Its immediate applications are in processes where air can be used for combustion of the fuel, and where volatile components must be recovered from the molten bath. Examples are the recovery of tin by sulphide fuming and the removal of toxic volatiles during smelting of copper by Sirosmelt. The technique is so versatile that it can be used for smelting of tin, lead, copper, zinc, nickel and other metals, and has the potential for use in large-scale operations.

The Sirosmelt technology was initially developed by the Division at its Clayton laboratories in Victoria, and subsequently tested at a number of industrial smelter sites. It is now close to full commercial realization for smelting of tin slags and concentrates at Associated Tin Smelters in Sydney. A large pilot plant with a feed rate of four tonnes per hour was operated by Aberfoyle Ltd for eighteen months during collaborative development of a tin-fuming version of the process. Mount Isa Mines Ltd is currently operating, at several tonnes per hour, a version of the Sirosmelt process known as Isasmelt for development of a process for direct smelting of lead from concentrate. Eastern Copper Pty Ltd intend to operate the Sirosmelt process for smelting a gold-rich copper concentrate.

Licenses for collaborative development of Sirosmelt have been signed with four Australian-based companies and other negotiations are under way. As a result of publicity through patents and publications, there is now a steady stream of approaches from local and overseas companies wishing to use the technology or to be involved in its development and marketing.


Lance lifting hoist
Fuel (oil, gas, pulv. coal)
Inspection port
Cons
Coal
Recycle
Flux
Flue gas
Air
Feeder
Flue off-take
Feed entry port
Castable refractory
Lance
Cons
Coal
Recycle
Flux
Insulating Bricks
Protective slag coating
Chrome Magnesite refractory bricks
SIROSMELT FURNACE SYSTEM
Steel Shell
Tap hole
Granulating pit
Slag
Separator
Matte or metal

A typical Sirosmelt installation for copper smelting at Olympic Dam (Roxby Downs), SA, including feed preparation and dust collection facilities.

High intensity smelting by Sirosmelt technology: molten high-lead slag being tapped from the Mount Isa Mines pilot plant for direct smelting of lead concentrates. This version of the process is known as ISASMELT.

Dynamic Advisory Speed Signs

A computer in the CSIRO test car provides instructions to the driver and gathers data used to evaluate the benefits of advisory speed signs. The computed advisory speed is displayed above the dash, on the left.

The Institute's energy programs are aimed at increasing the efficiency of Australia's use of petroleum. Two-thirds of the liquid fuel used for transport in Australia is expended on roads, and 65% of this on urban arterial roads. The Division of Energy Technology is studying a traffic control concept that could lead to urban fuel savings of over 10%.

Traffic signal systems have evolved in stages from isolated signals, through vehicle-sensitive and fixed-time coordination, to the adaptive traffic-responsive systems developed by the New South Wales Department of Main Roads in Sydney which are now being applied in most major Australian cities. Clearly, further advances must advise the driver on the appropriate speed to travel between successive traffic lights so as to have fewer stops and accelerations and conserve fuel.

The Division's approach has been through both simulation and on-the-road experiments. It has also addressed the psychology of modifying driver behaviour and the possible roadside or in-car equipment that might eventually be needed. Significant help and cooperation has been received from the Road Traffic Authority of Victoria, Monash University's Psychology Department and CSIRO's Divisions of Building Research and Mathematics and Statistics.

The Division of Energy Technology developed and installed in a vehicle an onboard computer and logging system capable of displaying information about fuel consumption and driving behaviour as they occur. Driving experiments conducted under a coordinated traffic light system confirmed the fuel consumption results predicted by computer models, and showed that fuel consumption could be reduced by 15% and the number of stops halved.

The outstanding problems will be investigated through road experiments in traffic signal systems that respond promptly to changes in traffic flow, a study of the best way to present the advised speeds to the driver, and how best to obtain driver compliance.

Water Quality

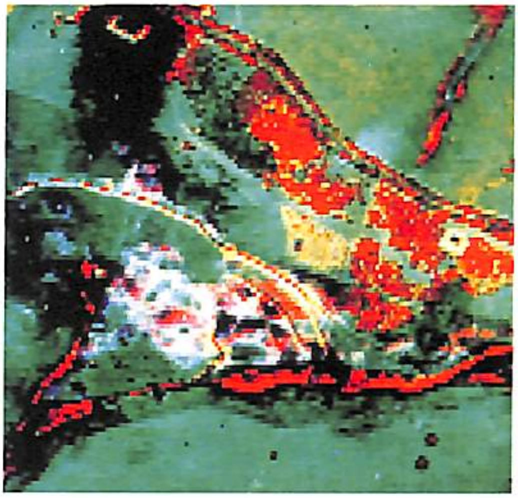
Research into water quality has two emphases, one being the processes that affect the quality and quantity of groundwaters, and the other being the effects of mining activities.

Some State governments have already legislated to restrict landholders and industry from discharging pollutants into rivers and lakes, and attempts will probably be made to control more closely discharges into groundwater. To be successful, the legislation must be based on sound techniques for investigating and understanding how pollutants are retained in or leached into groundwaters.

There is little systematic information from boreholes on how to assess groundwater quality by borehole sampling. The Division of Groundwater Research is therefore developing procedures for siting boreholes in the best places for monitoring polluted groundwater. This Division and the Division of Mineral Chemistry have developed sampling equipment which obtains representative samples from within water-filled boreholes. The task of defining plumes of pollution that spread from a single source in a shallow aquifer is made more difficult by local variations in hydrogeology and pollution sources. To help in this task, the researchers are developing a method for locating areas of polluted groundwater by monitoring the composition of gases, such as methane, that occur in the unsaturated zone of an aquifer and evaluating how groundwater constituents vaporize.

Research on diffuse pollution sources is being applied to drainage areas around the Peel-Harvey estuary in Western Australia, which is subject to oxygen depletion problems. The Division is particularly studying the movement through soil of micro-pollutants from pesticides, fertilizers and waste materials. The overall aim of the research is to determine the major processes in soil that affect the chemical and biological characteristics of groundwater.

At a broader level, the Division aims to develop an understanding of the way in which the chemical composition of water changes throughout the stages of rainfall and diffusion through soil to groundwater storage. In determining how the composition of groundwater changes with location and time, the researchers have found that the key factors are ion exchange processes, mineral weathering, the gases present in the unsaturated zone and the rate at which the water moves through it. From measurements made over a ten-year period, they have also concluded that groundwater chemistry changes more with location than with time.



Colour composite of three near infrared wavebands showing the progressive development of salinity on one of the monitored sites at CSIRO's Yalanbee Experiment Station, WA. This image was produced from data acquired by a 15-channel multi-spectral scanner developed by CSIRO and Carr Boyd. The typical saline progression of water-logging (dark reds), degradation and alteration of vegetation (black) and finally bare salt affected soil (blue/white) can be seen. Some of the lighter red and pink areas are plantations of trees designed to utilize groundwater.

It is expected that this research will lead to better information on the effects that different types of land use have on groundwater supplies, and that it may also be the basis of land and water use legislation.

Two other Divisions, Fossil Fuels and Energy Chemistry, work on the environmental impact program on water quality problems associated with mineral and fossil fuel developments and mining.

The Division of Fossil Fuels is carrying out modelling and computer simulations of the physical and chemical processes involved in the transport and removal of metals in and from inland waters. The aim is to minimize the occurrence and consequences of the pollution and its effects on associated ecosystems. Steady state and dynamic models, together with graphical techniques for data analysis, have been developed and applied to various polluted streams.

The mining and processing of oil shale has the potential for serious water pollution, and careful control of the waste waters will be required.

Calculating the growth rates of algae to estimate the toxicity of various forms of aluminium in waste waters from oil shale processing.

Retort water, that is the water that is distilled over with the shale oil, contains sulphides, ammonia, several toxic trace elements and a range of organic compounds. Rainwater that has leached through the oil shale and spent shale heaps also contains trace amounts of heavy metals plus some organic chemicals.

The Division of Energy Chemistry is measuring the concentrations of organic and inorganic material in oil shale waste waters with the aim of identifying which components most affect water quality. Some fifty chemical elements and several organic chemicals have been measured in samples of waste waters and retort waters, and a laboratory retort has been used for studying the distribution of trace elements between the spent shale, the retort water and the retort gases. Bioassays, using algae and other marine organisms, have been used to estimate the toxicity of organometallic compounds of a type likely to be present in shale waste waters; some organocopper compounds were found to be extremely toxic to marine organisms. Some of this work has been funded by an Australian Marine Sciences and Technologies grant.

The Division of Fossil Fuels is looking at the effects of oil shale wastes on inland waters, and in particular, what happens to the heavy metals leached into local creeks. Laboratory leaching experiments have been completed and studies of sediment uptake are under way. Two major field trials, carried out to investigate the effects of metal release, have used the advanced modelling techniques developed in earlier work on leaching from base-metal mines.

Run-off waters from coal washeries, coal storage heaps and disused coal mines may be acidic if the coal contains a significant amount of pyrite. These acidic waters often contain dissolved metals such as iron, aluminium and copper. Overseas researchers have shown that aluminium is the main toxic agent in rivers and lakes affected by acid rain. The increased acidity mobilizes aluminium from sediments, suspended matter and the surrounding soil, and the dissolved aluminium reacts with biomembranes (for example fish gills), hindering the transport of oxygen and nutrients. The Division of Energy Chemistry has found that dissolved aluminium is highly toxic to algae and also that the toxicity can be ascribed to a particular aluminium species, $Al(OH)_2^+$. However, natural organic matter and aluminium complexing agents decrease the toxicity of aluminium, which therefore becomes a problem mainly in water systems that are low in organic matter and nutrients.

The Division has also commenced a collaborative study with the NSW State Pollution Control Commission to study the concentrations and forms of trace elements in the waters and sediments of Lake Macquarie. The aim is to identify sources of pollution, the relative effects of different pollutant sources (such as sewage, industry, and fly-ash ponds) and the extent of biological mobilization of heavy metals from sediment. An attempt will also be made to predict the effects of dredging on the mobilization of toxic heavy metals from sediments.

11. Institute of Industrial Technology

Introduction

The research carried out in the Divisions of the Institute covers work of benefit to the three major sectors of industry: primary, secondary and tertiary.

Research for the primary sector is centred mainly in the Divisions of Textile Industry, Textile Physics and Protein Chemistry and is concentrated on wool, hides and skins. Research on wool includes studies of wool structure, wool scouring, making of top, yarns and fabrics, and improving the comfort and performance of wool products. A major effort is being directed to a marketing system for wool based on sale by description. Work on hides and skins includes research into improved methods of preservation and dehairing, new tanning processes, and studies of other processing technologies.

All the Divisions in the Institute make a contribution to the manufacturing sector. The Institute sees as one of its major thrusts the introduction of the latest technologies to existing resource-based industries in Australia which contribute significantly to the GDP and also to employment. This includes research for the wool processing and textile industries, and the hide and leather industries mentioned above. In addition, the Division of Chemical and Wood Technology does research related to forest products including pulp and paper, plywood, chipboard and other wood products.

The Institute is also very active in research for technology-based industries. The Division of Manufacturing Technology has research programs in the areas of metal fabrication and is particularly active in computer aided design and manufacture and the introduction of flexible manufacturing systems to industry. The Division of Applied Organic Chemistry is engaged in research into the design and synthesis of chemical compounds with biological activity which can be manufactured in Australia for the world market. It also carries out strategic and tactical research into the development of novel polymers. Two Divisions, Protein Chemistry and Chemical and Wood Technology have research activities in the field of biotechnology, concentrating initially on the production of genetically engineered vaccines against certain diseases of farm animals.

Research for the tertiary sector is centred in the Division of Building Research and is directed to assisting the building and construction industries. Programs are directed to strength, safety and durability of buildings of various designs and

Marathon runner, Robert de Castella, and middle-distance runner, Michelle Baumgartner, model the 1984 Australian Olympic Team's outfits. The fabrics were woven from wool yarns spun by the Sirospun process, developed at the Division of Textile Industry.

Sirospun is a worsted spinning process which combines spinning and twisting in a single operation, thereby offering significant increases in productivity and a shorter processing route. Sirospun is now in use on more than 100 000 spindles world wide, and is estimated to save $200 per annum per spindle.

Sirospun worsted wool yarns possess a distinctive physical appearance which produces fine, consistent fabrics with a high clarity of pattern and excellent resistance to abrasion and pilling. They are successfully used in a wide range of fabric constructions, particularly in areas where wool may not have been traditionally considered, such as lightweight wool products for the spring/summer market.

made of different materials. Attempts are being made to relate construction characteristics to maintenance requirements and life cycle performance. A major effort is being devoted to development of computerized techniques and information systems as aids to design and construction of buildings and to urban planning.

The Institute spends approximately $36m annually, spread over the wide range of industries mentioned above. Staff in Divisions are encouraged to liaise with industry representatives in order to seek inputs to help in the determination of research priorities. Gradually, good relations are developed with individual or groups of companies, significantly improving the chances of exploiting successful research results.

Three examples of recent projects follow.

Pulsed-arc Welding

The Division of Manufacturing Technology has become accepted by manufacturing industry as an important source of advice and assistance on various new and improved technologies. Through collaboration with a wide range of manufacturing organizations, the Division has successfully identified, developed and completed a number of cooperative research projects.

An outstanding example of joint research activity was the development of a pulsed-arc welding machine by the Division and Welding Industries of Australia Pty Ltd (WIA). The details of this technique were discussed briefly in the 1982/83 CSIRO Annual Report. The result of the venture, known as the Synchro-Pulse CDT (controlled drop transfer) welding machine, is becoming recognized internationally. It offers significant advantages over machines based on other welding techniques.

With the help of a welding expert from WIA, researchers at the Division were able to establish precise criteria for the frequency and duration of the pulsed currents used in gas-shielded pulsed-arc welding equipment. Improvements to operator control were made possible by considering essential design requirements; key observations were that:

- each metal drop should be of roughly the same diameter as the electrode wire;
- there should be only one drop per pulse;
- the drop should be impelled axially from the electrode wire with sufficient force to permit welding in all positions;
- separation of the drop from the electrode should be clean; no long liquid metal bridge should form which would subsequently break up into a string of droplets which tend to produce spatter;
- the temperature of the metal drops should be as low as possible; and
- there should be no short-circuiting of the arc.

The new technique offers continuous smooth welding metal transfer, a controlled single drop per pulse, and minimum through to maximum current adjustment at the touch of a single control knob. The ability to weld very thin material sections, enhanced productivity and better looking welds are other bonuses. Advantages over other welding techniques include:

- less heating of work pieces;
- minimal distortion and damage to heat-treated or painted areas;
- improved shaping and penetration of the weld;
- better circulation of the liquid in the weld pool;
- improved mechanical properties of the weld deposits;
- far less spatter; and
- all-position spray welding.

The standard Synchro-Pulse CDT is now available commercially and is fitted with pre-programmed circuit boards for welding materials such as carbon and low alloy steels, stainless steels and aluminium, with options for other weld materials. The system lends itself to automation. This was demonstrated recently in the robot-controlled pulsed-arc welding of automotive exhaust components.

A system in which a Synchro-Pulse CDT and a state-of-the-art robot are presented as a fully integrated package is now on the market. To maximize the benefit of this new technology to manufacturing industry, the Division is continuing cooperative and collaborative work in this field.

Understanding the Influenza Virus

Influenza has been called the last great plague of man. It continues to flourish today, causing major epidemics that sweep around the world with great rapidity, affecting a large proportion of the population regardless of age or previous infection history. In the present century, major pandemics occurred in 1918 (Spanish flu), 1957 (Asian flu), 1968 (Hong Kong flu) and 1977 (Russian flu). In addition to the major pandemics, severe epidemics occur almost annually in many parts of the world and cause severe illness and mortality.

Since 1933 it has been known that influenza is caused by a virus, and the first human influenza viruses were isolated in London in that year.

Electronmicrographs have shown that the surface of virus particles is dotted with small appendages projecting outwards. These appendages, which are protein in nature, are essential components of the virus and are of two types, one a haemagglutinin and the other a neuraminidase. Both are essential for infection.

As with other viral infections, such as measles, poliomyelitis, mumps, rubella and smallpox, our immune system reacts to an influenza infection by producing special protein molecules called antibodies, which react specifically with the two coat proteins of the virus. These antibodies help us to counteract the viral infection and should protect us from subsequent attacks in the future.

Why do we suffer repeated bouts of influenza and why can we not be permanently immunized as we can be with smallpox, poliomyelitis or rubella vaccinations? The answer is that the influenza virus constantly changes the structure of its outer coat proteins so that they are no longer recognized by the specific antibodies present in our immune system.

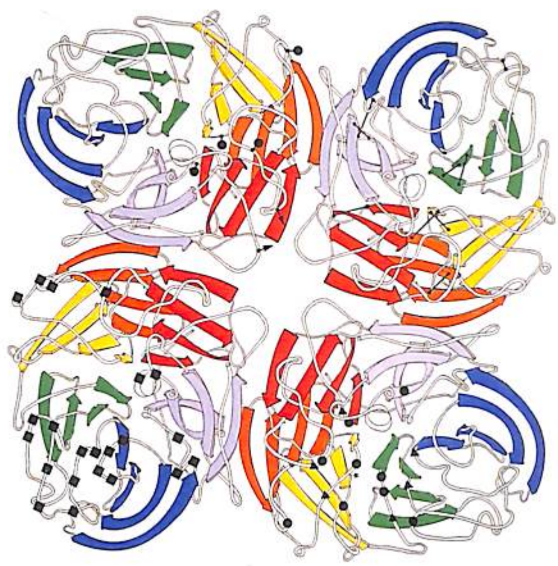
When new strains of the virus emerge, structural changes are found to have occurred in the coat proteins; these changes take place in both the haemagglutinin and neuraminidase molecules. The changes are too small to be seen under the electron microscope. In order to study these changes, a higher resolution image, presently only accessible via X-ray crystallography, is required. However, the image data obtained by X-ray crystallography are of little value without a detailed knowledge of the chemical structure of the protein.

In late 1978 the Division of Protein Chemistry commenced high resolution X-ray diffraction analysis of crystalline samples of neuraminidase from a strain of influenza prepared at the Australian National University, and by 1982 a high resolution image was available. This showed that parts of the structure of the neuraminidase are constant for all influenza strains.

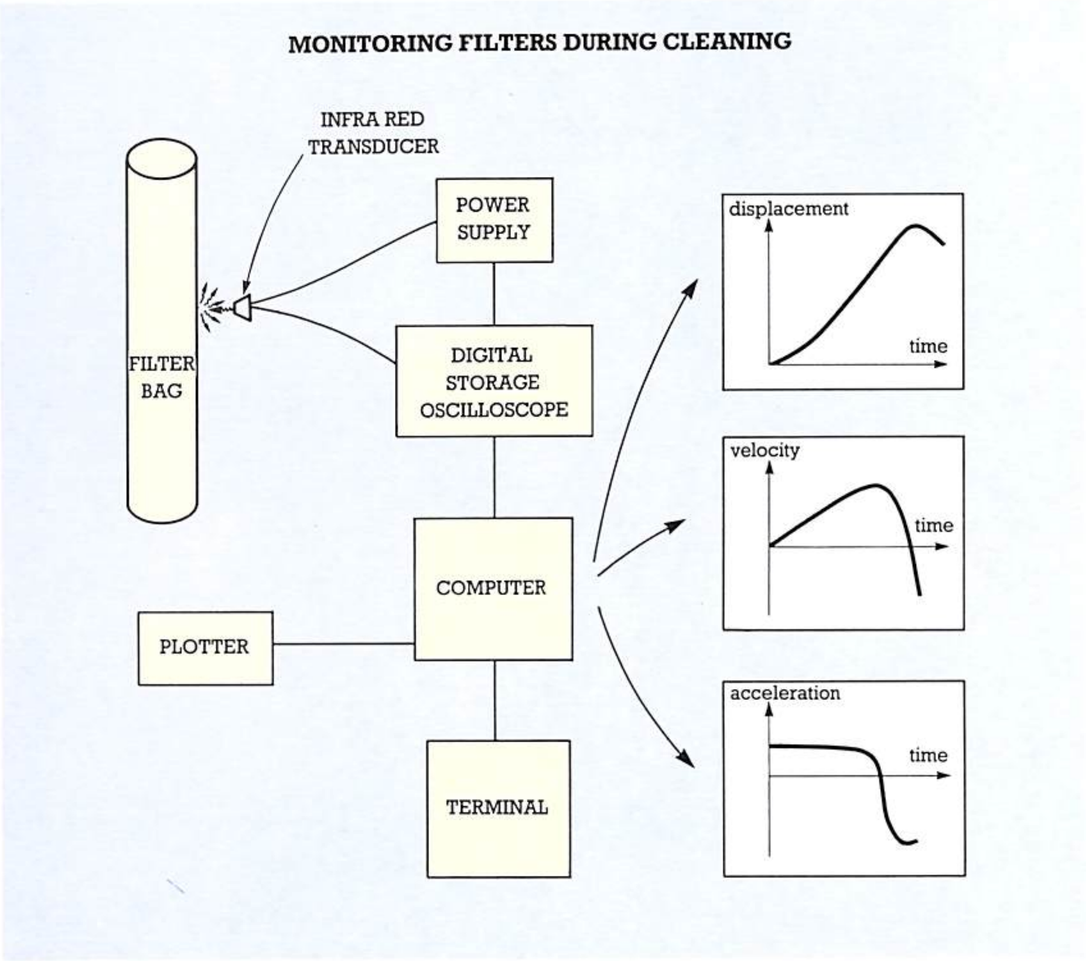
Since 1982, scientists at the Division have determined the amino acid sequence of neuraminidase from two different strains of virus. A number of other neuraminidases have been completely sequenced by other workers.

Studies of the amino acid sequence of the haemagglutinin component have been carried out in the Division simultaneously with the work on neuraminidase structure. The Division determined one of the first amino acid sequences of haemagglutinin. This data, together with amino acid sequences from different influenza haemagglutinins determined at the Division of Molecular Biology provided essential information for two important lines of investigation: mapping of the sequence changes in the haemagglutinins of different epidemic strains of virus, and interpretation of a three-dimensional image obtained at Harvard University. The results showed that the haemagglutinin proteins from each new strain of virus differed from those of the preceding strain by as few as one or two amino acid residues out of the total of 549. As new strains of virus appeared over a 10-year period, additional changes accumulated at new positions along the protein chain.

Overseas research indicates that it may now be possible to interfere with the critical functions of the haemagglutinin and the neuraminidase by designing small molecules to block the action of the haemagglutinin or the neuraminidase. Another aspect, which is also the target of investigation overseas, is how the haemagglutinin permits entry of the virus into the susceptible host cell. If the Australian and overseas work continues to bear fruit, the chances of reducing the costs of this disease should be high.



A diagram of the neuraminidase tetramer, showing different aspects of the structure on each subunit.



Removing Particulates from Gas Effluents

Fabric filters are used extensively for pollution control and product recovery in numerous industrial processes. They offer both economic and environmental benefits.

They are used in several Australian metallurgical industries, including lead, zinc, copper and aluminium smelting, and in the iron and steel industry. Also, smaller filters are used in manufacturing industry, particularly the food, chemical, and vehicle industries.

Because of their inherent high collection efficiency, they have replaced lower efficiency devices in a number of industries which need to comply with stricter emission standards.

Fabric filters can be cleaned by injecting a short pulse of compressed air into the filter bag. This rapidly accelerates the cloth causing the dust cake to be thrown off the outside of the bag. A non-contact method is being developed to measure the motion of the bag during the pulse. An infra-red beam is directed at the bag and the reflected radiation is sensed. The intensity of the reflected radiation is related to the distance between the bag and the emitter. Using a digital oscilloscope and computer, the very high acceleration of the bag which occurs in the first 10 milliseconds of the pulse can be measured and the dislodgement force applied to the dust cake can be calculated.

The most important new application of fabric filters is in the power generation industry. The Electricity Commission of New South Wales has installed the largest fabric filter in the world at its Eraring Power Station at a cost of $50 million. This filter contains 200 000 individual filter bags, each 5.5m × 165mm in size; such installations are known as baghouses. Fabric filters will also be used at the new Bayswater and Mount Piper power stations, and the Queensland Electricity Generating Board has recently introduced fabric filters at three of its power stations.

Australia has therefore a large commitment to fabric filters for fly ash collection from coal-fired boilers. The only other country, at present, with a similar commitment to fabric filters is the United States. However, because of the different coal burned and different boiler designs, the filters used there are different from those used in Australia, and information on U.S. filters is largely irrelevant to the Australian situation. Outside of the U.S. and Australia, only a handful of research establishments, mainly in Europe, devote resources to fabric filter research.

The use of fabric filters is not yet trouble free, and the Division of Textile Physics has been investigating the problems. One area of study is the various methods of cleaning the filters. To operate successfully, the dust deposit that accumulates on the fabric must be removed periodically. Inefficient cleaning results in a high pressure drop across the filter, which may limit flow through the filter which, in turn, will limit production of the process on which the filter is used. This situation is common in many industrial installations. Apparatus has been developed to measure the force with which the dust cake adheres to the fabric. In addition, a method is being developed to measure the very high accelerations (~100g) applied to the cloth during cleaning (see diagram). The aim of the work is to develop a mathematical model for the cleaning process which can be used to predict the pressure drop-flow relationship for a fabric filter. This will help process engineers to maximize production rates.

Another way of increasing the volume flow rate involves using electrostatic forces to change the permeability of the collected dust cake. This work is being conducted jointly with Mount Isa Mines Ltd. Initial work by the Division showed that, if the particles were charged by a corona discharge before entering the filter, there was a substantial decrease in resistance to flow. Later, Mount Isa Mines Ltd carried out large scale trials which showed that using the precharger could increase the capacity of the full-scale filter by at least 40%.

The Division is also using its textile production facilities to investigate the performance of new filter cloth structures. In collaboration with an industrial partner, work is underway to develop a seamless filter bag for the large fabric filters used in the power generation industry. Early experimental results suggest that the new filter material will lead to reduced pressure drops and the bags will be easier and cheaper to produce.

In the next decade it is likely that advanced design concepts using electrostatics, high performance fibres, and new cleaning technologies, will substantially improve filter performance and minimize the influence of the filter on the process.

12. Institute of Physical Sciences

Introduction

The philosophy of the Institute of Physical Sciences is to understand the science underlying important phenomena and processes, for it is only through a basic understanding that long-term progress can be made. At the same time, a great deal can be done on the basis of existing knowledge to solve particular industrial or community problems or to produce new techniques or products. The Institute tries to maintain this dual role at all times.

The research spans a range of scales from observation of the structure of galaxies to calculation and measurement of the structure and properties of molecules, and a range of applications from analysis of the statistical properties of radio signals to measurement of the rate of wear of railway tracks. Also, it includes important environmental work in atmospheric science and in oceanography.

Several important landmarks were reached during the year. The Division of Computing Research commissioned the new Cyber 205 supercomputer which will make available to Australian scientists, outside as well as within CSIRO, computing power for complex problems equal to that found anywhere in the world. The VLSI project of the same Division also met its assigned objective of designing and bringing to practical reality a silicon chip with 100 000 transistors. The new techniques developed in this study will form the basis of a new Australian high-technology industry.

Construction of two important national facilities also began during the year: the Australia Telescope of the Division of Radiophysics and the oceanographic research vessel being built for the Division of Oceanography. The ship will be completed by the beginning of 1985 but construction of the telescope will continue until 1988.

The Division of Applied Physics has strengthened its direct relations with industry through projects sponsored under the Applied Physics Industrial Program. Both that Division and the Division of Chemical Physics have developed several novel scientific instruments for manufacture by local industry.

Work is continuing with the development of the tough ceramic, PSZ, in collaboration with the industrial consortium Nilcra and, in collaboration with the Institute of Energy and Earth Resources, novel plasma processing techniques are being developed for refining Australian zircon and other minerals.

In the following pages we give more detailed attention to a small selection of these projects, chosen for their diversity and general interest as well as for their practical importance.

Clouds, Climate and Atmospheric Constituents

Clouds are the most variable and one of the most important aspects of weather. Their abundance or absence may signal floods or droughts, while daily fluctuations modulate the steady march of seasonal temperature changes.

Forecasting details of the daily weather is the major task of the Bureau of Meteorology, while CSIRO scientists investigate the physics and chemistry of atmospheric processes with the aim of understanding basic principles and applying them to solving problems for the benefit of the Australian community. The research extends from the study of long-term climate changes through meso-scale phenomena such as cold fronts and the dispersal of pollutants to small-scale phenomena in individual clouds.

The atmosphere is a complex system whose motions are driven by the radiant energy of the sun which is partly absorbed, partly reflected and partly transmitted by the clouds, the earth's surface, and the gases and tiny particles in the atmosphere itself. The heating and cooling of different parts of the atmosphere causes convective motion which interacts with the rotational motion of the earth to create winds, travelling high and low pressure regions, cloud bands and all the phenomena that make up the weather.

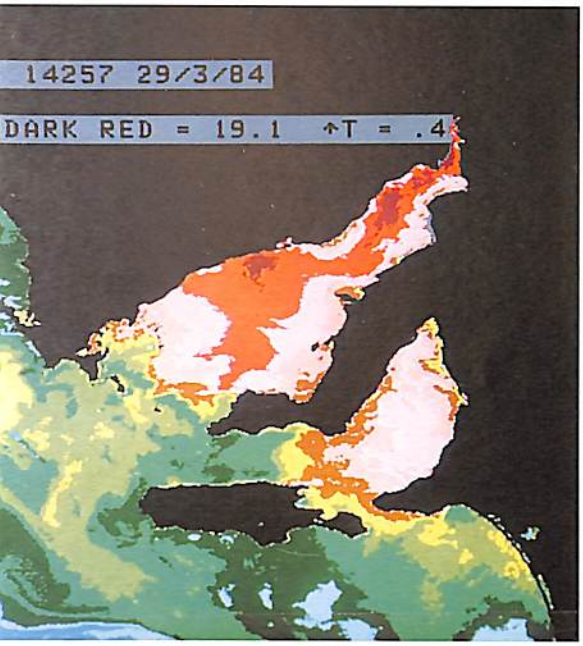
Of particular importance, therefore, is the interaction between radiation and clouds. A dense cloud cover reflects sunlight away from the earth, causing cooling, but at the same time it prevents the escape of long-wavelength infrared radiation from the surface. The balance between these two effects depends on the extent of the cloud cover, the cloud thickness and the cloud-top temperature or cloud-top altitude, and any real understanding must involve knowledge of these quantities over a large part of the earth's surface.

This requirement has led the Division of Atmospheric Research to develop the CSIRO System for Interactive Data Analysis (CSIDA) which gathers information from the geostationary meteorological satellite (GMS-3) positioned north of West Irian and from the polar orbiting meteorological satellites NOAA6 and NOAA7.

After computer processing, the images yield a mass of detailed information on cloud structure, land surface characteristics and sea surface temperatures. The operator can vary the display to pick out clouds of particular types or to display colour contours of sea temperature or other important variables. Sections of these images can then be processed to yield more detailed information. Because understanding climate is of both national and international interest, the Division is cooperating in the International Satellite Cloud Climatology Program (ISCCP) which aims to record the cloud cover of the entire earth continuously for five years as an essential preliminary to any detailed understanding of climate change.

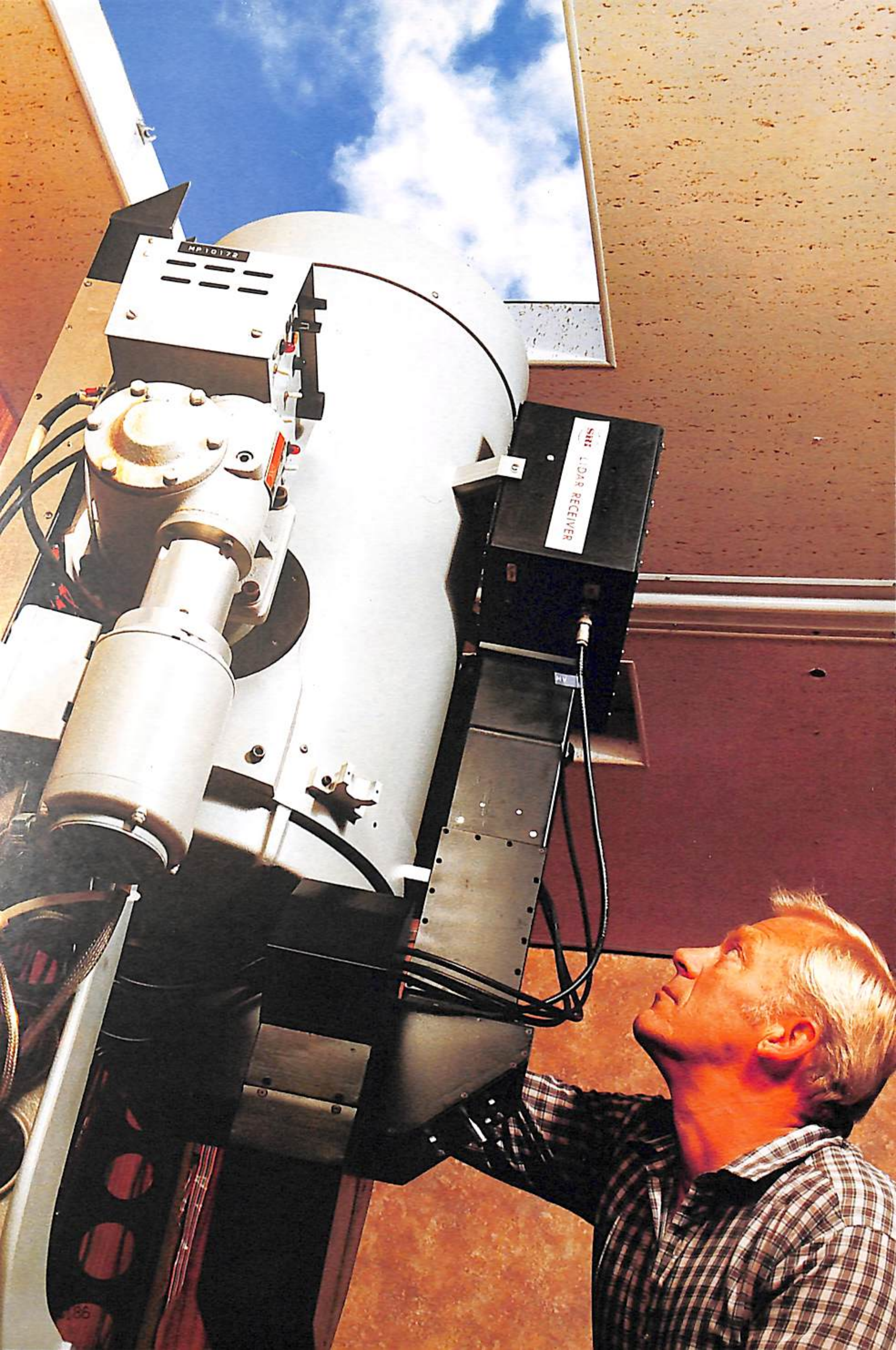
While making use of satellites which probe the atmosphere from above, the Division has also developed a high-powered laser radar (lidar) to probe it from below. A ruby laser transmits a short pulse of red light vertically into the sky, and a sensitive light detector records the light reflected as the beam passes upwards through clouds or dust layers. So powerful is the pulse and so sensitive the detector that the lidar can penetrate clouds as much as five kilometres in depth, providing detailed information about their light-scattering properties, and hence their impact on the earth's radiation budget.

To allow observations within and around clouds and cloud fields, the Division also makes radiation measurements from an aircraft. These provide



Satellite infrared radiometer readings of the Earth's atmosphere and oceans can be processed by the CSIDA facility to give sea surface temperature maps. Such information is relevant to a variety of users, such as environment protection authorites (the different temperature of effluent over surrounding water gives it away), the fishing industry (fish tend to congregate where cold and warm currents meet), and the Royal Australian Navy (naval submarine transport and communications require detailed knowledge of the currents off the Australian coast). The image shown here for the Spencer Gulf area near Adelaide shows temperature gradations from 14·7°C (deep blue) to 19·1°C (dark red) with increments of 0·4°C.

Tasmania on a clear day, as seen by the polar orbiting meteorological satellite, NOAA7, after image processing by the CSIDA facility.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LIDAR RECEIVER

information about the way in which such clouds interact with sunlight and allow the predictions of mathematical models formulated in the laboratory to be tested.

Experimental data collection is, however, only one part of the problem. The aim of the research is to be able to understand and predict future behaviour, and to do this theories must be devised and tested, and complex mathematical models set to run on large computers. These parts of the work are also carried out in the Division of Atmospheric Research, including the continuation of some aspects of the research previously done by the Australian Numerical Meteorology Research Centre (ANMRC). Among the problems being studied are the general dynamics of the atmosphere, the importance of clouds as a feedback mechanism, and the influence of the interaction between sea surface temperature and atmospheric motion and cloud cover. It will not be a quick or easy task to unravel these complex couplings, even with the power of a computer such as the Cyber 205, but the importance for the Australian community of achieving some measure of knowledge about the more drastic fluctuations that affect our climate can hardly be overestimated.

On a much longer time scale, scientists have become aware that the composition of the atmosphere itself is changing, largely because of human activities. The burning of fossil fuels is increasing the levels of carbon dioxide and particulate material, widespread use of halocarbons (as foaming agents, refrigerants, aerosol propellants and degreasing solvents) has led to contamination of the atmosphere by gases such as Freon-11 (CCl_3F) and Freon-12 (CCl_2F_2), and even methane levels are increasing due to man's industrial and agricultural activities.

The levels of these atmospheric constituents have probably not yet risen high enough to have a significant effect on climate through their influence on the absorption of radiation by the atmosphere, but it is clear that their continued increase might well lead to this situation. It is therefore vital to know the past and current background levels of such significant materials in the atmosphere and to monitor closely any change in their concentrations.

Mr Gauntis Grauze, of the Division of Atmospheric Research, aligning the LIDAR (laser radar). A laser pulse is fired into the atmosphere, and the light scattered by cloud droplets and aerosols is collected. This remote sensing technique provides valuable information on cloud properties and particulates in the atmosphere.

Australia is extremely well placed geographically for the measurement of such baseline values in air unpolluted by local industry or human habitation. CSIRO scientists have therefore taken a leading role in developing, over the past 13 years, the concept and reality of the Australian Baseline Air Pollution Station at Cape Grim on the northwest tip of Tasmania. This station, which is one of a network operated by several nations as part of a program coordinated by the World Meteorological Organization, is now operated by the Bureau of Meteorology with CSIRO providing most of the lead scientists for the research programs.

In the case of the halocarbons, the Cape Grim measurements show that, while atmospheric concentrations are currently rising at a rate of five percent each year, the rate of increase is slowing down as might be anticipated from reduced use of such compounds. To predict future trends accurately however, we must know the mechanisms by which these materials are slowly removed from the atmosphere and the rate at which this occurs. In the case of Freon-11, the Cape Grim measurements, which are the longest and most detailed continuous record available, show that its lifetime in the atmosphere is approximately 50 years, so that the effects of past and current halocarbon releases may be felt for a considerable time in the future.

The interchange of gases, such as carbon dioxide (CO_2), with the surface of the earth is important both for its global balance and because it is an important input to processes such as photosynthesis in plants and the growth of corals and shells in the ocean. The detailed mechanism of this interchange is very complicated because atmospheric components are transported by turbulent diffusion in the atmosphere near the earth's surface. An understanding of this turbulent transport is therefore important in relation to the growth of plants, from forests down to crops and pastures.

Work on these aspects of the atmospheric boundary layer is carried out in the Division of Environmental Mechanics, where the techniques of mathematical analysis, wind-tunnel measurements and carefully designed field experiments are all brought to bear on the problem. New methods for measuring the flux of CO_2 rely on a process called eddy correlation which averages out the continual fluctuations in flow caused by the turbulence. Even with this sophisticated technique the problems are formidable since the simultaneous eddy transport of heat and water vapour can produce large fluctuations in air density and this has to be allowed for to obtain reliable results.

Similar problems apply to the absorption of CO_2 at the sea surface, but there is a further complication on the liquid side of the interface where the CO_2 must somehow be transported away into the bulk of the deep ocean. Published estimates of this 'surface resistance' differ by as much as a factor of 60 and, since a knowledge of the correct value is of great importance to understanding the global balance of CO_2, the Division is involved in a program to determine a reliable value.

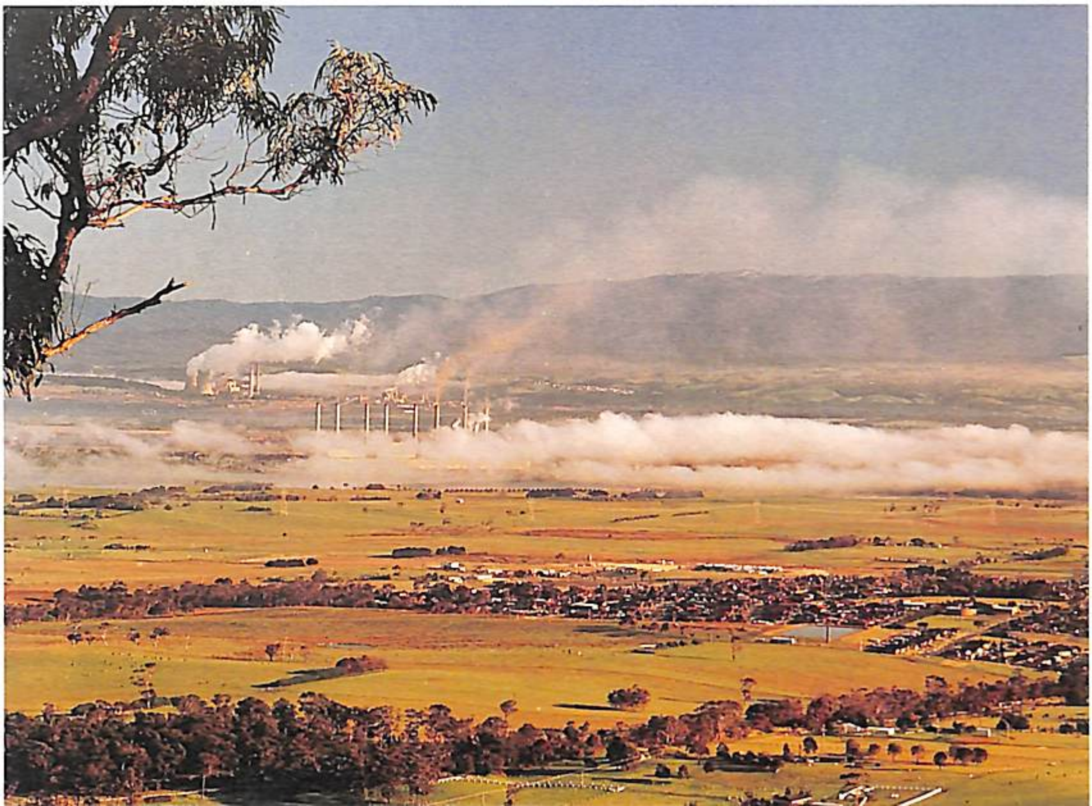
The Division of Atmospheric Research is also concerned with clouds, gases and atmospheric particulates at the mesoscale level where, instead of being global, the region studied is hundreds of kilometres in extent. Typical of this work is the Cold Fronts Research Program which began in 1981 and which will have its third and final observational phase in November 1984. This program brings together scientists from CSIRO, the Bureau of Meteorology and Flinders, Monash and Melbourne Universities in a cooperative research effort designed to gain a better physical understanding of the properties and motion of the cold fronts which are such an important feature of the weather in the southern part of Australia.

In addition to a network of surface meteorological instruments, the program uses the CSIRO research aircraft and the RAAF for aerial data gathering with a CSIRO oceanographic vessel and the RAN assisting with observations at sea. It is hoped that the detailed understanding gained as a result of this program will advance the science of meteorology and lead to increased accuracy in forecasting the motion of these fronts and their effect upon local weather.

In a similar way, the Division of Atmospheric Research is involved with extensive mesoscale studies of the motion of both gaseous and particulate pollution products in the vicinity of their sources. Field studies are carried out in Victoria's La Trobe valley where much of the State's coal-fired electrical generating plant is located. In order to be able to predict the direction of flow of smoke plumes and the rate at which they disperse, it is necessary to carry out detailed studies of the pattern of air flow in the

The Division of Atmospheric Research contributes to collaborative research efforts which concern the study of winds and air pollution in industrial regions. Such studies are necessary for gauging the effect of industry on local air quality and are essential for planning and design purposes.

The photograph shows power stations in the La Trobe Valley, Vic. It illustrates how the chimney height and buoyant plume rise allow the power station emissions to disperse above the stable air layer marked by the fog near the ground.



valley and its surroundings, and to examine the stability of the overlying atmosphere. Such detailed knowledge assists in allowing future power stations or other pollution sources to be located in positions where their effluxes will cause the least problems.

Other Divisions in CSIRO undertake related studies. The Division of Fossil Fuels is particularly concerned with the chemical processes taking place within an industrial smoke plume as it meanders away from its source, mixing with the surrounding air and being acted upon by solar radiation. The prime field laboratory for this work is the smoke released by the refinery at Mount Isa, the plume of which has been traced, using the CSIRO research aircraft, as far as the coastline of Western Australia. The Division of Environmental Mechanics is also concerned with the behaviour of smoke plumes in the near vicinity of chimneys where they can be influenced by buoyancy and the turbulent components of local flow. All these studies help in the long term to understand and minimize the pollution problems caused by those effluxes from industrial activities that cannot be removed or controlled at their source.

Applied Physics Industrial Program

In a major effort to increase collaboration with Australian industry, the Division of Applied Physics initiated its Applied Physics Industrial Program. The Program was designed to foster research and development in new technology that would be of immediate relevance to industry but was not available from existing consultants. The aim was to establish a number of collaborative projects with industrial partners, making use of the unique facilities and scientific expertise in the Division.

The Program was advertized nationally and a wide range of project proposals was received. The proposals were assessed by the Division for their scientific relevance and by a Program Committee, half of whom were prominent industrialists, for their commercial viability.

Ten projects were initially selected in February 1984. These included:

- The ultrasonic measurement of eccentricity and wall thickness of copper tubes, in collaboration with Metal Manufactures. The laboratory stage of this project was completed in six months, and a prototype device based on an array of three multiplexed tranducers is being tested under factory conditions.
- Development of portable equipment for geometric measurement of large gears, with a number of industrial collaborators in New South Wales, Victoria and Queensland. This is a three-year project and is progressing on schedule.

Other projects involved the development of a precision electronic voltage standard in conjunction with Statronics Power Supplies, and work on applications of infrared reflectance measurements with BHP.

The successful projects were announced by the Minister for Science and Technology, the Honourable Mr Barry O. Jones, M.P., at an open day in the Division in April 1984.

In June of this year, a further four projects were selected, including:

- Development of ion-assisted deposition processes for optical thin-films, in collaboration with A. G. Thompson and Co. of Adelaide. This project is aimed at overcoming porosity problems in optical thin-film coatings.
- Design and development of a precision power amplifier in collaboration with Paton Electrical Pty Ltd. The amplifier will be of particular value to testing laboratories and instrument manufacturers.

The Program has been well received by Australian industry, and the Division is now receiving far more project applications than it has the resources to undertake. Its appeal arises from two main features. Firstly, it provides industry with the established research and development facilities of the Division. This overcomes the very large capital cost and time-lag that would result if industry attempted to duplicate these facilities. Secondly, the Program Committee assesses the scientific credibility and commercial viability of all projects.

The Division views itself as a major national facility for applied physics research in Australia and it is satisfying that, as a result of the Program, the Division now has collaborative projects operating in all States of mainland Australia.

Advanced Materials

The development and use of new and improved materials can contribute greatly to the success of new products and processes, so the Institute is mounting an effort in a number of areas in the field of advanced materials. Work on ceramics, particularly partially stabilized zirconia (PSZ), polymers, metallic glasses and catalysts, described in last year's annual report, is continuing. Nilsen Sintered Products (Aust.) Pty Ltd and CRA, with CSIRO agreement, have formed a company, Nilcra, to further commercialize PSZ. In order to encourage the development of an integrated industry based on Australian beach sands, the Organization is paying considerable attention to new zirconia production methods, including plasma processing.

One application of zirconia ceramics, different from those envisaged for PSZ, is as a sensor of oxygen. These sensors are used for controlling the fuel-to-air ratio in combustion, measuring the amount of oxygen in molten metals, and monitoring the atmosphere in metallurgical processes. Until recently these sensors were inaccurate below 600°C but research has now extended the accurate operating range to 350°C, opening up new uses for the sensors.

With the growing interest in ceramic materials, a technique called reaction bonding, developed by scientists at the Division of Chemical Physics and Flinders University, is becoming increasingly important. Reaction bonding is a method of bonding metals to ceramic oxides and can be used to form strong, hermetic seals between a wide variety of these materials. Prior to the development of reaction bonding, the only way of joining a ceramic to a metal was by brazing after the ceramic had been metallized.

Reaction bonding is a direct solid state process discovered fortuitously when scientists were investigating a magnesium oxide crystal at high temperatures on a palladium grid in an electron microscope. Well below the melting point of either material, tentacles of the metal were seen to become fluid and to be absorbed by the crystal.

Bonding is brought about by applying sufficient heat and pressure to ensure good contact between the materials to be bonded. The technique can be carried out in air or in inert gas atmospheres to prevent oxidation. It can also be employed to join two ceramics by using an intermediary metal layer. The bonds are strong and maintain their strength at high temperatures. The technique is used in the oxygen sensors mentioned previously and also for bonding a platinum window to the ceramic sheath of thermocouples for temperature measurement in harsh industrial environments. As ceramics find more and more applications, reaction bonding will doubtless become increasingly important.

Administration

The CSIRO Executive (top photograph)

Standing, left to right

Dr. Geoff Taylor, Justice Michael Kirby, Mr Graham Spurling, Mr Bails Myer, Mr David Wright, Professor David Craig.

Seated left to right

Dr Keith Boardman, Dr Paul Wild

13. Management

CSIRO is governed by an Executive of three full-time members and five part-time members. The latter are drawn from primary, secondary and tertiary industries, and from the tertiary education sector. The Chairman, who must be a full-time member, is ex officio the chief executive of the Organization, responsible to the Executive for its day-to-day operation.

The Executive is primarily concerned with:

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

The Executive is supported by a Management Committee comprising the three full-time members of the Executive and the Directors of the Institutes and the Bureau of Scientific Services, the Executive Secretary, the Secretary (Finance and Administration), and the Secretary (Personnel).

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

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

The Bureau of Scientific Services provides information, publication and communication services to the Organization and assists with international cooperation in research.

The Planning and Evaluation Advisory Unit provides advice to the Executive in the development of priorities for the conduct of research.

Policy and administrative support services are provided to members of the Executive and Directors by the Organization's central administration as follows:

- by an Office of the Executive, in respect of broad policy formulation and organizational coordination and development;
- by a Finance and Administration Branch, in respect of the CSIRO budget, accounting and supply systems, works, buildings and property management services, administrative systems development, Regional Administrative Offices, physical security, archives, Freedom of Information and general administrative services;
- by a Personnel Branch, in respect of personnel, industrial relations, pay and conditions, and occupational safety and health policies.

The objectives and fields of research of Institutes, Divisions and Units are described in a publication entitled 'Directory of CSIRO Research Programs 1984'.

Administrative Reviews

Administrative Arrangements

In June 1982 the Executive established a committee to review CSIRO's administrative arrangements and advise on an Organization-wide administrative plan for the future.

Following an investigation of the work of the administrative sector and consultation throughout the Organization, the committee submitted its report to the Executive in February 1984. The report, which included 79 recommendations, recognized a need to modernize the Organization's administrative systems to cope with the changing environment in which it operates. The report also embraced a parallel requirement faced by CSIRO of changing its accounting system to an accrual based one. In reaching its conclusions, the committee took into consideration cost effectiveness, management information needs, staffing concerns and resource requirements.

Following wide distribution of the report, the Executive sought the assistance of an interim planning committee in considering the comments received. The Executive endorsed the report in principle and approved the recommendations as guidelines for implementation. Also, it established a committee to oversee the development of an enhanced administrative system, the introduction of which will probably take several years.

Library and Information Services

Following consideration by the Executive of the report of the committee established to review CSIRO Library and Information Services, an American consultant, Mr Herbert Landau, was engaged to:

- advise on the detail and implementation of Executive decisions on organizational structure, functions and objectives of CSIRO Information and Library Services; and
- prepare draft advertisements and selection guidelines for senior positions.

The consultant was also asked to comment on:

- the relationship between Divisional and central functions and responsibilities;
- the place of computerized library management systems and information services; and
- the likely effects of advances in technology.

The consultant's report has been finalized and distributed. Comments on the report and on an accompanying discussion paper are being sought.

Commercial Activities

As recorded in the CSIRO Annual Report 1982/83, a review of CSIRO's commercial activities was established in April 1982 to examine CSIRO's policies, procedures and administrative arrangements for technology transfer, especially the use of collaborative arrangements, property rights and corporation powers for this purpose. The Executive's response to the review committee's report is presented in Chapter 3.

Archives

As recorded in the CSIRO Annual Report 1982/83, a committee was appointed to review the Organization's archives. The committee submitted its report to the Executive in August 1983.

The Executive endorsed the committee's main recommendations of retaining an in-house CSIRO Archives and of developing the Archives as a central service agency with record management responsibilities. Also, the Executive agreed to issue a comprehensive statement of CSIRO's archiving policy and procedures.

Strategic Research Planning Activities

The Executive has instituted a public review of CSIRO's strategic research planning activities. This follows five years' experience with the development of strategic planning in the Organization. The review is being conducted by a seven-man committee chaired by Dr N.K. Boardman, Member of the Executive. It includes members nominated by the CSIRO Advisory Council and ASTEC, and other members providing special expertise in science policy, corporate planning and research management. The committee has circulated a discussion paper setting out its preliminary conclusions, and expects to report to the Executive early in 1984/85.

Office of the Executive

In August 1983 a decision was taken to review the functions and structure of the Office of the Executive, one of the three Headquarters support groups for the Executive. Submissions were sought from Divisions in October and the review committee commenced discussions and interviews in February 1984. Its report is expected to be presented to the Executive early in 1985.

Bureau of Scientific Services

On 3 October 1983 the Executive agreed to the establishment of a committee of the Executive comprising Dr G.H. Taylor (Chairman), Dr N.K. Boardman and Mr Justice Kirby to review the Bureau of Scientific Services.

The committee's terms of reference are:

- Against the background of Executive statements of policies and priorities, recent reviews of centres, units and groups within the Bureau, and other relevant reviews and activities within the Organization, to assess the Bureau's overall structure, objectives and balance of activities.
- On the basis of this assessment, to propose any changes in the objectives and structure for the Bureau for the next five to seven years.

A discussion paper has been circulated for comment prior to the development of recommendations to the Executive. The Executive is expected to make decisions on the recommendations late in 1984.

External Communication Activities

The Executive has commissioned a review of CSIRO's external communication activities. The review committee will examine and recommend policies for CSIRO's communication needs with particular reference to industry, technical and professional audiences, identifiable community groups and the general public.

In conducting the review, the committee will take into account the relevant sections of previous communication studies and other related reviews. The committee will also comment on the quality of the Organization's external communication activities and advise on the nature and optimum distribution of communication effort and resources.

Senior Management Conference

Full-time members of the Executive, Directors and Secretaries examined a range of management issues at a 2½-day conference held at Bowral, NSW, in March. The issues included:

- ways of developing broad strategies for CSIRO, particularly in new areas;
- resource planning at Institute level;
- clarification of management roles; and
- internal communication.

The respective roles of individuals and groupings in the Organization's top structure are receiving more detailed consideration as an outcome of the conference.

Executive and Staff Changes

Executive Changes

Mr H.M. Morgan, a part-time member of the Executive, resigned his appointment with effect from 31 July 1983.

The Hon. Mr Justice M.D. Kirby, CMG, was appointed a part-time member of the Executive for a period of three years commencing 11 August 1983, following the resignation of Mr Morgan.

Senior Staff Changes

Professor M.G. Pitman, OBE, FAA, Professor of Biological Sciences (Plant Physiology) at the University of Sydney, NSW, was appointed Director of the Institute of Biological Resources for a period of five years from 23 September 1983. He succeeded Mr M.V. Tracey, AO, FTS, who retired on 26 August 1983.

Dr A.F. Reid, FAA, formerly Chief of the Division of Mineral Engineering, was appointed Director, Institute of Energy and Earth Resources for a period of five years from 24 May 1984. Dr Reid had been Acting Director of the Institute since 9 December 1983, replacing Mr I.E. Newnham, AO, MBE, FTS, who is on sick leave prior to his invalidity retirement.

Mr W.A. Snowdon, Assistant Chief of the Division of Animal Health and Officer-in-Charge of the Australian National Animal Health Laboratory (ANAHL) was appointed Officer-in-Charge of ANAHL from 1 July 1983 until November 1984, following its establishment as an independant Unit.

Dr A.D. Donald was appointed Chief of the Division of Animal Health for a period of seven years from 15 July 1983. He replaced Dr A.K. Lascelles who retired as Chief of the Division on 31 December 1982. Dr Donald had been Acting Chief of the Division from 1 January 1983.

Dr G.W. Grigg, Officer-in-Charge, Molecular and Cellular Biology Unit, was appointed Chief of the Division of Molecular Biology from 11 August 1983, for a term of five years following the raising of the Unit to Divisional status.

Dr D.R. Hudson, Senior Principal Research Scientist in the Division of Mineralogy, was appointed Acting Chief of the Division from 4 October 1983, following the retirement of Mr A.J. Gaskin.

Dr R.D.B. Fraser, Chief Research Scientist in the Division of Protein Chemistry, was appointed Acting Chief of the Division of Protein Chemistry from 15 November 1983 following the retirement of the Chief, Dr W.G. Crewther.

Dr R.J. Batterham, Chief Research Scientist in the Division of Mineral Engineering, was appointed Acting Chief of the Division from 1 January 1984, following Dr A.F. Reid's appointment to the Institute of Energy and Earth Resources.

Dr E.G. Bendit Officer-in-Charge of the Physical Technology Unit, was appointed Chief of the Division of Fossil Fuels from 1 January 1984 until 21November 1985. He replaced Professor A.V. Bradshaw who completed his term as Chief of the Division of Fossil Fuels on 31 December 1983. The Physical Technology Unit was incorporated into the Division of Fossil Fuels from 1 January 1984.

Dr K.J. Whitely, Senior Principal Research Scientist in the Division of Textile Physics, was appointed Chief of the Division for a period of seven years from 1 June 1984. He succeeded Dr A.R. Haly who retired on 1 June 1984.

Dr A.D. Wilson, Chief Research Scientist in the Division of Wildlife and Rangelands Research was appointed Acting Chief of the Division from 18 July 1984, following Dr C.J. Krebs' absence on extended leave and subsequent resignation.

Freedom of Information

Requests Made to CSIRO Between 1 July 1983 and 30 June 1984

CSIRO had 39 requests and helped other agencies with some of their requests. Requests were handled as follows:

• access granted in full	13
• access granted in part or with deletions	16
• access refused	1
• transferred to other agencies	1
• request withdrawn	1
• awaiting decision	7

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

• 0–15 days	8
• 16–30 days	3
• 31–45 days	7
• 46–60 days	11
• over 60 days	1

Nineteen requests related to personal documents, with a further two made by third parties. Others related to a variety of research matters of which only one, herbicides, attracted multiple inquiries (three).

Handling of Rejections

Two complaints involving action by the Ombudsman were satisfactorily resolved. There were no cases before the Administrative Appeals Tribunal.

Costs of Freedom of Information

Fees received were $102 from sale of manuals and $45 from access charges. Total manpower costs were $75 000, and other costs for communication, travel and copying were about $3000.

Internal Procedures

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

Staff Training and Development

Eight officers attended FOI seminars and forums conducted by the Attorney-General's Department and Public Service Board. The Department of Prime Minister and Cabinet's FOI training film was shown to Trainee Administrative Officers.

14. Personnel

Equal Employment Opportunity

An inquiry into the status of women in CSIRO, undertaken by a sub-committee of the Consultative Council, has been completed. The inquiry found weaknesses in CSIRO policies and attitudes towards the employment of women in the Organization and made 49 recommendations for change. The Executive, in accepting all of these recommendations, endorsed a strategy for implementing full equal employment opportunity principles. The key aspects of the strategy are:

(i) declaration by the Executive of CSIRO's status as an equal opportunity employer;

(ii) full integration of equal employment opportunity principles in advertising, recruitment and promotion practices;

(iii) identification of women for appointment to policy and review committees;

(iv) upgrading of training courses on selection principles and techniques to emphasize equal employment opportunity principles;

(v) introduction of special retraining programs to enable female former officers to re-enter employment with CSIRO;

(vi) setting aside of a fixed proportion of apprenticeships for women, and provision of active assistance to successful female apprentices in seeking trades positions in CSIRO; and

(vii) establishment of an equal employment opportunity sub-committee of the Consultative Council to investigate and report on:
- the impact of equal employment opportunity and anti-discrimination legislation on CSIRO's personnel practices
- an affirmative plan of action
- dissemination of the equal employment opportunity policy
- evaluation of equal employment opportunity statistical data
- equal employment opportunity training programs
- part-time work and job sharing
- child-minding facilities.

The Secretary (Personnel) has been appointed Equal Employment Opportunity Coordinator to oversee the development of the Organization's policy and initiatives in this area. An Equal Employment Opportunity Officer has also been appointed. The role of this officer encompasses the implementation of the Organization's strategy and monitoring its level of effectiveness. The officer is also the focal point of a network of equal employment opportunity contact persons in each research Division, whose role is to counsel and inform staff on equal employment opportunity principles.

While the main thrust of the equal employment opportunity strategy deals with problems facing women in CSIRO, the Executive is equally committed to removing both conscious and unwitting discrimination against other groups. Therefore, the Equal Employment Opportunity Officer will also have a key role in identifying, and recommending strategies for eliminating discrimination on the basis of such factors as race, colour, religion, political opinion, social or ethnic origin, and physical disability.

Working in her first job since leaving school, 17-year-old Elizabeth Griffin is a trainee at the Pastoral Research Laboratory, Armidale, NSW. She is learning clerical skills in the Laboratory's library.

Occupational Health and Safety

The committee reviewing CSIRO's occupational health and safety presented its findings to the Executive in October 1983. In response to inadequacies in CSIRO's performance, the Committee recommended a planned and goal-directed occupational safety and health program. It recommended that the program should be accompanied by a revitalized policy, a clear and personal commitment to the achievement of policy objectives extending from the Executive downwards, and adequate staff and funding support.

The Executive endorsed the committee's findings and allocated staffing and financial resources for achieving change.

The reforms are being spearheaded by a small Occupational Health and Safety Unit. Advice on policy and programs in the fields of occupational medicine, occupational hygiene, ergonomics and safety engineering is being provided by the Unit to all groups in CSIRO. Mr G.E. Knobel was appointed Manager (Occupational Health and Safety) in the Personnel Branch from 16 March 1984.

Increased emphasis has been placed on employee participation in occupational health and safety matters. This is in line with current government initiatives. A strengthened central CSIRO Health and Safety Committee of staff association and management representatives meets on a regular basis to overview developments and performance. Upgraded occupational health and safety committees have been established at most CSIRO work sites around Australia and full staff participation is being encouraged.

During the year there has been increased concern among staff at several locations, notably Floreat Park, WA, over the possible harmful effects of long-term exposure to low levels of chemicals. In response to these concerns, arrangements were made for health surveys of workers and occupational hygiene surveys of relevant work sites. As a result, work has commenced on improving ventilation and chemical storage facilities in laboratories. A consultant specialist neurologist will investigate the possibility of solvent-induced peripheral neuropathy at Floreat Park. Staff associations have been fully involved in these matters.

To assist management in monitoring accident and occupational disease occurrences and to allow the prediction of trends, an ADP-based record system is being developed in consultation with the Department of Employment and Industrial Relations. The system will also monitor the cost of accidents to assist in improved control of compensation and litigation costs.

The establishment of a National Occupational Health and Safety Commission will complement CSIRO's efforts to meet its important objective of providing healthy and safe working conditions for all staff.

Review of Laboratory Craftsmen

The Executive has considered the report of the committee reviewing various aspects of the employment of laboratory craftsmen in the Organization. CSIRO employs about 440 laboratory craftsmen; these are highly skilled trades staff who participate in the design, fabrication and maintenance of specialized items of equipment and plant used for scientific research.

The review committee included management and laboratory craftsmen representatives. It examined recruitment, promotion, remuneration, conditions of employment, status and morale, and arrangements for workshop services in the Organization. The committee consulted widely within CSIRO, with other areas of Commonwealth employment where comparable staff are employed, with private employers, and with staff organizations.

Elizabeth Fowle (apprentice technician) with the power supply unit for the CSIRO Parkes Telescope's new Q band (42 to 50 GHz) receiver. The unit was built by Elizabeth to specifications provided by Graham Gay (senior technical officer).

The review committee's main conclusions were that:

- the specialized skills of CSIRO laboratory craftsmen are of a very high order and among the most varied and advanced craftsman skills to be found in Australia;
- laboratory craftsman recruits should be appointed at base levels in the salary structure, but should have their job performance critically monitored, and be given accelerated salary advancement if this is warranted by performance;
- enhanced promotional opportunities should be available to the best laboratory craftsmen and all laboratory craftsman promotions should be very closely monitored;
- the criteria for promotion should be reviewed and refined;
- the relative roles of laboratory craftsmen and technical staff in the provision of engineering and workshop services should be more closely defined, then documented and published;
- the regionalization of workshop services should be explored and arrangements made to further facilitate the internal transfer and wider availability of CSIRO's specialized engineering expertise;
- laboratory craftsmen should be more closely integrated into the teams of staff involved in the Organization's experimental work; and
- laboratory craftsmen should be encouraged to further develop their specialized skills and supervisory abilities by means of formal study and staff development programs.

A number of the committee's recommendations are being put into effect, while others have been passed to joint management/staff organization implementation committees for further examination.

Community Employment Program

CSIRO currently employs 150 people under the Commonwealth Community Employment Program (CEP). 120 of these people are employed as technicians while the remaining 30 are animal attendants and farm assistants. Each trainee is employed for 52 weeks. A total of 49 positions are in New South Wales, 43 in Victoria, 18 in Queensland, 10 in South Australia, 10 in Western Australia, 3 in Tasmania, 13 in the Australian Capital Territory and 4 in the Northern Territory. Details of people employed in the various target groups of women, migrants, disabled persons and Aborigines are shown in Table 6.

Table 6 Staff Engaged by CSIRO Under the Commonwealth Community Employment Program at 30 April 1984

	Male	Female	Migrant		Disabled		Aboriginal	
			Male	Female	Male	Female	Male	Female
Technical Assistants								
Junior	4	15	–	2	1	2	–	–
Grade 1	27	27	3	4	–	2	1	–
Grade 2	12	13	1	2	–	–	–	–
Technical Officer	3	1	–	–	–	–	–	–
Animal Attendant	3	1	–	–	–	–	8	–
Farm Assistant	13	–	3	–	–	–	2	–

Total Staff Employed = 150

Specific training programs aimed at a high skills transfer to future employment were prepared for each of the jobs. None of the training programs includes essential duties of an on-going nature. The actual duties of the trainees vary between laboratories and locations but the major skills to be acquired are:

- use of laboratory equipment, knowledge of analytical and sampling procedures and preparation of materials;
- training in application of microcomputers, with broad-based experience of scientific electronic equipment;
- care and maintenance of animals and animal husbandry; and
- farm management techniques.

The scheme has been operating in CSIRO since early February 1984 and already a small number of trainees have secured full-time employment with other employers in areas related to their training in the Organization.

The criteria for selecting trainees are:

- the trainee must meet Department of Employment and Industrial Relations' guidelines for participation in the scheme;
- the trainee must meet minimum educational entry qualifications appropriate to the classification of the training duties jointly agreed to by CSIRO and the relevant staff association; and
- trainees referred by the Commonwealth Employment Service (CES) must be from the relevant target group designated for each particular training program.

Funding for the trainees is provided directly to CSIRO under the terms of an agreement signed on behalf of the Minister for Employment and Industrial Relations and by the Chairman of CSIRO.

A further proposal for the employment of an additional 150 trainees has been submitted to the Department of Employment and Industrial Relations. The training will be similar to that for the initial 150 people, however, approximately half of the additional programs will run for only 26 weeks.

Promotion Guidelines

1983/84 was the first full year in which the revised guidelines for the promotion of research scientists were observed in assessing research workers. The development of these guidelines was reported in the previous annual report. During the year, the Advisory Council suggested some refinements to the wording of the guidelines which were adopted by the Executive.

15. Consultative Council

The establishment, role and composition of the CSIRO Consultative Council were described in detail in the CSIRO Annual Report 1979/80. The Council was established under section 56 of the Science and Industry Research Act 1949, following amendment of the Act in 1978. The Council's functions are 'to consider, and to report to the Executive on, any matter affecting, or of general interest to, the officers of the Organization, including any such matter that is referred to the Council by the Executive'.

The Council comprises a Chairman, Dr N.K. Boardman, who is a full-time member of the Executive; seven other members appointed by the Executive; and eight representatives of staff associations covering the various staff groups in CSIRO. Mr B. Cain of the CSIRO Technical Association succeeded Dr E.C. Potter of the CSIRO Officers Association as Deputy Chairman of the Council at the October 1983 meeting. As reflected in these representation arrangements, the Council provides a forum for consultation between staff associations and senior management.

The Council's tenth and eleventh meetings were held in Canberra in October and December 1983 respectively, while the twelfth meeting was held at the Australian National Animal Health Laboratory in Geelong, Vic., in April 1984. Although the Council normally meets only twice each year in April and October, the eleventh meeting in December 1983 was specifically arranged to consider the report by a Sub-committee on the Employment of Women which had been presented at the tenth meeting. The outcome of this report is referred to in Chapter 14.

At its tenth meeting in October 1983, the Council established two new Sub-committees. A Staffing Sub-committee is to examine the staff profile of CSIRO including levels of support staff, the impact of term appointment practices and the promotion process. An Internal Communications Sub-committee is to review the existing arrangements, both formal and informal, and consider ways in which these may be improved. Also at this meeting the personal counselling service was discussed, resulting in a Council recommendation to the Executive that the service be expanded; this was subsequently endorsed by the Executive.

At its twelfth meeting, Council discussed the Organization's grievance procedures and the development of a disciplinary code. The review of CSIRO's Administrative Arrangements was considered and the Council recommended to the Executive that the review report not be adopted until there had been full consultation with staff associations.

The work of the Council's Sub-committees on Technological Change and on Remote Localities is continuing.

Other matters which have been considered by Council include:

- the formation of an Equal Employment Opportunity Sub-committee;
- a review of staff training and staff development;
- occupational health and safety matters;
- redundancy and redeployment matters;
- staff vacancy advertising procedures; and
- research priorities and financial matters.

16. Finance and Works

Introduction

Expenditure from all funds under CSIRO's control amounted to over $377 million in 1983/84. Expenditure from funds directly appropriated by Parliament accounted for 88% ($331.5 million) of this total with a further 9% ($34.9 million) being expended from funds provided by other contributors, and the remaining 3% ($11.2 million) from revenue earned by the Organization and from unspent funds of the previous year. Further information on expenditure from the various sources of funds is provided in Table 7.

Table 7

Source of funds	Salaries and general running expenses	Contributions	Capital works and services and major items of equipment	Total
	$	$	$	$
Appropriation including Revenue	301 201 785	818 393	40 602 256	342 622 434
Wool Research Trust Fund	11 541 872	–	209 397	11 751 269
Meat Research Trust Account	4 098 371	–	14 845	4 113 216
Wheat Research Trust Account	784 434	–	–	784 434
Dairying Research Trust Account	285 548	–	–	285 548
Fishing Industry Research Trust Account	1 060 156	–	–	1 060 156
Oilseeds Research Trust Account	83 264	–	–	83 264
Dried Fruits Research Trust Account	96 178	–	–	96 178
Poultry Industry Trust Fund	77 318	–	–	77 318
Chicken Meat Research Trust Account	61 804	–	–	61 804
Pig Industry Research Trust Account	71 102	–	–	71 102
Cotton Research Trust Account	219 100	–	15 000	234 100
NERDDC-Coal Research Trust Account	546 470	–	–	546 470
NERDDC-Energy Research Trust Account	2 031 488	–	50 773	2 082 261
Rural Credits Development Fund	527 300	–	–	527 300
Other contributors	13 083 657	–	91 952	13 175 609
	335 769 847	818 393	40 984 223	377 572 463

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- occupational health and safety matters;
- redundancy and redeployment matters;
- staff vacancy advertising procedures; and
- research priorities and financial matters.

Appropriation Resources

In 1983/84 a change was made to the way funds are made available to CSIRO for major works, repairs and maintenance and acquisition of land and buildings. In the past, funds for these purposes have been appropriated to the Departments of Housing and Construction and Administrative Services for use on CSIRO's behalf. Such funds are now appropriated directly to CSIRO to allow expenditure of this type to be reflected in the Organization's accounts.

A further change relates to the payment for goods and services supplied by Australian government departments to CSIRO. While, as a general rule, charges are not made for goods and services provided between departments or non-trading authorities, the Minister for Finance has determined that CSIRO is now to be charged for these. In 1983/84 such charges amounted to $9.1 million. Of this total, $8.5 million represents charges levied by the Department of Housing and Construction for design development and construction supervision of capital works, and management of CSIRO's repairs and maintenance program. The remaining expenditure mainly represents fees paid to the Auditor-General for the audit of the Organization, and removal and storage expenses paid to the Department of Administrative Services in connection with appointment or transfer of CSIRO staff.

Salaries and operating expenditure from direct Appropriation and revenue funds amounted to $302 million this year. Excluding the effect on expenditure of the changes referred to above (inter-departmental charges $9.1 million, repairs and maintenance $5.3 million), this represents a 7% increase over 1982/83 operating expenditure. The bulk of the increase was due to funds being made available to meet inescapable salary increases ($9.2 million), for expansion of important areas ($3.2 million for biotechnology, advanced materials, new generic technologies, information technology and industry development of research results), and for other specific purposes which included additional running costs of ANAHL ($2.1 million), Project Aquarius ($1.1 million), and costs associated with the relocation of CSIRO laboratories ($2.0 million). No additional funds were provided to meet the increased cost of goods and services due to inflation.

National Facilities

CSIRO is responsible for two new scientific facilities, the Australia Telescope and the Oceanographic Research Vessel which have been funded by the Government on the basis that they will be operated as 'national facilities'; that is, that they will be accessible to as wide a group of interested scientists as possible according to the merit of their proposals.

Australia Telescope

The engineering firm of MacDonald Wagner Pty Ltd has been contracted to assist the Division of Radiophysics with the design of the telescope and to supervise its construction. Preliminary design work has been completed and tenders are to be called during the second half of 1984 for construction of the major works associated with the project. The telescope is scheduled for completion in 1988.

Oceanographic Research Vessel

Work on the 55-metre oceanographic research vessel is proceeding on schedule. Major hull construction is now complete, final design work is proceeding, and detailed outfitting has commenced. The vessel should be launched in October 1984 and is due to be handed over to CSIRO by January 1985. The Minister for Science and Technology has appointed an Interim Steering Committee whose responsibilities include allocating vessel time for projects proposed by the Australian marine science community.

Accrual Accounting

In May 1983 the Department of Finance issued guidelines on the form and standard of financial statements of Commonwealth undertakings. To comply with these guidelines, CSIRO is changing the way in which it presents its annual financial statements. The present cash-based statements, which have their origins in the way CSIRO receives most of its funds on an annual cash basis through Commonwealth appropriations, are to be replaced by statements prepared in accordance with accrual accounting principles more commonly used by business organizations. Considerable work is involved in bringing about such a change in an organization the size of CSIRO. It is expected that reports for the 1985/86 financial year will be produced on this new basis.

Capital Works and Property

During 1983/84 CSIRO acquired a number of properties. Also, as part of a continuing policy of rationalizing property holdings, some other properties were disposed of. Fourteen houses were purchased in the Northern Territory from the Department of Administrative Services. These houses were occupied by CSIRO staff who rented them from the Department. As the Government decided that the Department should no longer be responsible for providing such accommodation, funds were made available to CSIRO to acquire the houses so that suitable accommodation would continue to be accessible to CSIRO staff.

A small parcel of land was added to the Division of Molecular Biology's site at North Ryde to permit the more economical construction of a proposed biotechnology laboratory.

The Forestry Research Station at Kelmscott, WA, was sold and staff there transferred to the Floreat Park, Perth, site where better technical and library support is available. Leases were relinguished for property no longer required near Amberley, Qld (Division of Entomology), and at Yarra Bank Road, Melbourne (Division of Chemical and Wood Technology). The Division of Plant Industry's Burrenda Experiment Station, near Narrabri, NSW, was sold and the cotton research work previously carried out there was transferred to a newly-leased property in the same district but in an area more suitable to the changing needs of the research.

Details of Progress with Major Buildings

Australian National Animal Health Laboratory (ANAHL)

Work on the Australian National Animal Health Laboratory is now practically complete. The first scientific staff occupied part of the laboratory section in January 1984 and other areas are being progressively handed over to CSIRO. The final cost is expected to be in the order of $170 million at a unit cost per square metre similar to that of a conventional modern hospital building. The project continues to interest overseas organizations developing their own high security laboratory complexes, and ANAHL will be the model followed for a number of years to come. Scientists, engineers and other visitors from the USA, Canada, UK, China, USSR, Denmark and Switzerland were shown the facility during the year.

Crop Adaptation Laboratory

The Crop Adaptation Laboratory at Black Mountain, ACT, was occupied by the Division of Plant Industry in December 1983 and was officially opened by the Minister for Science and Technology in March 1984.

Clayton Laboratories Complex

The Chemical and Wood Technology Laboratories at Clayton, Vic., were occupied during 1983. The Prime Minister officially opened these laboratories in May 1984. Work on the Materials Science Laboratories continued during 1983/84. This $10.1 million project is now about 40% complete. Tenders have been called for the construction at Clayton of laboratories for the Division of Applied Organic Chemistry.

Marine Laboratories

Work on the Marine Laboratories at Battery Point, Hobart, is almost complete. Some areas are already in use and the remaining buildings should be available for handover to CSIRO in September 1984.

Projects costing more than $250 000 which were completed during 1983/84 were:

Institute of Animal and Food Sciences	Animal Production, Armidale NSW — erection of library — $330 000
Institute of Biological Resources	Entomology, Black Mountain, ACT — erection of Stage 1 of High Security Quarantine Insectary Building — $850 000

Ministerial Directions

The Science and Industry Research Act 1949 provides that the Minister may give a direction to the Executive in relation to certain matters and that copies of such directions should be included in the Organization's annual report to Parliament.

On 28 July 1983 the Minister gave the Executive the following direction:

I, BARRY OWEN JONES, Minister of State for Science and Technology, by this instrument, direct the Executive of the Commonwealth Scientific and Industrial Research Organization to devote the same proportion of the Organization's 1983/84 appropriation to research as was allocated in 1982/83.

Dated twenty-eighth day of July 1983
Sgd. Barry O Jones
Barry O Jones
Minister of State for
Science and Technology

The Minister subsequently provided the following expanded definitions of terms used in the direction:

Proportion of research	=	$\dfrac{\textit{(research salaries and allowances) + (operating funds)}}{\textit{(total salaries and allowances) + (operating funds) + (support research/overheads)}}$
where		
Research salaries and allowances	=	*total salaries for all research Institutes and the Bureau of Scientific Services*
Total salaries and allowances	=	*Research salaries + Headquarters staff salaries*
'Same proportion'	=	*not less than the same proportion of the Organization's 1983/84 appropriation to research as was allocated in 1982/83'*

I agree that we should exclude appropriations for capital works.

On 16 August the Minister conveyed a formal request to the Chairman, as follows:

My dear Chairman

As a consequence of recent Budget Cabinet deliberations I am pleased to advise that a further $4m has been appropriated to CSIRO to support specified key technology areas and SIROTECH.

You will recall that in our New Policy Proposals Submission (Attachment A to Submission 141) we had put forward a package totalling $5.1m comprised as follows:

CSIRO research programs	*$m*	*Existing Policy*
• *biotechnology*	*1.16*	*(6.7)*
• *advanced materials*	*00.50*	*(5.8)*
• *generic technologies*	*1.80*	*(1.6)*
• *information technology*	*0.89*	*(3.7)*
• *SIROTECH and industry development of research*	*0.75*	*(0.5)*
	5.10 +	*(18.3) = $23.4m*

Given the constraints in formulating the 1983/84 Budget I consider the allocation of $4m to be a reasonably satisfactory result.

I know you share my emphasis on the importance of increased effort in the above areas. Accordingly, the $1.1m reduction in the new policy component notwithstanding and because of the very high priority I attach to these programs, would you please ensure that the full $23.4m originally allocated against this package of programs is expended by CSIRO as you and I have already discussed.

I look forward to receiving your report on advances in these particular areas and improvements in the development of the industry/CSIRO research interface.

Yours sincerely

Sgd
Barry O Jones

In relation to the direction, the proportion of Appropriation funds devoted to research was 81.06% . The proportion for 1982/83 was 81.15%. In relation to the formal request the total funds expended in 1983/84 in the programs involved were $25.9m.

OFFICE OF THE
AUDITOR GENERAL

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

F83/725

11 October 1984

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

Dear Minister

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION
AUDIT REPORT ON FINANCIAL STATEMENTS

Pursuant to sub-section 57 (3) of the Science and Industry Research Act 1949, the Commonwealth Scientific and Industrial Research Organization has submitted for my report financial statements for the year ended 30 June 1984. These comprise —

Summary of Receipts and Payments
Consolidated Statement of Payments
Statement of Payments — General Research Account
Statement of Payments — Specific Research Account, and notes to and forming part of the accounts.

The financial statements, which have been prepared having regard to the policies outlined in note 1, are in the form approved by the Minister for Finance under sub-section 57 (1) of the Act. A copy of the statements is attached for your information.

I now report in terms of sub-section 57 (3) of the Act that the statements are in agreement with the accounts and records of the Organization and in my opinion —

the statements are based on proper accounts and records, and

the receipt, expenditure and investment of moneys, and the acquisition and disposal of assets, by the Organization during the year have been in accordance with the Act.

Yours faithfully

(Sgd.) K. Brigden

K F Brigden
Auditor-General

Commonwealth Scientific and Industrial Research Organization
Summary of Receipts and Payments for the year ended 30 June 1984

(Figures in brackets refer to 1982/83 financial year)

	Funds held 1 July 1983 ($)	Receipts ($)	Total Funds available ($)	Payments ($)	Funds Held 30 June 1984 ($)
General Research Account	3 164 896 (4 988 932)	344 010 554* (277 267 647)	347 175 450 (282 256 579)	342 622 434 (279 091 683)	4 553 016 (3 164 896)
Specific Research Account	4 082 244 (4 347 125)	37 819 433 (33 944 522)	41 901 677 (38 291 647)	34 950 029 (34 209 403)	6 951 648 (4 082 244)
Other Trust Moneys **	587 625 (335 792)	5 640 695 (4 731 233)	6 228 320 (5 067 025)	5 131 354 (4 479 400)	1 096 966 (587 625)
Total	**7 834 765** **(9 671 849)**	**387 470 682** **(315 943 402)**	**395 305 447** **(325 615 251)**	**382 703 817†** **(317 780 486)**	**12 601 630‡** **(7 834 765)**

* See Note 2
** See Note 3
† See Note 4
‡ See Note 5

J.P. Wild
(*Chairman*)

G.I. Batchelor
(*Assistant Secretary, Management Services*)

1982/83 ($)		1983/84 ($)
	Institute of Energy and Earth Resources	
409 259	Institute Headquarters	443 668
4 564 487	Energy Chemistry	5 117 687
3 547 682	Energy Technology	3 569 577
7 468 635	Fossil Fuels	7 350 429
3 831 062	Geomechanics	3 171 612
2 877 486	Groundwater Research	3 092 356
5 505 311	Mineral Chemistry	5 933 781
4 282 508	Mineral Engineering	4 859 241
4 545 644	Mineralogy	4 880 717
5 827 233	Mineral Physics	6 815 981
42 859 307		45 235 049
	Institute of Industrial Technology	
340 315	Institute Headquarters	277 053
4 527 423	Applied Organic Chemistry	5 386 635
6 942 134	Building Research	7 316 229
7 653 147	Chemical & Wood Technology	7 784 383
3 910 798	Manufacturing Technology	4 295 831
5 008 441	Protein Chemistry	5 278 784
7 293 172	Textile Industry	7 538 351
4 206 336	Textile Physics	4 781 324
39 881 766		42 658 590
	Institute of Physical Sciences	
295 097	Institute Headquarters	285 097
14 660 755	Applied Physics	15 153 972
5 090 667	Atmospheric Research	5 612 060
620 600	Australian Numerical Meterology Research Centre	506 487
–	Australia Telescope*	694 940
4 983 130	Chemical Physics	5 224 815
10 258 286	Computing Research	10 245 277**
1 257 100	Environmental Mechanics	1 461 371
3 528 739	Materials Science	4 233 049
4 201 887	Mathematics and Statistics	4 485 887
4 864 352	Oceanography	5 262 594
7 370 836	Radiophysics	7 221 693
669 475	Research Aircraft Facility	889 958
–	Research Vessel†	50 000
57 800 924		61 327 200

* Australia Telescope was introduced to identify annual expenditure associated with The Australia Telescope project.

** Expenditure for Computing Research excludes $4 000 000, which is the value of CSIRONET services provided to CSIRO users (see note 6).

† Research Vessel was introduced to identify annual expenditure associated with The Oceanographic Research Vessel project.

1982/83 ($)		1983/84 ($)
	Bureau of Scientific Services	
374 267	Bureau Headquarters	335 562
6 015 446	Central Information, Library and Editorial Section	6 307 847
318 794	Centre for International Research Cooperation	900 013
2 118 874	Commercial Group	2 614 015
1 587 824	Science Communication Unit	1 637 353
10 415 205		11 794 790
5 725 499	Miscellaneous	7 278 400
286 094 914	Total Research Programs	312 979 154
823 830	**Contributions**	818 393
– *	**Repairs and Maintenance**	5 326 210
	Capital Works and Services	
1 102 822**	Buildings, works, plant and developmental expenditure	27 157 946
5 230 011	Major items of laboratory equipment	5 653 575
3 926 994	Construction of research vessel	6 339 233
391 302	Australia Telescope	845 931
– †	Acquistion of Sites and Buildings	987 538
10 651 129		40 984 223
	Other Trust Moneys	
	Remittance of revenue from investigations financed	
401 804	from Industry Trust Accounts	528 643
4 077 596	Other miscellaneous remittances	4 602 711
4 479 400		5 131 354
317 780 486‡	**Total Expenditure**	**382 703 817**

* This expenditure was funded in 1982/83 by Direct Appropriation to the Department of Housing and Construction. Expenditure in 1982/83 was $5 000 998.

** Part of this expenditure was funded in 1982/83 by Direct Appropriation to the Department of Housing and Construction. Expenditure in 1982/83 was $58 009 240.

† This expenditure was funded in 1982/83 by Direct Appropriation to the Department of Administrative Services. Expenditure in 1982/83 was $4 796

‡ Dissection details of 1982/83 expenditure have been adjusted, where necessary, to allow comparison with 1983/84 figures.

J.P. Wild
(Chairman)

G.I. Batchelor
(Assistant Secretary, Management Services)

Commonwealth Scientific and Industrial Research Organization
Statement of Payments — General Research Account — for the year ended 30 June 1984

1982/83 ($)		1983/84 ($)
	Headquarters (including Regional Administrative Offices)	
10 273 620	Salaries and allowances	10 850 319
481 334	Travelling and subsistence	439 716
666 504	Postage, telegrams and telephone	652 913
3 989 817	Incidental and other expenditure	5 093 700
233 500	Advisory Council	278 299
81 365	State Committees	144 583
15 726 140		17 459 530
	Research Programs	
	Institute of Animal and Food Sciences	
293 876	Institute Headquarters	320 679
6 696 744	Animal Health	6 286 855
8 240 562	Animal Production	8 813 092
3 315 481	Australian National Animal Health Laboratory	11 594 508
7 675 338	Fisheries Research	8 157 985
9 297 056	Food Research	9 800 474
3 040 500	Human Nutrition	3 301 958
2 597 910	Molecular Biology	2 876 154
5 354 499	Tropical Animal Science	5 794 484
347 364	Wheat Research	509 899
46 859 330		57 456 088
	Institute of Biological Resources	
432 070	Institute Headquarters	445 904
2 296 152	Centre for Irrigation Research	2 394 199
9 587 998	Entomology	9 634 207
8 682 399	Forest Research	9 571 550
2 675 676	Horticultural Research	2 787 527
13 181 700	Plant Industry	14 357 700
7 166 398	Soils	7 601 099
8 804 771	Tropical Crops and Pastures	9 498 266
4 864 599	Water and Land Resources	5 157 771
6 705 984	Wildlife and Rangelands Research	7 214 480
64 397 747		68 662 703

1982/83 ($)		1983/84 ($)
	Institute of Energy and Earth Resources	
406 097	Institute Headquarters	441 991
4 545 299	Energy Chemistry	4 918 533
3 159 142	Energy Technology	3 407 779
5 912 838	Fossil Fuels	5 935 868
2 679 096	Geomechanics	2 883 407
2 700 077	Groundwater Research	2 963 907
4 726 756	Mineral Chemistry	5 219 945
3 559 395	Mineral Engineering	3 870 173
3 965 799	Mineralogy	4 247 476
4 695 669	Mineral Physics	5 097 122
36 350 168		38 986 201
	Institute of Industrial Technology	
340 315	Institute Headquarters	277 053
4 394 794	Applied Organic Chemistry	5 264 388
6 731 276	Building Research	7 027 391
7 028 317	Chemical & Wood Technology	7 204 373
3 759 898	Manufacturing Technology	4 217 449
4 998 092	Protein Chemistry	5 203 470
3 049 797	Textile Industry	2 971 046
2 548 296	Textile Physics	2 557 290
32 850 785		34 722 460
	Institute of Physical Sciences	
295 097	Institute Headquarters	285 097
14 505 195	Applied Physics	15 034 037
4 944 299	Atmospheric Research	5 425 331
620 600	Australian Numerical Meterology Research Centre	505 487
–	Australia Telescope*	694 940
4 939 949	Chemical Physics	5 196 899
10 067 098	Computing Research	9 861 600**
1 257 100	Environmental Mechanics	1 461 371
3 252 395	Materials Science	3 942 942
4 131 798	Mathematics and Statistics	4 405 347
4 839 834	Oceanography	5 252 889
7 081 632	Radiophysics	6 984 010
669 475	Research Aircraft Facility	889 958
–	Research Vessel†	50 000
56 604 472		59 989 908

* Australia Telescope was introduced to identify annual expenditure associated with The Australia Telescope project.

** Expenditure for Computing Research excludes $4 000 000, which is the value of CSIRONET services provided to CSIRO users (see note 6).

† Research Vessel was introduced to identify annual expenditure associated with The Oceanographic Research Vessel project.

1982/83 ($)		1983/84 ($)
	Bureau of Scientific Services	
362 198	Bureau Headquarters	335 562
5 788 600	Central Information, Library and Editorial Section	5 920 896
318 794	Centre for International Research Cooperation	900 013
2 118 874	Commercial Group	2 614 015
1 535 393	Science Communication Unit	1 559 571
10 123 859		11 330 057
5 382 358	Miscellaneous	7 268 628
252 568 719	Total Research Programs	278 416 045
823 830	**Contributions**	818 393
– *	**Repairs and Maintenance**	5 326 210
	Capital Works and Services	
1 020 384**	Buildings, works, plant and developmental expenditure	27 096 333
4 634 314	Major items of laboratory equipment	5 333 221
3 926 994	Construction of research vessel	6 339 233
391 302	Australia Telescope	845 931
– †	Acquistion of Sites and Buildings	987 538
9 972 994		40 602 256
279 091 683‡	**Total Expenditure**	**342 622 434**

* This expenditure was funded in 1982/83 by Direct Appropriation to the Department of Housing and Construction. Expenditure in 1982/83 was $5 000 998.

** Part of this expenditure was funded in 1982/83 by Direct Appropriation to the Department of Housing and Construction. Expenditure in 1982/83 was $58 009 240.

† This expenditure was funded in 1982/83 by Direct Appropriation to the Department of Administrative Services. Expenditure in 1982/83 was $4 796.

‡ Dissection details of 1982/83 expenditure have been adjusted, where necessary, to allow comparison with 1983/84 figures.

J.P. Wild
(*Chairman*)

G.I. Batchelor
(*Assistant Secretary, Management Services*)

Commonwealth Scientific and Industrial Research Organization
Statement of Payments — Specific Research Account — for the year ended 30 June 1984

1982/83 ($)		1983/84 ($)
	Headquarters (including Regional Administrative Offices)	
–	Incidental and other Expenditure	877
–	Salaries and allowances	4 271
5 073	Travelling and subsistence	(195)
5 073		4 953
	Research Programs	
	Institute of Animal and Food Sciences	
863 427	Animal Health	822 687
3 946 656	Animal Production	4 157 456
–	Australian National Animal Health Laboratory	17 280
507 141	Fisheries Research	1 377 112
2 711 796	Food Research	2 629 398
133 462	Human Nutrition	161 836
241 500	Molecular Biology	244 725
1 885 753	Project for Animal Research & Development	1 134 258
1 020 573	Tropical Animal Science	861 826
323 379	Wheat Research	283 169
11 633 687		11 689 747
	Institute of Biological Resources	
224 638	Centre for Irrigation Research	239 107
2 378 781	Entomology	2 534 118
223 926	Forest Research	337 227
103 456	Horticultural Research	161 126
1 020 696	Plant Industry	1 159 386
339 511	Soils	259 349
827 526	Tropical Crops and Pastures	785 365
785 427	Water and Land Resources	839 185
617 488	Wildlife and Rangelands Research	561 724
6 521 449		6 876 587

1982/83 ($)		1983/84 ($)
	Institute of Energy and Earth Resources	
3 162	Institute Headquarters	1 677
19 188	Energy Chemistry	199 154
388 540	Energy Technology	161 798
1 555 797	Fossil Fuels	1 414 561
1 151 966	Geomechanics	288 205
177 409	Groundwater Research	128 449
778 555	Mineral Chemistry	713 836
723 113	Mineral Engineering	989 068
579 845	Mineralogy	633 241
1 131 564	Mineral Physics	1 718 859
6 509 139		6 248 848
	Institute of Industrial Technology	
132 629	Applied Organic Chemistry	122 247
210 858	Building Research	288 838
624 830	Chemical & Wood Technology	580 010
150 900	Manufacturing Technology	78 382
10 349	Protein Chemistry	75 314
4 243 375	Textile Industry	4 567 305
1 658 040	Textile Physics	2 224 034
7 030 981		7 936 130
	Institute of Physical Sciences	
155 560	Applied Physics	119 935
146 368	Atmospheric Research	186 729
–	Australian Numerical Meterology Research Centre	1 000
43 181	Chemical Physics	27 916
191 188	Computing Research	383 677
276 344	Materials Science	290 107
70 089	Mathematics and Statistics	80 540
24 518	Oceanography	9 705
289 204	Radiophysics	237 683
1 196 452		1 337 292

1982/83 ($)		1983/84 ($)
	Bureau of Scientific Services	
12 069	Bureau Headquarters	–
226 846	Central Information, Library and Editorial Section	386 951
52 431	Science Communication Unit	77 782
291 346		464 733
343 141	Miscellaneous	9 772
33 526 195	Total Research Programs	34 563 109
	Capital Works and Services	
82 438	Buildings, works, plant and developmental expenditure	61 613
595 697	Major items of laboratory equipment	320 354
678 135		381 967
34 209 403*	**Total Expenditure**	**34 950 029**

* Dissection details of 1982/83 expenditure have been adjusted, where necessary, to allow comparison with 1983/84 figures

J.P. Wild
(*Chairman*)

G.I. Batchelor
(*Assistant Secretary, Management Services*)

Commonwealth Scientific and Industrial Research Organization
Notes to and forming part of the Accounts for the Year ended 30 June 1984

1. CSIRO's operations are funded principally from Parliamentary Appropriations. Accordingly its main accounts are kept on a cash basis, that is, no account is taken of accruals and only the amounts received and spent in a financial year are brought to account.

2. Receipts to the General Research Account comprise:

	1982/83 ($)	1983/84 ($)
Appropriations — Consolidated Revenue Fund		
Operational	258 206 000	290 854 300
Capital	6 985 000	40 760 900
	265 191 000	331 615 200
Revenue and other Receipts		
General Operations		
Sale of publications	640 664	657 544
Receipts in respect of expenditure in former years	466 576	630 126
Sale of produce, including livestock	470 490	466 567
Royalties from patents	181 937	183 325
Fees for tests and other services	345 527	450 900
Interest on investments	596 661	480 514
International Consultancies	–	650 671
Miscellaneous receipts	613 442	459 438
	3 315 297	3 979 085
CSIRONET Operations		
Computing service charges	8 740 048	8 364 682
Receipts in respect of expenditure in former years	7 779	39 776
Miscellaneous receipts	13 523	11 811
	8 761 350	8 416 269
	12 076 647	12 395 354
Total receipts	277 267 647	344 010 554

3 Other Trust Moneys Account is the repository for moneys held temporarily on behalf of other organizations and individuals.

4. Total expenditure comprises:

	1982/83 ($)	1983/84 ($)
Salaries	219 028 027	232 502 414 *
Travel	8 634 880	10 165 194
Equipment	17 465 218	17 214 258
Maintenance	62 001 184	82 649 348
Capital	10 651 177	40 172 602
	317 780 486	382 703 816

* The total salary expenditure includes expenditure of $31 846 572 on the employer's share of superanuation.

5. Funds held at 30 June 1984 included investments (at cost) in Reserve Bank of Australia Interest Bearing Deposits totalling $4 000 000. The comparative investments figure at 30 June 1983 was also $4 000 000. Of the total funds held, $158 644 represents funds which had been appropriated to CSIRO but which were not expended in 1983/84.

6. Receipts and payments relating to the provision of CSIRONET computer services are as follows:

	1982/83 ($)	1983/84 ($)
Receipts		
CSIRO users	3 617 857	4 000 000
Other users	8 740 048	8 364 682
Receipts in respect of expenditure in former years	7 779	39 776
Miscellaneous receipts	13 523	11 811
	12 379 207	12 416 269
Payments		
Operational expenditure	13 684 955	13 861 600*
Capital expenditure	220 561	415 861
	13 905 516	14 277 461

* Of the operational expenditure recorded for CSIRONET the Division of Computing Research research activities were funded by CSIRO Appropriation to the Division of $2 341 200

7. Cash held at Banks and in hand.
In addition to funds in CSIRO's main bank accounts, $215 848 was held in various Divisional Imprest Accounts. These funds were expensed when the advances were established.

8. Moneys held in Trust

These funds were previously reported in the Organization's Specific Research Account.	1983/84 ($)
Funds on hand 30/6/84	566 566
held as:	
Investments (at cost)	
Commonwealth Inscribed Stock	50 000
State Electricity Commission of Victoria	12 200
Primary Industry Bank of Australia	96 000
Reserve Bank of Australia Interest Bearing Deposits	9 000
Civic Permanent Building Society Ltd	385 674
	552 874*
Cash at Bank	13 692

* The comparative figure at 30 June 1983 was $158 200

9. Auditors Remuneration
The total amount paid to the Auditor-General for the audit of the Organization amounted to $487 350. This represents fees in respect of the period ended: — 31 March 1982 — $116 600, 31 March 1983 — $177 350, 31 March 1984 — $193 400. No other benefits were received by the Auditor-General.

10. Fees paid to Department of Housing and Construction — $8 500 000.
Represents interdepartmental charges levied on the Organization by the Department of Housing and Construction for design development, construction supervision, and management costs of CSIRO's 1983/84 Capital Works and Repairs and Maintenance Programs.

11. During 1980/81 CSIRO joined with Knight Actuaries Pty Limited and The Australian Mineral Development Laboratories in the establishment of Siromath Pty Limited, a company registered in the State of Victoria, for the purposes of providing a high level mathematical and statistical consultancy organization to industry, commerce, governments, educational institutions and other persons. CSIRO is represented on the Board of Directors and the Management Committee of the Company.
On 30 June 1981 CSIRO exercised its option to purchase a one-third shareholding in Siromath Pty Limited. CSIRO purchased a $1 share in the Company and as at 30/6/84 CSIRO has subscribed a total of $36 000 to the working capital of Siromath Pty Limited.

12. Following the death in December of 1980 of Miss T. McMaster, the life interest left to her by her father, the late F.D, McMaster, fell to CSIRO. The interest was in the form of 60601 shares (or 32.05% of the issued capital) in F.D. McMaster Pty Ltd. The principal asset of the company is a property at Cassilis NSW named 'Dalkeith'. CSIRO has disposed of its shareholding in F.D. McMaster Pty Ltd for $1 050 000. CSIRO has since received $350 000, the balance (secured by first Mortgage) will be repaid by 10 consecutive annual instalments, plus interest.

13. During 1983/84 CSIRO expended $143 000 for the purchase of 130 000 US$1 class B shares in Austek Microsystems Limited.

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

	1983/84 ($)
Full time members of the Executive	205 857
Other members	30 157
	236 014

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

J.P. Wild
(*Chairman*)

G.I. Batchelor
(*Assistant Secretary, Management Services*)

Advisory Council and State and Territory Committees

17. Advisory Council and State and Territory Committees — Advice and Activities

ADVISORY COUNCIL

The Advisory Council is established under the Science and Industry Research Act 1949. The function of the Council is to furnish advice to the Executive in connection with the following matters:

- the objectives that should be pursued by the Organization and the priorities to be followed to achieve those objectives;
- industrial or economic matters that may be of importance in formulating those objectives;
- the identification of the interests of the Australian community that may be furthered by the Organization; and
- any other matter that is referred to it by the Executive for advice.

In addition, the Executive is required to include in the annual report of the Organization all advice furnished by the Advisory Council during the year and comments by the Executive on that advice.

During the year Council met three times. There were fifteen meetings of Council's standing committees and of the Chairpersons of the standing committees. The standing committees are: Manufacturing Industries; Rural Industries; Natural Environment, Renewable Natural Resources; Mineral, Energy and Water Resources; and Information and Social Impact. Among the matters considered by Council during the year were a survey by Professor A.J. Birch on the implementation of Government decisions following the report of the Independent Inquiry into CSIRO in 1977, strategic research planning activities in CSIRO, and questions referred by State and Territory Committees for Council's consideration.

Changes in Membership

Dr J. R. de Laeter, Associate Director, Division of Engineering and Science, Western Australian Institute of Technology, was appointed to Council in April 1984.

The following members retired or resigned from Council:

Professor L. M. Birt, Vice-Chancellor, The University of New South Wales;
Mr R. K. Gosper, Chairman, The Shell Company of Australia Ltd;
Dr G. A. Letts, former Director, Conservation Commission of the Northern Territory;
Mr P. R. Marsh, Industrial Officer, Victorian Trades Hall Council; and
Dr B. W. Scott, Chairman and Managing Director, W. D. Scott and Co Pty Ltd.

Full lists of members are set out in the next chapter.

Council Advice

Council provided advice to the CSIRO Executive on membership of CSIRO review committees, rangelands research, and manufacturing research policy and priorities.

Membership of Review Committees

At its meeting in October 1983, Council considered a paper on the membership of CSIRO review committees. Council's subsequent advice and the Executive's response were as follows:

Council welcomes the Executive's decision to consult its Chairman about membership of CSIRO review committees prior to a decision being taken by the Executive Committee. Further, it commends to the Executive the practice of appointing potential users of CSIRO research and development to CSIRO review committees, particularly when the reviews are in an applied research area, and recommends that an appropriate CSIRO policy be developed and promulgated.

Response:
An examination of review processes in CSIRO is being conducted by the Executive and the Council's advice will be considered in the context of this examination.

Rangelands Research

At its meeting in October 1983, Council endorsed the views of the Rural Industries Standing Committee on rangelands research arrangements. Council's recommendations to the Executive and the Executive's responses were as follows:

Council recommends that it:

(a) Supports the integration of national and State rangelands research programs, and indicates its willingness to initiate and coordinate such programs through the Standing Committee on Agriculture and the State Departments if appropriate;

Response:
Section 10 of the Science and Industry Research Act requires the Executive as far as possible to cooperate with other organizations and authorities in the coordination of scientific research.

The Executive recognizes that the research of CSIRO should be complementary to that of the States. It believes that the most effective collaboration takes place by interaction between the respective agencies in the planning and operational stages of research. It will continue to facilitate collaboration between the Organization's research scientists and those of other institutions and departments. The rangelands research program already interacts with a large number of State/Territory authorities, currently 17, and more collateral arrangements are planned, subject to available resources.

Through its representatives on the Standing Committee on Agriculture and its Technical Committees, and the Standing Committee on Soil Conservation, the Organization gains an awareness of future research needs which may reveal where further interaction and cooperation might take place. If discussions at SCA level indicate a general support for the view that CSIRO could usefully take a more central role in fostering collaboration in either broad or specific areas in rangelands research, the Executive would be prepared to give earnest consideration to such a proposal.

(b) Maintains and strengthens its own commitment to CSIRO rangelands research, with particular emphasis on support for the placement of staff in the arid and semi-arid areas, based at CSIRO centres and facilities operated by State Departments, supplemented by mobile laboratories;

Response:
The Executive assigns a high priority to arid and semi-arid lands research and has strengthened this research by the allocation of four additional staff positions together with operating funds. The use of mobile laboratories is planned for field sites associated with the two centres for rangelands research, Alice Springs and Deniliquin. The locations of field work are determined after wide consultations with appropriate individuals and bodies, including relevant State and Territory Departments.

Experience in CSIRO has shown quite clearly the need to group the core of professional staff at a limited number of centres in order to provide adequate teamwork and scientific exchange. The extent to which research scientists can be based in small numbers at many scattered locations is therefore restricted, but research will continue at a wide range of locations within the rangelands.

(c) Recognizes the excess costs associated with work in a difficult environment when considering proposals from the Director of the Institute of Biological Resources, or the Chief of the Division of Wildlife and Rangelands Research, for funds for rangelands research.

Response:
The Executive recognizes that there are in the Organization several research units, including rangelands research, with unique operating characteristics. It is accepted that substantial deviations from standard operating costs need to be taken into consideration in fund allocation.

Manufacturing Research Policy and Priorities Statement

Council's advice on the manufacturing research policy and priorities statement, and the Executive's response, were as follows

(1) The Advisory Council welcomes CSIRO's statement of policy and priorities for manufacturing research and the Organization's renewed determination to increase the effectiveness of its research for manufacturing industry. Council encourages the ranking of programs into several levels of priority and particularly endorses the intended concentration of resources on selected technologies with high impact on several industry sectors and advanced technology-skill content. Council's Manufacturing Industries Standing Committee (MISC) was unanimous in its view that the policy, together with the formation of SIROTECH, represents a major step forward in the Organization's re-orientation to the needs of the Australian economy.

Response:
The Executive welcomes Council's endorsement of the Organization's initiatives in the area of its manufacturing industry research.

(2) In line with the Government's increased emphasis on support for manufacturing industry and the associated highest priority technologies, the Organization should consider an overall re-allocation of its resources between sectors of the economy as part of its strategic planning.

Response:
Accepted; the Executive is currently examining its allocation of resources as part of its development of an overall strategy for the Organization (refer Chapter 1). A review of CSIRO's strategic planning is nearing completion and will be considered by the Executive early in 1984/85.

(3) The Executive of CSIRO should set growth rate targets for re-allocation of research and development resources to the highest priority technologies. In view of the financial constraints on Government funds an increased proportion of these funds should be derived from (a) internal re-allocation of resources currently dedicated to the manufacturing sector programs and (b) by attracting contributions in manpower or funds through collaborative projects with Australian manufacturing industry.

Response:
Accepted; steps will be taken to set such targets. CSIRO is committed to increasing the resources available to the highest priority manufacturing industry research topics identified, including through internal redeployment of resources from other manufacturing industry research programs. The Executive endorses the suggestion for increasing industry contributions through collaborative projects.

(4) Future CSIRO manufacturing research policy should promote the greater involvement of CSIRO staff, at all levels, who service manufacturing industry by communication and personal contact with industry and/or industry associations. In this context, Council warmly endorses CSIRO's explicit policy of rating practical achievement as a key criterion for staff promotion.

Response:
Accepted; The Executive welcomes Council's endorsement of the new promotion guidelines for CSIRO research staff and acknowledges Council's contribution towards these.

(5) CSIRO should define mechanisms for implementation of its manufacturing research policy and monitor the implementation of the policy in regard to:

(a) overall objectives and those of individual programs;

(b) the proportion of tactical, strategic and fundamental research in each Division servicing manufacturing industry.

Response:
Accepted; in addition to the actions specified in the Executive's statement, further detailed mechanisms for implementation and monitoring will be developed.

(6) In view of industry's short time span of planning and economic prediction and the difficulties of classifying research and development into tactical, strategic and fundamental, the Organization should use, as an additional criterion, the prediction of the most likely timing of industrial implementation of its research projects.

Response:
Accepted; the likely timescale of all projects is to be specified as part of computerized project data files, development of which has commenced.

(7) Council noted that a significant proportion of manufacturing research and development is in support of the textile (wool) industry. This is largely a technical service for wool exports and, more appropriately, might be considered as research and development in support of agriculture.

Response:
The Executive notes Council's view on the categorization of CSIRO's textiles research. The Executive is considering this issue in its development of a revised research program directory and new project data files which will be completed during 1984/85. Proportional allocation of research programs to multiple industry sectors has been agreed as a new feature in the classification system.

Informal Advice and Comment

Council and its Standing Committees have provided informal advice and comments on a wide range of subjects, including satellite imagery and receiving facilities, the Australian National Animal Health Laboratory (ANAHL), CSIRO's library and information services, public communication activities, promotion guidelines for research scientists, and SIROTECH Ltd.

Comment has been made on a number of CSIRO reviews, including those of the Divisions of Computing Research, Materials Science, Protein Chemistry, Mineralogy and Mineral Physics, Human Nutrition, the Molecular and Cellular Biology Unit, and the review of CSIRO's library and information services. Also, Council made a major submission to the committee reviewing CSIRO's Strategic Research Planning Activities. Members of Council were included in the membership of some of the review committees.

Dr Susan Bambrick inspects the heavy ion analytical facility at the Division of Mineral Physics. Dr Bambrick, Chairperson of the Advisory Council's Mineral, Energy, Water Resources and Soils Standing Committee, members and coopted participants were visiting the North Ryde Laboratory of the Institute of Energy and Earth Resources for discussions about CSIRO research for the mining and metal industries.

Other Council Activities

Council provided substantial comments on several initial planning documents prepared by CSIRO's Planning and Evaluation Advisory Unit (PEAU).

Council members attended various meetings arranged by State and Territory Committees and visited Divisions. Informal discussions took place with Directors of Institutes, Chiefs of Divisions and CSIRO staff. In this way, members were able to acquaint themselves with the work of Divisions and to draw attention to community interests.

The Chairman of Council, Sir Peter Derham, attended meetings of most of the State and Territory Committees. He participated in seminars and inspections at Mount Isa, Gladstone and Rockhampton (Qld), and Launceston (Tas.), and visited CSIRO Divisions in several States.

STATE AND TERRITORY COMMITTEES

New South Wales

The Committee met five times during the year. There was a marked increase in activities relating to its statutory role.

Major submissions were made on technology transfer, the role and structure of the Advisory Council and State Committees, and the review of CSIRO's strategic planning. Other submissions included comments on CSIRO's planning documents on the natural environment and fisheries research, advice about Landsat and satellite imagery, and contributions to several subject and Divisional reviews.

Committee members were involved to a greater extent in Advisory Council business through the standing committee system. Also, the various sub-committees met on several occasions and contributed greatly to the operation of the State Committee.

Other activities included meetings with senior executives from industry and government, an address by the Chief on the work and future directions of the Division of Atmospheric Research, visits to other Divisions, and participation in an Executive seminar at the Centre for Irrigation Research, Griffith.

Northern Territory

The Committee met four times at Darwin, Kapalga and Yulara (NT), and Mount Isa (Qld). During this period the Committee completed its initial review of all CSIRO research based in the Northern Territory. The Committee has proposed to the Advisory Council that a greater research effort, covering a wide range of topics, is required in tropical Australia, especially in the north and north-west (monsoonal region). The Committee is preparing a detailed submission to Council on this subject.

The Committee strongly endorsed the strengthening of tropical agricultural research based at the Katherine Research Station, and saw a serious need for expanded environmental research in the Kapalga program, particularly fire research. The Committee also made a submission to Council on the proposed redeployment of rangelands research from Deniliquin.

A joint meeting was held at Mount Isa in March 1984 with the Queensland State Committee. Discussion covered the mining and pastoral industries and new initiatives in tropical research.

Queensland

The Committee met six times. It contributed to reviews of the Divisions of Mineralogy, Mineral Physics and Computing Research, and to a subject review of materials science and technology. Members also took part in meetings of standing committees of the Advisory Council.

A joint meeting with the Northern Territory State Committee at Mount Isa gave Committee members an opportunity to understand more fully the degree of CSIRO collaboration with Mount Isa Mines Ltd. Committee members also heard talks about research by the Division of Entomology on the biological control of the water weed *Salvinia*, and water quality research conducted by Mount Isa Mines Ltd. Members also attended a symposium on research into the problems of the arid zone pastoral industry, held in conjunction with the Queensland Department of Primary Industries and regional pastoralists.

Sir Peter Derham, Chairman of the CSIRO Advisory Council (fifth from left, back row) and members of the Queensland State Committee during an inspection of the Tropical Cattle Research Centre, Rockhampton.

Discussions between the Committee and the City and Towns Local Government Association on treatment of waste disposal in medium-sized local government areas drew attention to the difficulties of current methods, and possibilities for research assistance.

South Australia

The Committee met six times, despite some difficulties associated with replacing retiring members. Early in the year, the Committee was involved with the review of the structure and function of the Advisory Council. Also, considerable interaction was generated between CSIRO Divisions and Units and representatives from industry and commerce.

Research areas studied by the Committee included water repellant sands (Division of Soils); an oceanographic study of South Australian waters, including St Vincent and Spencer Gulfs (Division of Oceanography); environmental problems related to atmospheric research (Division of Atmospheric Research); and water research (Division of Water and Land Resources).

Committee members welcomed CSIRO's decision to relocate the Deniliquin group of the Division of Wildlife and Rangelands Research to Adelaide and to establish a Science Education Centre in South Australia. The Centre has been a collaborative project with the South Australian Education Department, which has provided funding.

Tasmania

The Committee met on four occasions in 1983/84, and provided input to the Advisory Council on a range of issues, chief of which was a response to the Birch Survey proposals on the Advisory Council (see CSIRO Annual Report 1982/83). Another major submission was to the review of CSIRO's strategic planning.

Sub-committees directly corresponding to Advisory Council Standing Committees were reconstituted, and their activities became a main feature of the State Committee's work. The Rural Industry Sub-committee considered ways of identifying the areas of rural industry in Tasmania most in need of research support, and a preliminary meeting was arranged with the research committee of the Tasmanian Farmers and Graziers Association. Other sub-committees contributed comprehensive responses to the Advisory Council on the planning documents prepared by CSIRO's Planning and Evaluation Advisory Unit on fisheries research, forest research and knowledge and management of the natural environment. In each case, specialists from industry, State Government departments and research institutions were coopted by the sub-committee.

Representatives from the Tasmanian sub-committees attended meetings of the corresponding Advisory Council Standing Committees several times during the year.

A three-day visit to Launceston in November 1983, the Committee's first major activity in the north of the State, included a public seminar which was addressed by senior staff of CSIRO representing marine science, forestry, manufacturing industry and entomology. Also, the Committee visited the State Department of Agriculture's research centre at Mt Pleasant, the Australian Maritime College and several industries in the Tamar region.

Victoria

The Committee met four times during the year, and in December 1983 met informally with Victorian Chiefs of CSIRO Divisions and members of the various sub-committees.

The Committee maintained its interest in CSIRO's involvement with manufacturing industry. Several members attended a meeting of the Advisory Council's Manufacturing Industry Standing Committee to discuss research and development needs and a proposed policy paper on research in this area. They also discussed the review of CSIRO's commercial activities and the proposal to establish SIROTECH Ltd. The Committee made submissions to Council and commented on a number of issues including CSIRO's new initiatives, the role and structure of the Advisory Council and State Committees, information technology in CSIRO, knowledge and management of the natural environment and extra-terrestrial research, CSIRO's fisheries research, and the review of the Division of Computing Research. It also made submissions to the review of the Division of Plant Industry and on changing public perceptions of CSIRO.

Western Australia

The Committee met on six occasions during the year. Also, Dr J. Moore of the University of Sussex and several senior CSIRO staff addressed special meetings of the Committee at which representatives from government, industry and tertiary institutions were present.

Submissions were made to the reviews of strategic planning and the Division of Horticultural Research and on planning documents prepared by CSIRO's Planning and Evaluation Advisory Unit.

The Committee's long-term interest in the transfer of the Surface Chemistry Section of the Division of Mineral Chemistry to Perth culminated in the Section occupying a new laboratory at the Western Australian Institute of Technology. The Western Australian Government provided certain funds to assist with staff relocations.

Local Divisions have collaborated with the Committee in a program of monthly visits by community leaders. Chiefs and Officers-in-Charge regularly report research of current interest.

18. Advisory Council and State and Territory Committee Members

Advisory Council

Chairman

Sir Peter Derham, BSc, FAIM, LPIA, FInstD, former Managing Director, Nylex Corporation Ltd.

Chairmen of State/Northern Territory Committees

G.I. Alexander, BVSc, MSc, PhD, FACVSc, Director-General, Queensland Department of Primary Industries (*Queensland*).

R.A. Footner, AM, Chairman and Joint Managing Director, Bridgestone Australia Pty Ltd (*South Australia*).

G.J. Hunt, B Arch, Principal, Hunt, Giles & Partners, and Principal, Gary Hunt and Associates (*Northern Territory*) (Acting from April 1984).

J.E. Kolm, AO, IngChemEng, Consultant and Company Director (*Victoria*).

J.R. de Laeter, PhD, Associate Director, Division of Engineering and Science, W.A. Institute of Technology (*Western Australia*) (from April 1984).

G.A. Letts, CBE, DVSc, Director, Conservation Commission of the Northern Territory (*Northern Territory*) (until December 1983).

K. Satchwell, BSc, MSc, former Managing Director, AFL Holdings Ltd (*New South Wales*).

Professor P. Scott, OBE, PhD, LLD, former Pro-Vice-Chancellor, University of Tasmania (*Tasmania*).

Other Members

S.C. Bambrick, OBE, BEcon, PhD, Dean of Students, Australian National University.
Professor L.M. Birt, CBE, DPhil, Vice-Chancellor, University of New South Wales (until September 1983).
V.A. Brown, MSc, PhD, Lecturer, Centre for Adult Teaching, Canberra College of Advanced Education.
L.P. Duthie, BCom, Secretary, Department of Primary Industry.
H.R. Edwards, BA, DPhil (Oxon), FAIM, FASSA, MP, Member for Berowra
Professor P.T. Fink, CB, CBE, BE, FTS, Chief Defence Scientist, Department of Defence.
A.M. Godfrey, BEcon, Deputy Secretary, Department of Industry and Commerce

R.K. Gosper, BA, Chairman and Chief Executive Officer, Shell Company of Australia Ltd (until September 1983).
D. Hartley, BE, Hartley Computer Applications Pty Ltd
J.H.S. Heussler, Grazier.
D.J. Ives, BSc, BEcon, Deputy Secretary, Department of Resources and Energy.
R.J. Kirby, AO, BE, Managing Director, James N. Kirby Holdings Pty Ltd.
P.R. Marsh, BEcon, Industrial Officer, Victorian Trades Hall Council (until November 1983).
B.W. Scott, DBusAdm, Managing Director, W.D. Scott & Co Pty Ltd (until August 1983).
M.S. Shanahan, Member of Australian Wheat Board.
P.R. Staples, BAplSc, MP, Member for Diamond Valley.
W.J. McG Tegart, PhD, FTS, Secretary, Department of Science and Technology.

Observers

I. Castles, OBE, BCom, Secretary, Department of Finance.
Professor R.O. Slatyer, AO, FAA, FRS, Chairman, Australian Science and Technology Council.
J.P. Wild, CBE, ScD, FTS, FAA, FRS, Chairman, CSIRO.

Secretariat

G.D. McLennan, BCom, Secretary (until February 1984).
D.B. Thomas, BA, Acting Secretary (from March 1984).
I.D. Gordon, Assistant Secretary.
Mrs B. Magi, Administrative Assistant.

State and Territory Committees

New South Wales

K. Satchwell, BSc, MSc (*Chairman*), Managing Director, AFL Holdings Ltd.
C.S. Barnes, PhD, Manager, Research, Biotechnology Pty Ltd.
C.G. Coulter, BE, ME, FIE, Officer-in-Charge, Power Development Division, NSW Electricity Commission.
K.P. Farthing, ASTC, Executive Director, Manufacturing, Metal Manufactures Ltd.
R.A.K. Long, BSc, PhD, Assistant Director, NSW Department of Industrial Development and Decentralisation (until December 1983).
D.J. McGarry, BSc, Managing Director, Australian Oil and Gas Corporation.
D.R.H. MacIntyre, Grazier.
G.R. Peart, MRurSc, Agricultural Consultant.

D.A.J. Swinkels, PhD, Minerals Process Research Manager, BHP Central Research Laboratories.
Professor A.R. Toakley, PhD, Professor of Building and Head of School of Building, University of New South Wales.
R.A. Williams, BSc, Cotton Farmer.
T.C. Clark, AASA, ACIS (*Secretary*), Regional Administrative Officer, CSIRO, Sydney.

Northern Territory

G.A. Letts, CBE, DVSc (*Chairman*), Director, Conservation Commission of the Northern Territory (until December 1983).
G.J. Hunt, BArch, (*Acting Chairman*), Principal, Hunt, Giles and Partners, and Principal, Gary Hunt and Associates (from April 1984) (previously member of the Committee).
B.J. Cameron, BAgSc, Chairman, Agricultural Development and Marketing Authority (until March 1984).
D.P. Drover, BSc, PhD, Chief Scientist, Department of Primary Production (until March 1984).
W.J. Fisher, Mining Consultant.
W.M. Kirke, Research Writer (until April 1984).
R.M. Morrison, DipArch, FRAIA, ARIBA, Architect.
J.V. Quinn, MD, Assistant Secretary, Environmental Health Division, Northern Territory Department of Health (until April 1984).
C. Rioli, Member of Executive, Tiwi Land Council (until April 1984).
J.W. Suiter, BSc, MSc, PhD, FRMIT, Vice Principal, Darwin Community College.
M.J. Tilley, Company Director and Farmer.
W.J. Waudby, Pastoralist.
M.G. Ridpath, BSc, PhD (*Secretary*), Officer-in-Charge, CSIRO Darwin Laboratories.

Queensland

G.I. Alexander, BVSc, MSc, PhD, FACVSc (*Chairman*), Director-General, Queensland Department of Primary Industries.
J.A. Allen, PhD, FTS, Chairman, Board of Advanced Education.
A.J. Allingham, Grazier.
G.L. Baker, MSc, Deputy Director (Technical), Department of Commercial and Industrial Development, Queensland
D.W. Beattie, BE, FIE, Commissioner of Water Resources, Queensland.
J.M. Hudson, Grazier.
B.J. Meynink, BSc, Lecturer.
J.C. Rivett, ME, FAIM, Chairman, Gutteridge, Haskins & Davey (until April 1984)
D.M. Traves, OBE, BSc, Consultant, Peat, Marwick & Mitchell.
Professor D.H. Trollope, PhD, DEng, Deputy Vice-Chancellor, James Cook University of North Queensland.
R.J. White, FASA, DipCom, Managing Director, Consolidated Fertilizers Ltd (until December 1983).
C.D. Williams, MAIMM, Research Manager, MIM Holdings Limited.
D.B. Thomas, BA (*Secretary*), Regional Administrative Officer, CSIRO, Brisbane (until February 1984).
K. J. Turner, BCom (*Acting Secretary*), Senior Finance Officer, CSIRO, Brisbane.

South Australia

R.A. Footner, AM (*Chairman*), Chairman and Joint Managing Director, Bridgestone Australia Pty Ltd.
F.E. Acton, General Manager, South Australian Co-operative Bulk Handling Ltd.
D. Andary, OBE, FAIM, Chairman, Berri Co-op Packing Union Ltd.
J.E. Harris, BEng, Managing Director, Adelaide and Wallaroo Fertilizers Ltd (until April 1984).
I.J. Kowalick, BSc, BEc, Deputy Director-General, Department of Trade and Industry.
J.C. McColl, MAgrSc, Director-General, Department of Agriculture (until December 1983).
Professor J.P. Quirk, DSc, FAA, Director, Waite Agricultural Research Institute.
P.M. South, BSc, DipFor, Director, Woods and Forests Department, South Australia.
R. Woodall, AO, BSc, MSc, Director of Exploration, Western Mining Corporation Ltd.
B.W. Bartlett, AASA (*Secretary*), Divisional Secretary, CSIRO Division of Human Nutrition.

Tasmania

Professor P. Scott, OBE, PhD, LLD (*Chairman*), Former Pro-Vice-Chancellor, University of Tasmania.
J.R. Ashton, BCivilEng, Commissioner, Hydro-Electric Commission, Tasmania.
R.D. Barker, Dip Metallurgy, Dip ChemEng, General Manager, Electrolytic Zinc Co.
E.C. Best, BSc, BE, Manufacturing Manager, Cadbury-Schweppes Ltd.
M.C.P. Courtney, Editor, Launceston 'Examiner'.

T.M. Cunningham, BSc, BFor, PhD, Commissioner (Management), Tasmanian Forestry Commission.
R.J. Downie, Grazier.
P.J. Fountain, BSc, Director, Tasmanian Department of Agriculture.
Professor J.N. Lickiss, MD, FRACP, FRCP, Professor of Community Health, University of Tasmania (until September 1983).
Captain D.M. Waters, MSc, Principal, Australian Maritime College.
B. Wilson, MSc, Research Manager, Goliath Portland Cement Co. (until April 1984).
A.C. Woods, BSc, MSc (*Secretary*), CSIRO Division of Oceanography.

Victoria

J.E. Kolm, AO, IngChemEng (*Chairman*), Consultant and Company Director.
J.D. Brookes, MC, MSc, former Director of Conservation, Ministry of Conservation, Victoria.
I.W. Cameron, BMechE, Group Managing Director, Repco Corporation Ltd.
D.J. Constable, BE(Civil), Commissioner, State Rivers and Water Supply Commission, Victoria.
A.J. Farnworth, MBE, PhD, Chief General Manager, Australian Wool Corporation.
Professor K.H. Hunt, FTS, MA, Professor of Mechanical Engineering, Monash University (until November 1983).
F.C. James, MSc, Dean, Faculty of Applied Science, RMIT (until November 1983).
J.A. Kelly, Executive Member, Cattle Council of Australia (until April 1984).
Sir Laurence Muir, VRD, LLB, former Senior Partner, Potter Partners (until April 1984).
R.D.E. Parry-Okeden, BE, Managing Director, Vickers Ruwolt.
E.F. Sandbach, BA, BSc. Director Research, Telecom Australia.
E.J.L. Turnbull, Managing Editor, The Herald & Weekly Times Ltd.
J.A. Pattison, MBE, AASA (*Secretary*), Divisional Secretary, CSIRO Division of Building Research (until May 1984).

Western Australia

J.R. de Laeter, PhD (*Chairman*), Associate Director, Division of Engineering and Science, W.A. Institute of Technology (from April 1984).
E.N. Fitzpatrick, MAgSc, Director, Department of Agriculture (until March 1984).
E.R. Gorham, BE, Co-ordinator of Industrial Development, Department of Industrial Development.
R.M. Hillman, BEng, Director of Engineering, Public Works Department.
W.J. Hughes, Chairman, Westwools Group (until August 1983).
J.B. Kirkwood, FInstEngsA, FTS, Commissioner, State Energy Commission.
S.L.G. Morgan, BE, Director, Westfi Manufacturing Ltd.
J. Shepherd, BSc, Farmer and Agricultural Scientist.
Professor R. Street, DSc, FAA, Vice-Chancellor, University of Western Australia.
J.P. Brophy, MBE (*Secretary*), Regional Administrative Officer, CSIRO, Perth.

Appendices

The complex focus observed when laser light is reflected from the surface of a generalized diffraction grating. The grating consists of a mirror surface into which a curved pattern of finely spaced grooves is etched. Such gratings may be used in materials processing to anneal, cut or print complex shapes using pulsed laser light.

Appendix I Science and Industry Endowment Fund

The CSIRO Annual Report 1982/83 provided an historical perspective of the operation of the Science and Industry Endowment Fund since its establishment by the Science and Industry Endowment Act 1926. The policy of the trustees in deciding whether to support a project was also outlined.

In the reporting year the trustees have followed the same policies as reported earlier, and the expectation of an annual call for applications has not been implemented. During 1983/84 the trustees received nine applications for grants, all of which were approved. A total amount of $7 486 was disbursed on eleven grants. Details are listed in the table. At 30 June 1984 the funds available for distribution were more than $20 000.

Table 8 Applications for Grants During 1983/84

Applicant	Project	Amount $
Mr K. Prestedge	Research on *Patiriella vivipara*—provision of a new microscope head for an Olympus microscope which had been provided on loan to Mr Prestedge	108
Mr K.M. Moore	Paper on *Glycaspis*—additional finance to assist with publishing costs (Mr Moore received $1 600 in 1982 for a field trip re taxonomy of Psyllidae and $1 000 in 1980)	208
Dr B. Smith Senior Curator (Zoology), National Museum of Victoria	Overseas visit to major museums and presentation of a paper to the Eighth International Malacological Congress in Budapest in August 1983—provision of an amount towards travel expenses	1 500
Ms P. Greenslade Entomology Section, South Australian Museum	Visit to France and England to study taxonomy of Australian Collembola—additional amount for extension of visit (Ms Greenslade received $3 730 for travel expenses in 1982 and a grant of $500 in 1977)	1 000
Mr A.A. Page	Optical observation of flare stars—reimbursement of cost of repairs to printer for microcomputer system ($6 077 was provided in 1982 for purchase of microcomputer system)	110
Mr D. Schultz	Participation in the development of the computer-based Nest Record card—provision of funds to enable visit to the Royal Australasian Ornithologists Union (RAOU) Headquarters, Melbourne	300

Table 8 (cont.)

Applicant	Project	Amount $
National Science Summer School	'Hands On' activities conducted as part of the first National Science Summer School held in Canberra in January 1984 — assistance towards the costs of transportation of small groups of students	500
Mr W. Holden	Research and development of a versatile robotic arm and its control system — funding for further development of multi-task robot prototype	2 500
Mr L. Winsor	Research on the taxonomy, distribution and ecology of land Planariums — provision of additional equipment in the form of Periplan eyepieces	660
Science Teachers' Association of Victoria	Provision of an amount for their annual science talent search	200
Science Teachers' Association of the ACT	1984 Science Fair — provision of an amount towards the overall value of prizes and an amount to be awarded to the most outstanding entry from a college student in the Scientific Enquiry Section	400
Total		**7 486**

Appendix II CSIRO Submissions to Parliamentary and Official Inquiries

CSIRO made submissions during 1983/84 to ten official inquiries with implications for the Organization's activities in scientific and industrial research. Details of these submissions are given below.

Inquiry into the Environmental Impact of Bushfires

In its submission to the House of Representatives Standing Committee on Environment and Conservation, CSIRO summarized present knowledge of the environmental impact of prescribed and wild fires in Australia. These can cause significant changes in local flora and fauna, and contribute to a deterioration in soil and water quality. Details were also provided of Project Aquarius, in which the effectiveness of aerial bombing techniques are being compared with conventional fire fighting methods.

Animal Welfare Inquiry

The submission to this Senate Select Committee stressed the importance of treating animals in research humanely. CSIRO has produced jointly with the National Health and Medical Research Council a Code of Practice for the Care and Use of Animals in Research which has been widely adopted in Australia. A key requirement is the establishment of Animal Experimentation Ethics Committees to ensure that research conforms with Code guidelines. Such committees operate at all CSIRO sites involved in animal research. Wherever possible, CSIRO adopts techniques that enable fewer animals to be used. However, progress in many areas of biological science, including the control of human and animal diseases, will continue to require the use of some animals.

Government Inquiry into the Need for an Institute of Freshwater Studies

The submission to the Interim Council for the proposed Institute suggested that its most appropriate role would be to identify suitable research and development projects and provide funding and contract support. Appropriate projects would be concerned with general water quality management or with particular problems in the Murray-Darling Basin. Projects could be contracted to groups from State agencies, tertiary institutions, and CSIRO. As such an Institute would require only a small but expert staff and have modest infrastructure needs, it could be established quickly with minimal cost and would not have to be located on a river system.

Government Review of Future Arrangements for Coastal Surveillance

The submission identified CSIRO needs for information in coastal waters and drew attention to the potential application of new technologies to coastal surveillance, notably remote sensing and radar.

Government Inquiry into a Manufacturing Advisory Service on Computer Assisted Manufacturing (CAM)

The CSIRO submission indicated the advantages of a nation-wide manufacturing advisory service on CAM. Subject to availability of resources, CSIRO could participate in the service. In the short term, however, CAM might best be promoted by establishing demonstration facilities in a real manufacturing environment and by providing appropriate taxation incentives to industry.

Government Review of the Experimental Building Station (EBS)

The submission noted the complementary roles of the CSIRO Division of Building Research (DBR) and EBS, located within the Department of Housing and Construction. Thus, longer term strategic research at DBR provides a basis for much of the short term tactical research undertaken at EBS. These arrangements are meeting national needs in 'public interest' building research, although the depleted capability at EBS needs strengthening.

Government Inquiry into the Australian National Animal Health Laboratory (ANAHL)

Certain exotic animal diseases, notably foot-and-mouth disease (FMD), would have a major impact on Australia's livestock industries. Accordingly, the national strategy for dealing with such outbreaks includes a secure facility, represented by ANAHL, where suspect specimens may be handled safely. Prior to ANAHL's completion, a proposal to import live exotic animal pathogens, particularly FMD virus, caused public controversy.

Following the establishment of a Ministerial Committee to consider the future role of ANAHL, an ad hoc Advisory Committee was formed in September 1983 to provide urgent technical advice. The CSIRO submission to the ad hoc Advisory Committee presented the case for ANAHL to operate at its full capacity as a diagnostic, research, training and vaccine production centre.

Industries Assistance Commission (IAC)

CSIRO submissions to three IAC inquiries are summarized below.

1. **Telecommunications and Related Equipment and Parts**

   CSIRO activities and research initiatives with implications for telecommunications were outlined, as well as the difficulties of transferring the results of such research to industry. While the Australian telecommunications industry needs to be broadly based and have a strong research component, this would require a coordinated approach between Government funded R&D and manufacturing support, official procurement, offsets arrangements, and more traditional forms of Government assistance.

2. **Southern Bluefin Tuna (SBT)**

   The submission summarized recent information on the SBT fishery and included a report of a meeting of experts from Japan, Australia and New Zealand held in April 1983. Several options were outlined for maintaining the SBT spawning stock at an acceptable level.

3. **Dried Vine Fruits**

   The submission summarized relevant studies by the Division of Horticultural Research under the headings of Technological Change, Diversification, and Alternate Crops.

Appendix III Reporting requirements

Statutory Reporting Requirements

Section 57 of the Science and Industry Research Act 1949 requires that certain items be included, together with a general account of the operations of the Organization, in each annual report. These items are listed in the table below in the order in which they appear in section 57, together with responses or cross-references to other parts of the report.

Financial statements in respect of that year in such form as the Minister for Finance approves.	See Chapter 16.
Copies of all determinations of the Minister made under sub-paragraph 9(a)(iv).	No determination was made.
Copies of all directions of the Minister given under section 13.	See Chapters 3 and 16.
All advice furnished by the Advisory Council under section 34 during that year.	See Chapter 17.
A statement of the policies of the Organization in relation to the carrying out of the scientific research of the Organization that were current at the beginning of the relevant year, together with a description of any developments in those policies that occurred during that year.	The response developed by the Organization to meet this requirement has two main components. These are: • a comprehensive statement each year of the research objectives being pursued by the Organization and the level of resources devoted to each objective; and • an initial statement of general policies relating to research, followed by statements of policies relating to specific areas of research, as these policies are developed. The statement of research objectives and resources is presented in Chapter 2. The initial statement of general policies relating to research appeared in the CSIRO Annual Report 1978/79. Policies relating to specific areas of research which were developed during 1983/84 appear in Chapters 1 and 3–6.
Comments of the Executive on advice furnished to it by the Advisory Council during that year.	See Chapter 17.
Auditor-General's report.	See Chapter 16.

Additional Reporting Requirements

In November 1982 the Government announced decisions on general information to be provided to Parliament in the annual reports of statutory authorities (see Senate Hansard pages 2258-2261). These items are listed in the table below in the order in which they appear in the Government's announcement, together with responses or with cross-references to other parts of the report.

Enabling legislation	Science and Industry Research Act 1949.
Responsible Minister	Minister for Science and Technology. The Minister's statutory powers of direction are mentioned in Chapters 3 and 16.
Powers, functions and objects	See page 2
Membership and staff	Names of Executive members and senior staff are shown on the Organization chart. Staff are employed under Section 32 of the Science and Industry Research Act 1949. At 30 June 1984 CSIRO had a total staff of 7276. Terms of office of Executive members are as follows: **Chairman and Chief Executive** J.P. Wild, CBE, ScD, FTS, FAA, FRS 14.12.78–24.9.85 **Full-time Members** N.K. Boardman, ScD, FAA, FRS 14.12.78–24.9.85 G.H. Taylor, DSc, DrRerNat, FTS 1.5.82–30.4.89 **Part-time Members** D.P. Craig, DSc, FAA, FRS 26.3.80–25.3.83; 26.3.83–22.12.84 M.D. Kirby, CMG, BA, LLM, BEc 11.8.83–10.8.86 S.B. Myer, MA 14.12.81–13.12.84 G.G. Spurling, BTech, MAE, ED 9.9.82–8.9.85 P.D.A. Wright 1.12.79–30.11.82; 4.2.83–3.2.86

Information about CSIRO may be obtained from the sources listed below.

Scientific and technical inquiries:

Central Information Service, CSIRO,
P.O. Box 89, East Melbourne, Vic. 3002.
Tel. (03) 418 7333.

The Librarian, CSIRO, P.O. Box 225,
Dickson, A.C.T. 2602.
Tel. (062) 48 4228.

Regional Information Office, CSIRO,
P.O. Box 218, Lindfield, N.S.W. 2070.
Tel. (02) 467 6211.

Regional Information Office, CSIRO,
P.O. Box 374, West Perth, W.A. 6005.
Tel. (09) 322 2111.

Freedom of Information inquiries:

Freedom of Information Unit, CSIRO,
P.O. Box 225, Dickson, A.C.T. 2602.
Tel. (062) 48 4123.

Media inquiries:

Media Office, CSIRO, P.O. Box 225,
Dickson, A.C.T. 2602.
Tel. (062) 48 4484.

Financial statements

See Chapter 16.

Activities and reports

See Chapters 1–16. CSIRO maintains relations with a wide range of Commonwealth, State and local Government organizations concerned with science and technology matters and relevant national and international bodies.

CSIRO publications

CSIRO produces about 2000 publications annually. Information on these can be obtained from:

Central Information, Library and Editorial Section, CSIRO, P.O. Box 89, East Melbourne, Vic. 3002.
Tel. (03) 418 7333.

Operational problems

See Chapters 1–16.

Subsidiaries

CSIRO has no subsidiaries as such. However, it holds a one-third equity shareholding in Siromath Pty Ltd, a private company established to provide high level mathematical consultancy services, primarily to Australian industry. CSIRO's participation in the formation of the company was an exercise of its powers under paragraph 9 AA(b) of its Act.

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Commonwealth Scientific and Industrial Research Organization, Australia