CSIRO'S CONTRIBUTION TO THE NATION

CSIRO
AUSTRALIA

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A record of how Australia has benefited from its investment in scientific research

Australian Science, Australia's Future

1991

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INTRODUCTION

This is a document about the bottom line: the costs and the benefits. It focuses on CSIRO's contribution to the nation.

While it contains a description of CSIRO's contribution in fields ranging from mining to communication technologies, from wool technology to wildlife ecology, its primary message is one about the future. It's about the role CSIRO can — and to my mind must — play in Australia's future.

Now, as we move into the final decade of this century we face a new set of challenges and opportunities.

CSIRO has been a powerful force in the development of Australia since 1926 and in the generation of Australia's wealth through research work with primary and secondary industries.

Our special mission will continue to be one of service to Australia and Australians. Scientific excellence and its application will help us meet the economic and environmental challenges facing our nation.

These challenges are more complex and more fundamental than ever before. As a nation we need to be smarter, more innovative, more receptive, and more perceptive.

Back in the sixties Australia lived comfortably from the strong world demand for mineral and agricultural products. Our manufacturing and service industries operated behind protective barriers. The nation's current account deficit, foreign debt, interest rates and inflation were matters of small numbers and little public interest. They were largely matters for the finance pages of our newspapers.

We now must struggle to be competitive internationally: the nation's newspaper

headlines scream about disturbing foreign debt, high inflation, and high interest rates.

To trade out of these problems, we must not only build on our traditional strengths, but also capture some of the rapidly growing markets for goods and services based on advanced technologies.

Meeting our economic challenges is being made all the harder by the pressing need to protect and repair our fragile environment. The greenhouse effect, which threatens dramatic changes to our climate, holes in the ozone layer and land degradation are major concerns, along with a myriad other environmental issues ranging from the destruction of wilderness to the chemical contamination of Australia's oceans.

Community health is also now recognised as a significant economic factor. The annual cost to Australia of diet-related diseases has

been estimated at over $5 billion. This burden can be reduced only by adopting more effective nutritional strategies based on research that provides a better understanding of diet and lifestyle.

In the face of such demand for clever solutions, it is a sad commentary on Australia's present circumstances that it is now performing less research and development in relation to the size of the economy than it did 20 years ago.

However recognition is dawning that we must respond to these economic and environmental problems right now — not 20 years hence. The way in which we respond will determine our destiny as a nation.

Australia must expand and diversify its export and import-replacing industries if it is to overcome its current economic difficulties; and it must integrate this with sustainable resource use and environmental protection.

CSIRO has the experience and the record to marshal the sort of research effort Australia now requires — as has no other organisation, private or public.

It has the potential to change the bottom line for the better.

INDUSTRIAL TECHNOLOGY

One of the iron laws of research and development is that if you don't look, you won't find.

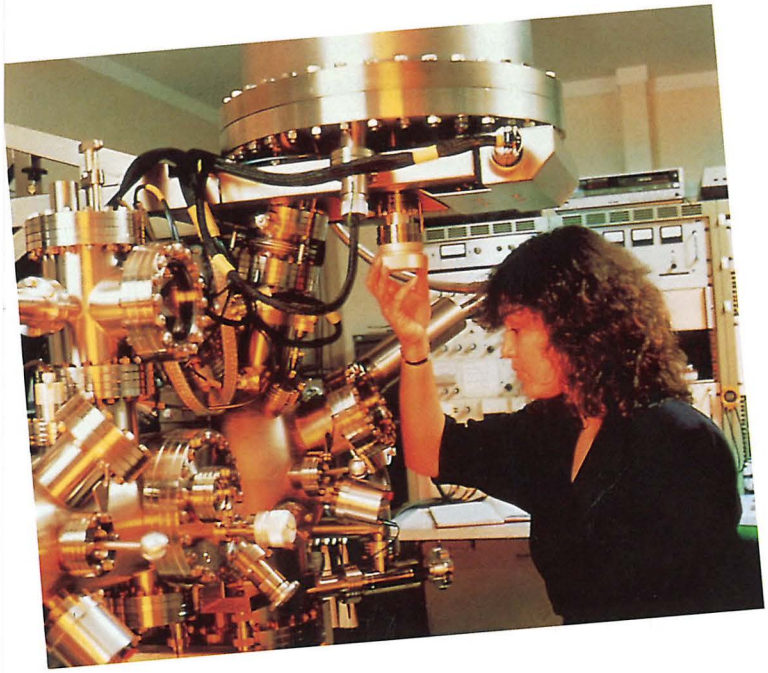
If, as a manufacturer, you don't look ahead to new products and processes, and even new solutions to old problems, you will be left behind by those who do.

Unfortunately for Australia, that is a lesson being learnt the hard way. The nation's trade balance is evidence of opportunities lost.

CSIRO has led the way in Australian research and development (R&D).

In the early 1950s, CSIRO came up with an invention that still stands as a monument to local talent.

The atomic absorption spectrometer is an instrument that revolutionised chemical analysis, sparked a new Australian industry, and introduced new technology to laboratories all over the world.



The instrument has earned $150 million in export sales. It sowed the seeds for Australia's $1 billion scientific and medical equipment export industry, which is one of Australia's fastest growing export areas.

CSIRO continues to contribute products such as **UMIST,** a revolutionary hardness measuring instrument, **DMT-CASTFLOW** (a novel personal computer-based program which incorporates a computer-aided design and manufacture approach to casting), and instruments which draw upon CSIRO's expertise in standards measurement.

PROJECT NOTE

Getting timber products out of Australia's forests and leaving the tall timber standing sounds like a conservationist's dream.

But this is exactly what CSIRO has achieved through the development of a new processed wood product.

Called **Scrimber**, it's strong and tough. While it looks much like ordinary timber, it outperforms timber for many applications.

Scrimber is made primarily from pine thinnings and small trees — wood that would be wasted, or turned into pulp.

Conventional sawmilling techniques use 40 per cent of the log. **Scrimber** uses 85 per cent.

It is made by crushing, drying and hot-pressing the timber with an adhesive mix.

The key to the process is that the natural orientation of the timber fibres is retained while knots and other imperfections are removed, which means that **Scrimber** has uniform and predictable strength.

The manufacturing technology was developed in Australia with Australian industry. The markets for **Scrimber** include south-east Asia and North America, as well as Australia.

Research links

CSIRO's manufacturing technology research aimed at the agricultural and mining industries has created substantial benefits for Australia.

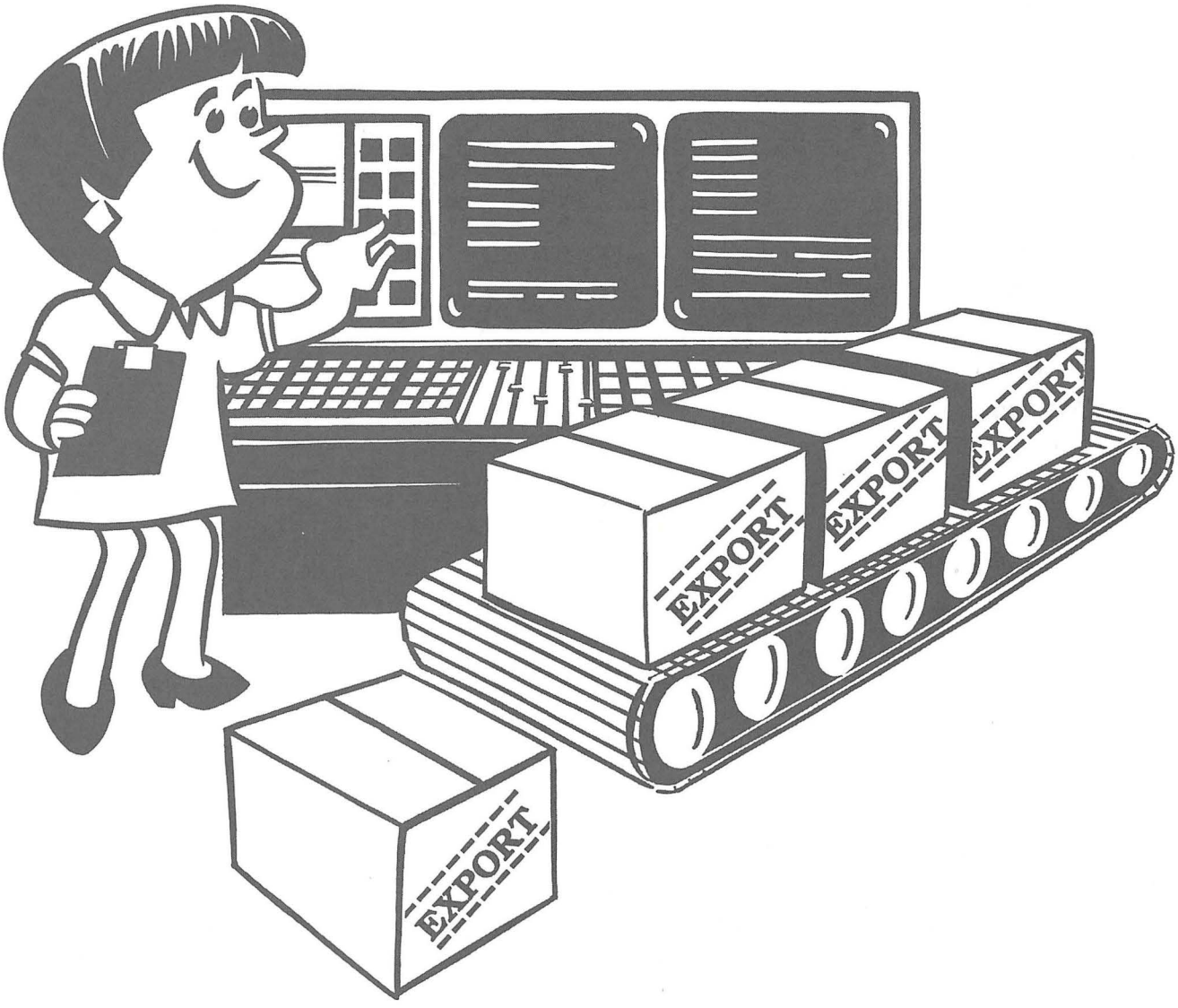
CSIRO's newly developed genetic engineering-based vaccine against footrot is now undergoing registration trials. Developed in collaboration with Arthur Webster Pty Ltd, Biotech Australia Pty Ltd and the University of Sydney, the vaccine will aid control of a bacterial infection that costs the Australian sheep industry $100 million per annum.

An environmentally safe insecticide, **Cycloprothrin**, has been developed by CSIRO and is currently being used in Japan by licensee Nippon Kayaku. It will, if adopted in Australia, save Australian woolgrowers around $60 million over 10 years by reducing the incidence of blowfly strike in sheep.

CSIRO is working with Arthur Webster Pty Ltd on a new generation of biotechnology-based vaccines for the poultry industry which will revolutionise treatment of various diseases and earn substantial export revenue.

From CSIRO's coal research has come a smog monitor, **Airtrak**, that can measure smog levels, predict its occurrence and pinpoint its sources. **Airtrak** is being manufactured and sold by MCI Ltd. The world market for this technology is about $100 million.

Some R&D work is literally 'down to earth'. CSIRO has developed a new adhesive for laying the nylon gas pipelines being used



to renew Sydney's reticulation system. The economic benefits have been valued at $4 million, but, much more importantly for pipeline workers, the new adhesive minimises toxicity levels in the trenches where pipes are laid.

Sand and opportunity

Zircon sand and a CSIRO interest in zirconium chemistry are the two factors that led ICI, Z-Tech and Nilcra to target a potential $100 million a year export industry.

Australia is the world's largest supplier of zircon sand, and has traditionally exported it unprocessed.

Now Australia has the largest plant of its kind in the world which manufactures high purity zirconia powders and chemicals. Zirconia powders alone have an international market of $400 million, and are the key ingredient in a new very tough ceramic — **PSZ** (for Partially Stabilised Zirconia).

CSIRO developed the process called transformation toughening, which was a scientific breakthrough of the classic kind and led to the development of PSZ.

But the breakthrough itself was not enough. In line with its commercial policy, CSIRO pursued the zirconia thread for 15 years to ensure Australia exploited the technology it established in the 1970s.

The benefit is easy to measure: Australia can now get 100 times the value of the raw zircon sand it exports.

Sex, sewage and sweeteners

Male Oriental Fruit Moths get no joy from CSIRO research into insect pheromones. Pheromones are the scents insects use in communication.

Tubes containing female moth pheromone — conveniently named **Isomate M** — are being made in Australia as part of a battle against fruit moths that attack peach orchards. Hung in the peach orchards, they confuse the male moths mightily. In the airborne confusion, the males fail to find mates and so fail to reproduce, reducing a problem for orchardists.

Revolutionary research into the use of magnetic particle technology for water, industrial effluent and sewage treatment is bringing a significant return to Australia.

The world market for water treatment technologies is estimated at hundreds of millions of dollars per year.

Four full-scale treatment plants based on the CSIRO **Sirofloc** technology are already operating in Australia and the UK. A further two plants are under construction in the UK and Taiwan.

A large-scale trial of the sewage treatment version is to take place at Malabar, NSW. This is aimed at helping alleviate Sydney's significant sewage problem.

CSIRO has developed a commercial process to produce the artificial sweetener **Aspartame**. Aspartame is produced by the tens of tonnes for an annual $1 billion market.

The enzyme catalyst which is the key to the CSIRO process comes from an unlikely, but plentiful source — the skins of green paw paws. The method is less complicated, more economic and more environmentally friendly than production processes currently in use.

Prosthetics and packaging

Materials research within CSIRO is looking at the development of biocompatible materials for medical and dental applications and the production of specialised film wraps.

Biomaterials are used in pacemaker leads, artificial hearts and heart valves, synthetic blood vessels and joint replacements. World sales of biomaterials are around $13 billion. At the moment, Australia imports more of these materials than it exports. CSIRO research is aimed at turning this around.

One thing Australia's climate provides is an abundance of fresh vegetables, fruit and cut flowers — all of which are in demand in Asia.

CSIRO has developed a new plastic film wrap which prolongs the life of this produce, vastly increasing the export potential of the market garden industry. The film itself is also likely to be a substantial export earner for Australia.

ENVIRONMENT

CSIRO is frequently in the headlines on environmental matters, providing advice on a large range of projects and propositions from mining in Kakadu in the Northern Territory to a pulp mill in Wesley Vale in Tasmania.

CSIRO's environmental research and cross-disciplinary analysis of environmental issues is clearly recognised by industry, governments and the Australian community.

Australia accepts CSIRO's credentials. In a national survey, 51 per cent of respondents rated CSIRO as a reliable and trustworthy source of information on environmental issues — well ahead of environmental groups, universities and governments.

CSIRO is an honest broker. As a public sector research body, its commitment is to the national interest. Its advice must always be rational, balanced and based on a foundation of uncompromising scientific excellence.

The ability to provide advice stems from decades of research into the Australian environment, and a research framework that knits together scientific expertise across disciplines.

Measuring the value of the research — and the advice that flows from it — is not difficult, in one sense, because quality advice on which decisions can be made is worth hard dollars in opportunities created or damaging environmental impacts avoided.

The worth of CSIRO's work can be quantified in terms of costs and benefits.

A study of six CSIRO environment projects showed a benefit of $192 million compared with a research and implementation cost of $48 million. Benefits were measured in goods traded in the marketplace and by using contingent valuation methods, including measurements of the willingness of beneficiaries to pay for the research results.

Community values

One project, CSIRO research into the distribution of vegetation and fauna and their response to logging in south-east temperate forests, was measured by what value the community and forest and natural resource managers placed on the research.

The study identified the substantial value the community placed on research that could lead to improved forestry management, including the conservation of important habitat areas.

The research was able to show conclusively that soil quality was the prime factor determining forest wildlife densities.

The result has already had an impact on the management of native forests.

The evaluation showed the $3.4 million costs were easily outweighed by community willingness to invest $19 million in the research.

Predictions

Measuring what's in the air, tracking smoke-stack plumes and computer modelling have all been combined by CSIRO to help predict the effects of industrial activity on air quality.

Advice from CSIRO has helped the New South Wales and Victorian governments make decisions about industrial and power developments.

CSIRO has even advised American authorities on how to choose best weather conditions for burning-off in the Grand Canyon.

The benefits of other environmental research projects emerge readily.

- A project aimed at preventing nitrogen deficiency in crops through better control of urea fertiliser in irrigation water has produced benefits estimated at $22 million over 20 years from a total research expenditure of less than $2 million. The benefits came in higher crop yields of maize, sorghum and sunflowers.
- Weed control using a different mix of herbicides in aerially sown rice brought benefits of approximately $1 million a year in cost savings for an investment of less than $800,000.
- Computerised methods of environmental assessment based on remote sensing were developed originally by CSIRO for the management of the Great Barrier Reef. Wider applications of the **Microbrian** technique have brought cost savings estimated at $24.4 million against a research cost of $2.6 million.

PROJECT NOTE

A Brazilian weevil that attacks the world's worst waterweed is living illustration of CSIRO's approach to environmental research.

The problem: Salvinia, a fast-spreading waterweed which started as an aquarium plant and spread to choke waterways in many countries, including Australia. In the Sepik River in New Guinea it disrupted fishing, food-gathering and travel.

The solution: CSIRO scientists discovered the Brazilian weevil, tested it on a lake at Mt Isa and found that its capacity to attack and sink Salvinia was startling.

The end result: Clear waterways and satisfied weevils from Mt Isa to the Sepik and Sri Lanka without the use of chemicals or anything else having a harmful effect on the ecology of waterways. In short, a natural solution.

The financial equation: Research costs were about $1 million. The return in clear waterways can be measured in many millions.

Waste treatment

Environmental work takes some strange turns and comes up with some unexpected results — like using swamp plants to treat wastes.

CSIRO is working on a low-cost waste water treatment system based on what are described in scientific terminology as aquatic macrophytes — large water plants.

Pilot systems are operating at Port Macquarie, Griffith, at the Kapooka Army barracks in Wagga Wagga and in households in Wagga Wagga, Coffs Harbour, Leeton and Queanbeyan.

Already a provisional assessment of the worth of the idea shows that the world market for the system is very large.

The system would cost between 25 and 50 per cent less than conventional treatment of discharge water of the same quality.

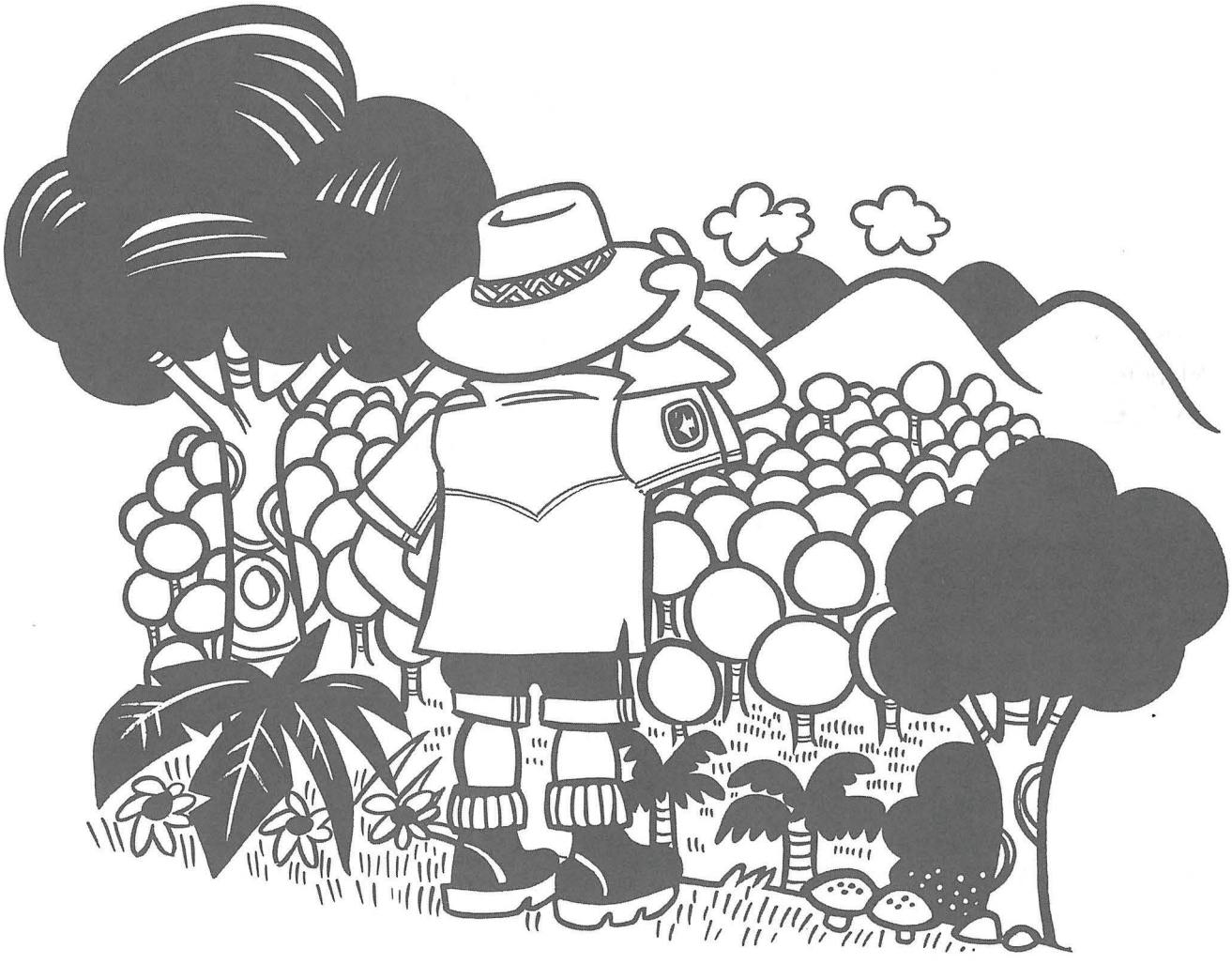
Industry value

How much does all this environment research cost? In round figures, about $68 million per year.

Its worth can be gauged by contrasting expenditure to the value of Australian industries inextricably bound to the condition of the environment.

These include rural production ($23.2 billion in 1989–90), the water supply industry ($2.3 billion annually in operating costs), the fishing industry (earning $840 million per annum), and tourism ($2.5 billion expenditure and export earnings of $4.5 billion).

CSIRO is the largest single contributor to environmental research in Australia. This contribution — given that environmental issues will be key issues in Australia's future — is of a value that transcends dollar measurements, because CSIRO research is also about the quality of life Australians can expect from the continent they inhabit.



COMMUNICATION AND INFORMATION INDUSTRIES

CSIRO aims to be an Australian leader in strategic research on information and communications technologies so that Australia can benefit directly from those advances.

While it sometimes seems a world of ultra high-tech research, it is, in fact, relevant to us all.

Applications range from communications to aerospace, and from mines to medicine.

The benefits are available to many Australians :

— Service and retail providers can select the best locations for their outlets, thanks to the **Interactive Territory Assignment** software designed by CSIRO to handle many complex factors affecting such decisions. This software is also being used by the Electoral Commission to revise boundaries of electoral districts.

— Aircraft and airports all over the world will soon be using the **Interscan** landing system, a concept developed in the 1970's by CSIRO and the then Department of Transport. It has been adopted as the international standard system of the future. Interscan International, an Australian company, has been awarded contracts to supply and install the system at airports in several countries, including Australia (Canberra airport).

— A CSIRO spin-off company, The Preston Group, has also developed advanced airport simulation software to help make airports safer. The **Total Airspace and Airport Modelling System** uses three-dimensional graphics to simulate airspace and airports, runways and taxiways, air routes and movements on the ground.

— CSIRO designed, built and tested one of the prototypes for the antennas that will go into space in 1992 in the next generation of AUSSAT satellites. Remote area TV broadcasts and mobile communications will benefit greatly from the new satellites. This project was a significant step in building up Australia's ability to design and produce hardware for space flights.

Export markets

CSIRO has developed its radiophysics, electronics and engineering skills to become a world leader in microwave and millimetre-wave technologies, antenna design, signal processing and ultrasonics.

These skills have helped OTC Ltd to use Australian-designed earth station communication antennas instead of imports,

and build a successful export market, particularly in south-east Asia and the Pacific.

In manufacturing and service industries, statistical thinking underpins quality improvement programs. CSIRO is working with a range of Australian companies to integrate such thinking into company processes, in order to improve their product quality and hence their international competitiveness.

Better images

By making the best use of remote sensing technology, CSIRO is ensuring Australia gets the most value from the satellites that orbit above us.

CSIRO scientists are expert at using satellite images to show farmers and land managers the fluctuations in vegetation growth that may mean a change of over $2 billion in the value of annual production. Images of sea-surface temperatures are also used to study the effects of climate on fisheries.

CSIRO's reputation in image processing is well earned, as evidenced through sales and applications of two of its image processing and graphics systems.

One system, **DISIMP**, is achieving world-wide sales for applications such as land resource management, mineral exploration and oceanography.

The second, **GAIA** software to model terrain, has been used in Queensland to help analyse sensitive forestry operations. The product is also particularly well suited to military applications such as planning of radar installations. The return to Australia from these uses is estimated at $20 million over 10 years.

Higher, faster

While the silicon chip seems to appear in everything from desktop computers to washing machines, CSIRO has concentrated on more specialised chips made from gallium arsenide.

Gallium arsenide devices can handle higher frequencies than silicon, and therefore work faster. They are used in communications systems, radar and navigation instruments.

The work offers $90 million in benefits to Australia over the next 10 years.

CSIRO, with the Defence Science and Technology Organisation and Australian industry, is developing a new airborne radar system that could be used for coastal surveillance and search and rescue missions. A piece of CSIRO hardware makes it possible to produce high-resolution, real-time images of land and sea during the aircraft's flight.

This project is aimed at a world market and will provide a low-cost alternative to radar systems currently available.

Safer, easier

CSIRO's researchers are working on several developments to make our lives safer and easier:

— two mine safety devices based on techniques arising from radar research;

— ultrasound techniques to assess risk in pregnancy;

— ultrasonic assessment of the quality and yield of meat on-the-hoof; and

— software for an 'electronic telephone book' to help computer users work on networks.

PROJECT NOTE

The last place you might expect to find applied mathematics and statistics is in a sports car.

Some statisticians may not drive sports cars, but applied statistics from CSIRO contribute to Australia's newest sports car.

The car — Ford Australia's Capri — has caught the imagination of Australian car buyers and already has the prospect of strong demand overseas, particularly in America.

Where do the statistics come in?

To break into the American market Ford had to comply with new design requirements which could only be assessed by crash-testing the car.

Crashing cars is expensive and time-consuming. Ford asked CSIRO's mathematical and statistical professionals to help, to ensure it gained the absolute maximum from each set of crash data.

CSIRO's expertise meant fewer crash tests and more useful data. Each crash prevented saved Ford $200,000 per car. And, just as importantly in a competitive car market, it gave Ford Australia an early lead in its entry into the American market.

RURAL INDUSTRIES

Australian agriculture and CSIRO have gone together, like wine and cheese, for most of this century.

Australian woolgrowers, with CSIRO's help, have maintained and strengthened wool's position on world markets. Australia's cattle breeders and CSIRO have produced cattle better suited to the climate, defeated a range of pests, and developed better processing techniques.

Australian wheatgrowers, ricegrowers, cotton growers, orchardists, winemakers and graziers all owe some of their productivity and success to CSIRO research.

The value of the research is obvious on every diningroom table and supermarket shelf in Australia.

With help from CSIRO, Australians are able to enjoy some of the best food in the world — including wine and cheese.

The quality and quantity of Australian agricultural exports is further evidence that our rural industries are among the most efficient and productive in the world.

Leading the way

Wool research is one of the best examples of how research has moved with the times.

CSIRO's involvement stretches from the farm paddock to the wool garment fashion parade.

CSIRO has been involved in a wide range of strategic research involving sheep — in developing a footrot vaccine, pasture research, mineral supplementation, and the breeding of healthier, more productive sheep.

At the same time CSIRO has transformed the processing of wool.

New technologies for spinning, dyeing, permanent pleating, mothproofing and shrinkproofing were all developed in CSIRO's laboratories.

One CSIRO development in wool spinning — **Sirospun** — has cut by 40 per cent the cost of producing lightweight woven fabrics. It underpins the International Wool Secretariat's Cool Wool campaign which markets lighter woollen garments for spring and autumn wear around the world.

The introduction of 'sale by sample' and test certificates is estimated to save the wool industry $100 million annually.

Further objective measurements to describe wool for sale could bring additional yearly benefits of $50 million compared to a research cost of $2.3 million.

Work on fabric finishing and fabric testing, including the ability to predict how wool fabrics will perform during wear, is expected to bring $80 million in benefits to fabric and garment manufacturers. The research cost is $2.7 million per year.

Wool processing and environmental considerations come together in CSIRO's work on treating the effluent from wool scouring and other processes to ensure the continued sustainability of the industry worldwide.

Putting a precise dollar total on the worth of all this research is not easy. However, there is no dispute that Australia's large annual income from wool exports rests as much on research as it does on any natural comparative advantage.

Prawns and pest control

In the warm waters off the northern coast of Australia, CSIRO research is the foundation of a venture that has turned the tropical prawn into a multi-million-dollar industry.

PROJECT NOTE

CSIRO's contribution to what could become one of Australia's most valuable scientific discoveries has already been valued at $22.5 million.

That's the value placed on CSIRO's participation in a joint venture which could see the discovery earning many millions of dollars on world markets.

The discovery is termed gene shears — a high-technology route to 'switching off' undesirable genes.

The gene shears are actually molecules called ribozymes that destroy particular bits of RNA. The RNA molecules are essential for translating genetic instructions carried by genes (DNA) into proteins. The RNA molecules are also the means by which viruses multiply once they have invaded the cells of living organisms.

So gene shears have the potential to be directed against any gene in any living organism. They could be used to stop the actions of harmful or undesirable genes.

- Gene shears could be used to switch off the genes that make plants inedible or unpalatable.
- Livestock diseases could be controlled and the fertility of stock could be increased.
- In medicine, gene shears could possibly be used to control genetic and viral diseases — even the AIDS virus. The US Department of Health is already investigating the potential of the technology in AIDS treatment.

The northern prawn fishery now earns approximately $200 million a year and provides up to 90 per cent of national production. It had its beginnings with pioneering CSIRO research in the 1960s and 1970s on the factors that affect distribution and growth of populations of tropical banana and tiger prawns.

The work is continuing to improve knowledge of the prawn fishery. Between 1983 and 1990 CSIRO investment was $26.1 million. Benefits in that same period amounted to $119 million.

Research into insect control also results in large benefits.

An Industries Assistance Commission report, for example, put estimated benefits of 13 insect control projects at $350.4 million up to the year 2000, for a 15-year investment of $32.9 million.

The projects ranged from research into termites and locusts, to blowflies and cattle ticks.

Controlling cattle ticks with a new vaccine developed by CSIRO and Biotech Australia Pty Ltd will help the beef industry to avoid more than $150 million in production losses and other costs each year. The research and development required to produce a commercial vaccine can take ten years, but the rewards are substantial.

Chickpeas and cotton

Consider another small object: the chickpea. Next time you see a bag of local chickpeas on the supermarket shelf or toss a handful into the weekend soup, you may be seeing the results of CSIRO research.

CSIRO developed the **Tyson** cultivar which, because of its improved performance, has helped the Australian chickpea industry to develop rapidly, adding value to food products.

So far, the benefits of CSIRO research, which cost $0.45 million, are in the $30 million a year chickpea industry.

Cotton farming is usually farming on a large scale. CSIRO's contribution has been equally large, both in new cotton varieties, which have already provided a benefit to the

industry of around $100 million, and in a computer-based management system.

Considerable benefits already flow from better management and in reduced use of pesticides.

The same computer management concept, which can cope with everything from pesticide levels to sudden rainstorms and regional soil peculiarities, has been adapted to other crops, to shrub control, and grazing management.

Adding value

It is now becoming accepted that Australian agriculture should add value to primary products through quality control and additional processing.

On that front CSIRO has been involved with Australian horticultural industries in examining a whole range of new products from fruits, nuts and ornamentals.

Already, new varieties have emerged which are better protected against pests and diseases.

By providing facilities for taste-testing in Japan, the CSIRO Sensory Research Centre is helping Australian food companies tailor their products specially for the $400 billion Japanese food market.

Foodstuffs are not the only rural exports that can have their value increased. Australia exports about 65% of cattle hides and more than 90% of woolly sheepskins in an unprocessed state, worth $630 million annually. The early processing stages hold the best potential for adding value; CSIRO is targeting these stages in research that takes into account both economic efficiency and reduction of effluents.

Forest potential

Australia's forests also have potential to increase their contribution to Australia's economy through import replacement and exports.

CSIRO has worked on increasing the productivity of pine and eucalypt plantations.

Research into radiata pine breeding, alone, represents a $2 million investment by CSIRO which has brought benefits of $7 million per year to the industry.

CSIRO developed the basis for the Australian hardwood pulp and paper industry by developing processes which allowed eucalypts to be used in paper making.

The establishment of a local industry means savings of hundreds of millions of dollars in imported paper.

Grass roots

CSIRO's rural research extends from the treetops to grass roots: in the north of Australia, tropical legume technology pioneered by CSIRO has moved from the laboratory into commercial practice.

About 500,000 hectares of new stylo varieties have been sown and an additional 70,000 are being planted each year.

Other varieties suited to drier and cooler areas mean additional future plantings of 100,000 hectares.

Benefits of this work are easy to measure: to date, there has been an increase in gross value of Queensland beef production of approximately $300 million.

Wine and cheese

Australian wine and cheese owe at least some of their market appeal to CSIRO.

Most Australian cheddar cheese is now manufactured with bacteriophage-resistant starter cultures, isolated in factory laboratories using technology developed by CSIRO.

The world's first continuous, automated cheesemaking system is **APV-SiroCurd**, developed by CSIRO with APV Baker. Its benefits include increased yield and uniform product quality. Plants are operating in Australia and in the USA and the annual benefits to Australian cheesemakers could eventually exceed $10 million.

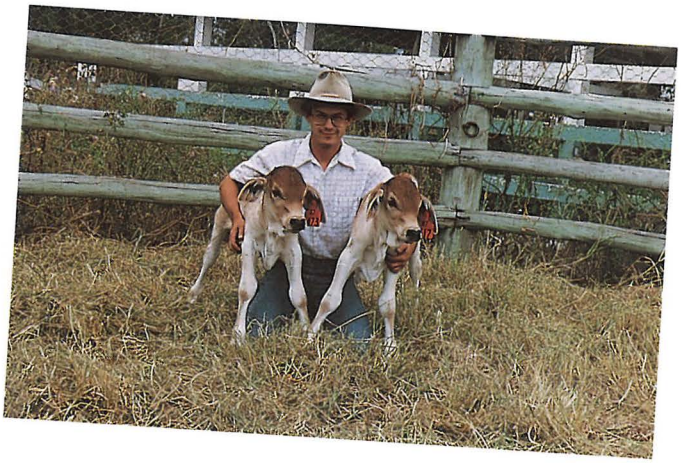
CSIRO has worked on better grape varieties for different wine styles, such as the **Tarrango** light red variety, and on more efficient winegrape production through mechanical harvesting and improved vine management.

This research is bringing an estimated $10 million each year in benefits from a CSIRO research expenditure of less than $2 million over 21 years.

Totalling it up...

Rural research makes up about 40 per cent of CSIRO's total research effort, costing the public purse on average around $150 million a year over the past 10 years.

The benefits of CSIRO's rural research, which flow to individual industries, consumers, processors and exporters, stretch into hundreds of millions of dollars each year.



PROJECT NOTE

CSIRO is investing $9 million a year in 14 projects aimed at developing vaccines to control pests and diseases in Australia's farm animals.

The estimated potential benefit of the work is $1.2 billion yearly — well over 100 times the cost of the research.

Targets for vaccine research include the sheep blowfly, cattle tick, worm parasites, the Australian paralysis tick (which can also affect humans), and diseases such as footrot and salmonellosis.

Vaccines are also being developed to control animal reproduction and growth.

One promising line of research may eventually enable animals to maintain condition even when feed is scarce.

While there can be a 10-year gap between research and a commercial product, vaccines in agriculture provide a long-term alternative to chemicals, and bring benefits to producers, consumers, the environment, and the animals themselves.

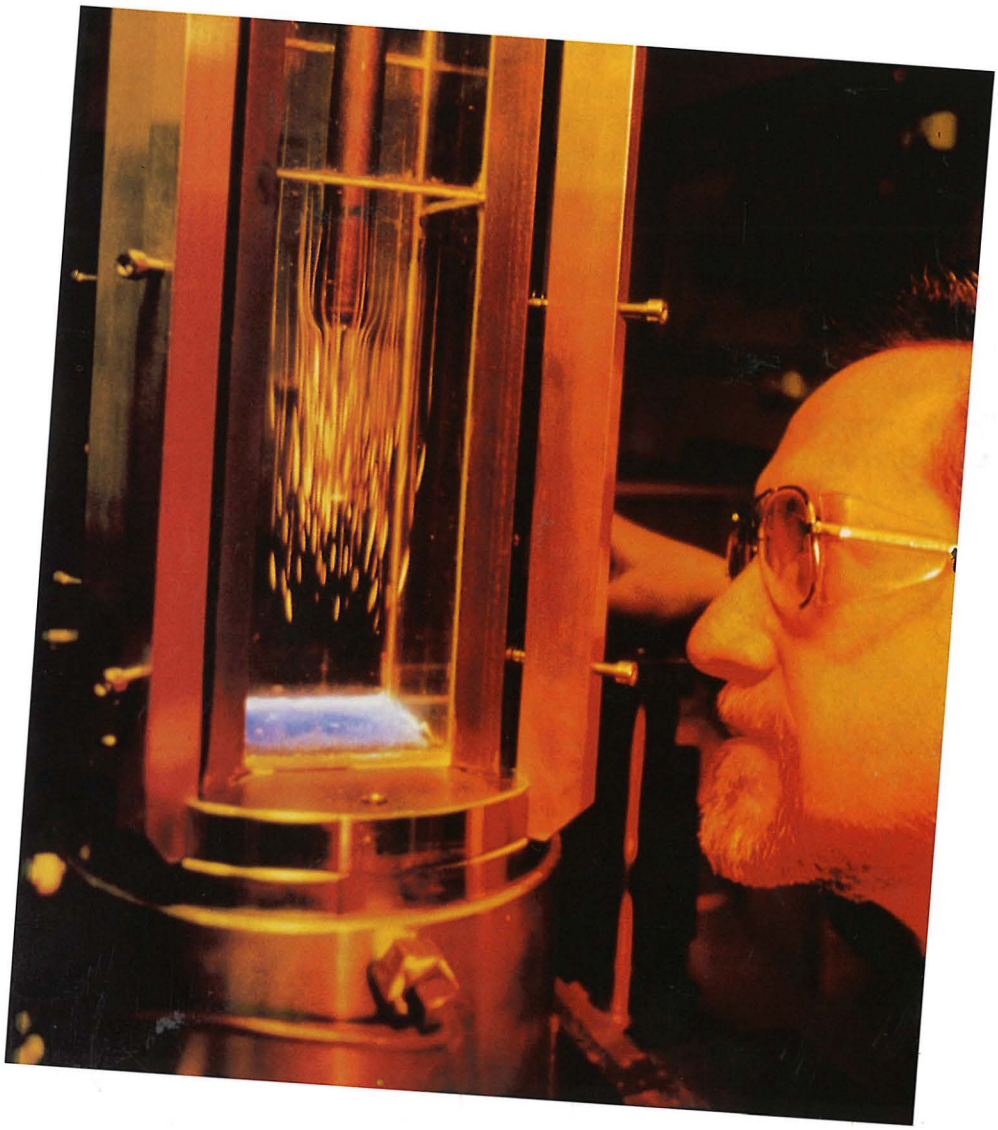
MINERALS AND ENERGY INDUSTRIES

Australia may be lucky that it has one of the world's richest stores of minerals buried beneath its surface.

However, these minerals are usually well hidden under a thick weathered surface unlike any other in the world and Australia has had to marshal the know-how to find, extract and process them. CSIRO has contributed innovative solutions to this problem as well as many other areas of the mining industry.

In a long association with the mining industry in Australia, CSIRO has made major contributions to exploration, mining and processing, which have helped make the industry one of the most competitive, safe and environmentally responsible in the world.

Finding Australia's mineral deposits is tough; overseas mineral exploration technology does not work well in Australia, so local techniques have to be developed.



Even the sophisticated Landsat satellite remote sensing technology, which has had outstanding success in mapping minerals in North America, has problems in Australia. Our weathered land surface and our sparse but ubiquitous vegetation make Australia a difficult target.

CSIRO developed sophisticated computing techniques to enhance satellite images. Not only has this helped Australian mineral exploration, but it makes Australia a world leader in the area of remote sensing.

Under the ground, the emphasis is on productivity and safety. CSIRO's work with a large consortium of mining companies has led to improved methods of large-scale ore extraction that are safer and more productive than those previously used.

CSIRO's research has had a high level of economic benefit to the industry.

Comparing costs and benefits, one consultancy study of six of the most successful projects in the minerals and energy area showed a return of $395 million from an investment of $80 million — a return rate nearly five times the original R&D expenditure.

Processing minerals

Australian ore deposits are chemically complex and contain high levels of impurities.

Imported technology and processing techniques therefore do not always work with Australian minerals, so CSIRO has played a leading role in developing new techniques.

CSIRO has contributed to a better understanding of the flotation process because, though it works brilliantly for simple ores, no-one has actually unravelled all the reasons why it does work. In some cases, CSIRO research has lifted mineral recovery from ore by 30 per cent.

Over a five year period, the benefit of the research for flotation processing has been quantified at $20 million compared to R&D costs of $6.9 million.

High-tech quality control

The **Coalscan** process is a good example of high technology harnessed to resource production. It allows on-line monitoring of the ash content of coal, Australia's biggest mineral export earner. The ash content — which determines how the coal burns — has more than scientific interest. Overseas buyers specify its amounts and when orders are measured in millions of tonnes, a fraction of a percentage point difference in ash content can mean million-dollar differences in profit.

The direct benefits of the **Coalscan** process have been assessed at $161 million over a 15-year period. The research and development cost was $12.9 million, which means a return of more than 8 times the original investment.

An additional benefit is that an Australian company, MCI Ltd, now makes **Coalscan** ash monitors and markets them very successfully in Australia and overseas.

PROJECT NOTE

Finding the largest deposit of magnesite in the Western World gives a mining company some interesting options.

It can dig up the magnesite and sell it as unprocessed ore for $100 million a year, or it can take a risk, try processing the ore in Australia, and develop an export industry that eventually could earn well over $500 million a year.

Queensland Metals Corporation (QMC) took the second choice with its deposit near Rockhampton in Queensland.

One of the factors (along with the quality of the deposit and the location) was the availability of CSIRO's expertise in mineral processing.

CSIRO had developed a process that produces high purity magnesium chloride, which can then be used to make magnesium metal. This process gives QMC a ready alternative to imported technology.

QMC is now developing a $120 million mine and plant with joint venture partners.

Ian Howard Smith, Managing Director of QMC, said of CSIRO's role: 'To realise the full commercial potential of the deposit, we must first bridge a technology gap. CSIRO is building that bridge.'

Cost-saving

Other benefits in the minerals and energy industries come from some decidedly unglamorous science.

The grinding and crushing of raw ore into the best particle size for processing, for example, can be a dirty and noisy process, and is not always efficient.

In the 1960s, CSIRO was able to describe mathematically what happened inside giant mill crushers. Using this knowledge to adjust feed rates, lead and zinc recovery levels at Broken Hill were improved by up to 1.5 per cent.

Over time, CSIRO work at the Renison mine brought a 5 per cent increase in tin recovery. Now the research is aimed at providing optimum specifications for new crushing plants, and allowing the use of smaller-scale tests to predict accurately large-scale performance. CSIRO now leads the world in this area.

In dollar terms, net benefits over the current 5 year period from the work on ore crushing amount to $93.5 million, compared to a research cost of $7.5 million. This has meant a return of over 12 times the original investment.

There are many other examples of large returns from comparatively small investments in CSIRO.

- CSIRO's work on developing a way to burn coal washery wastes and generate power at the same time is estimated to bring a $77 million benefit from a research and development cost of $21.1 million.
- For more than a decade, CSIRO has been working with industry to perfect an advanced bath smelting process called **SIROSMELT**. Two companies, MIM Ltd and Ausmelt, have been licensed to market the technology worldwide.
- A revolutionary instrument, **QEM*SEM**, which processes signals from a scanning electron microscope through a computer program is already into its second million dollars in sales overseas. Productivity gains through its use in mineral separation costs have been measured by a prive consultant at $22 million, well above R&D costs of $16.8 million.

As Australian minerals face tougher competition on world markets, Australian technology is clearly the key to a larger market share. CSIRO continues to provide major input to the technology.

MANAGEMENT AND CHANGE

CSIRO is geared to action: to respond to national scientific needs and to get the results of CSIRO research from the laboratory to industry and the community.

In recent years, CSIRO has seen many changes to its structure and operations, all aimed at sharpening its focus and improving communication with potential users of its research.

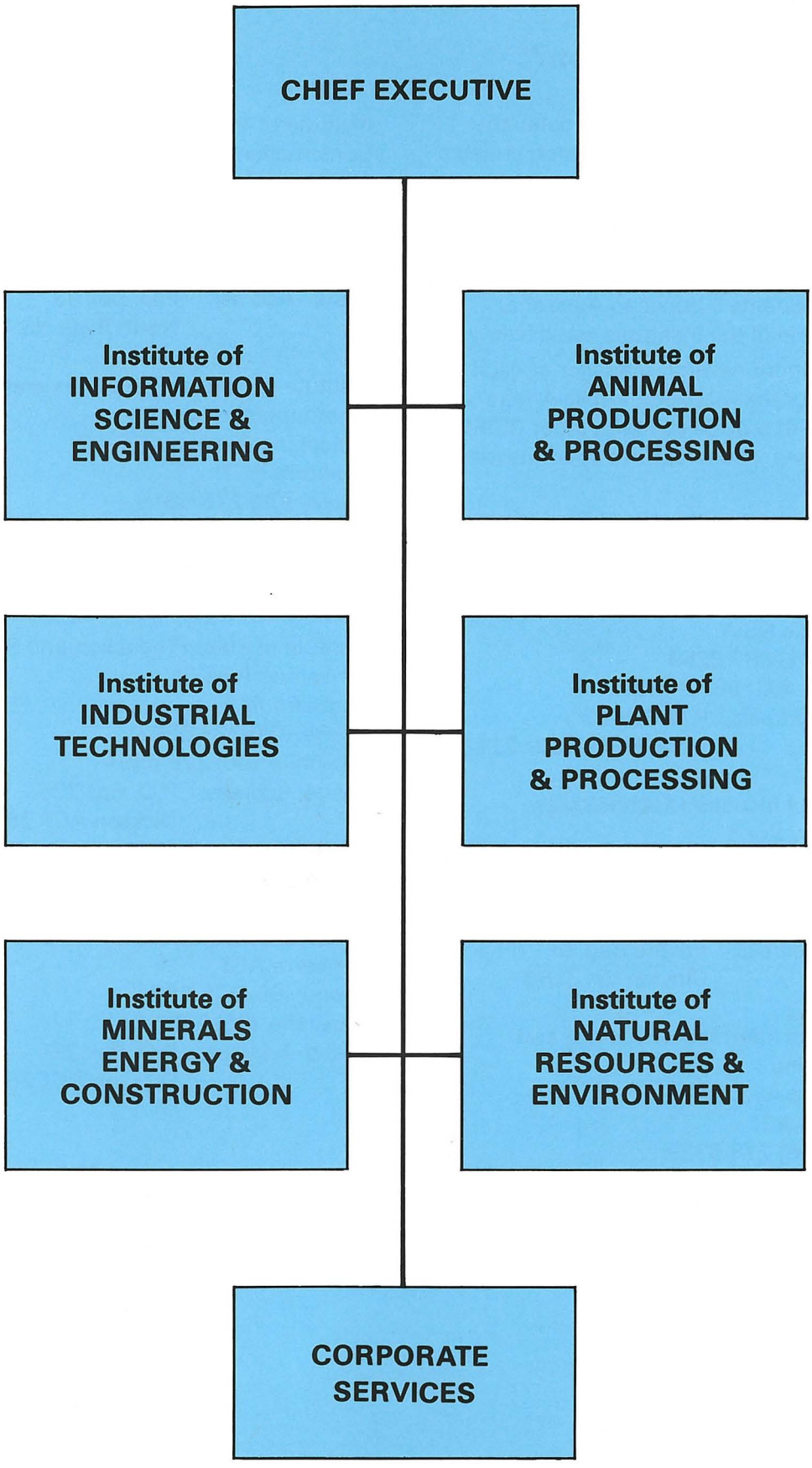
Since 1988, its research Divisions have been grouped into six Institutes, each reflecting a different industry or community sector.

With about 100 sites around Australia, CSIRO is close to many collaborators and users of research. They range from farmers, to miners, industry, and local authorities.

Good research depends on good management and sound policies. CSIRO sets its broad research priorities with a careful eye on economic, environmental and social benefits; research prospects and costs; and technology transfer, competitive advantage and community acceptability.

Project evaluation on a cost-benefit basis, regular progress assessment against objectives, and increased interaction with the people who will use the research are also important parts of the management framework. In the past CSIRO has undertaken evaluation studies on some of its work, particularly in the agricultural sector. More formal and structured evaluations have been introduced in recent years.

Sirotech Ltd, set up in 1984 to help commercialise CSIRO's research, has increased the number of patent applications lodged (174 in 1988–89) and negotiated many industrial contracts. The value of research sponsored in CSIRO by private companies reached over $33 million in 1989–90, whilst $74 million was earned from competitive government and industry funding schemes.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Institute of NATURAL RESOURCES & ENVIRONMENT
CORPORATE SERVICES

Need more information?

This booklet cannot cover in detail the many hundreds of CSIRO research projects or all the costs and benefits associated with those projects.

However, if you want additional information on CSIRO's work and the specific benefits it brings to Australia, contact one of the Institutes listed below.

The Communication Manager of each Institute or the Manager, Public Affairs, will be happy to provide you with other CSIRO publications, and to discuss your questions with you.

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Phone: (02) 887 8259
Facsimile: (02) 887 8260
Postal Address: P.O. Box 93
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Institute of Industrial Technologies
Normanby Road
Clayton, Victoria
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Institute of Information Science and Engineering
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